Relationship Between Teacher Formative Feedback Types, Self-Regulated Learning, And Perception of Feedback Among Chinese Public Middle School Students

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Abstract
The aim of this study was to determine the relationship between five types of formative feedback, self-regulated learning and perception of feedback and their respective levels. The study used proportional stratified random sampling method to select 558 students from four Chinese public secondary schools in Liaoning Province. A correlational research design was used and descriptive and Pearson correlation analyses were conducted. The results showed that the level of self-regulated learning was at a moderate level, while the other two variables were at a higher moderate level. Furthermore, bivariate correlation analysis indicated that there was a significant positive correlation between verification feedback, directive feedback, scaffolding feedback, teacher praise, self-regulated learning and perceptions of feedback, while there was no correlation for teacher criticism. In conclusion, this result revealed that students perceived the feedback at a higher level but perceived their self-regulated learning at a lower level. Except for teacher criticism, significant positive correlations were found between other formative feedback types and self-regulated learning and feedback perceptions. In practice, teachers should increase scaffolding feedback and teacher praise with task-specific information, and emphasize the development of student responsibility and self-regulated learning, working to create a more equal dialogue between teachers and students.
Keywords: Relationship, Teacher Formative Feedback Types, Regulated Learning, Perception Of Feedback, Students

Introduction
Teacher feedback is at the center of formative assessment instruction and, when used appropriately, can have a powerful and positive impact on student learning (Panadero & Lipnevich, 2022; Vattøy & Smith, 2019). Although feedback is effective in most cases, its

effectiveness still varies widely. Numerous studies have investigated the effectiveness of teacher feedback (Jonsson & Panadero, 2018; Van der Kleij & Lipnevich, 2020; Winstone, Nash, Parker, & Rowntree, 2016). The research generally suggests that some features of formative feedback contribute to students being more likely to utilize the feedback, while some features do the opposite (Lipnevich, Berg, & Smith, 2016). A growing number of researchers have argued that the quality of how learners perceive, engage with, and use feedback likewise determines the effectiveness of feedback (Van der Kleij & Lipnevich, 2020). Therefore, in order to gain a fuller understanding of the usefulness of feedback, this study will explore a narrower but important aspect of the inner workings of instructional feedback (Lipnevich & Smith, 2022).

Reviewing previous research, Winstone et al. (2016) were the first to introduce Johnson and Johnson's (1994) Interpersonal Communication of Model into the study of feedback effectiveness, conceptualizing giving and receiving in feedback mechanisms as a communicative activity. The feedback process is divided into three parts, i.e., the sender (the source of feedback, the teacher or the student, etc.), the message (the feedback itself), and the receiver (the learner). Specifically, the teacher delivers the feedback in the form of a message to the learner, who interprets the message through self-regulation and produces a psychological or behavioral response. This is a cyclical and dynamic process, and problems at any one point will lead to the failure of teacher-student communication (Winstone et al., 2016).

Also, more recently, in Lipnevich and Smith's (2016, 2022) Student - Feedback Interaction Model, researchers have emphasized that feedback effectiveness research should focus more on students' overall processing rather than on a step-by-step understanding of how feedback is processed. Meanwhile, the model also lists the factors that may affect students emotionally, cognitively, and behaviorally from four perspectives: context, source of feedback, teacher characteristics, and student characteristics. The type of teacher feedback and students' self-regulated learning abilities are also central to the model (Lipnevich et al., 2016; Lipnevich & Smith, 2022). Van der Kleij (2020) further reviewed 164 existing studies and defined students' affective and cognitive responses to feedback as "perception of feedback", which were incorporated into Lipnevich's model, and suggested that students' perceptions of feedback determine later behavioral engagement with feedback. Therefore, this study will also delve into the relationship between different types of formative feedback, self-regulated learning, and feedback perceptions in order to understand the underlying mechanisms of how feedback works.

Formative Feedback

Formative feedback refers to any type of information related to academic performance that a teacher provides to students during the learning process, with the primary purpose of closing the gap between the student's current state and the goal (Hattie & Timperley, 2007; Panadero & Lipnevich, 2022; Shute, 2008). Research has generally recognized that teacher feedback has four functions: verification, directive, scaffolding, and motivational functions (Finn & Metcalfe, 2010; Wenjuan Guo & Wei, 2019; Kluger & DeNisi, 1996; Kulhavy & Stock, 1989; Lipnevich & Smith, 2009; Shute, 2008). Guo (2017) systematically reviewed and studied teachers' written and verbal feedback and categorized it into five types: verification feedback, directive feedback, scaffolding feedback, teacher praise, and teacher criticism. Specifically, verification feedback refers to providing students with information containing correct or incorrect dichotomous judgments, grades, or rankings. Directive feedback refers to providing

students directly with the correct answer or solution to a problem. Scaffolding feedback refers to helping students find solutions on their own by providing successive prompts, modeling, or demonstrations. Teacher praise refers to all forms of praise for positive learning attitudes and actual performance, while teacher criticism, on the contrary, refers to all negative reactions to a student's attitude, performance, or behavior. Verification feedback is the most common form of feedback used by teachers in Chinese classrooms. The survey also shows that teachers are used to not giving students time to think and tend to provide students with solutions to problems directly. With the deepening of China's education reform, the frequency of scaffolding feedback and teacher praise has increased significantly (W. Guo, 2020; Wenjuan Guo, Lau, & Wei, 2019; Wenjuan Guo & Wei, 2019). However, few studies have investigated teachers' formative feedback in China's education resource-poor areas, so this study will also focus on this point.

Self-Regulated Learning
Self-regulated learning, as one of the essential skills for personal development, is seen not only as a dynamic learning process, but also as a relatively stable learning competency over a period of time (Panadero, 2017; Schunk & Zimmerman, 1997). In parallel, the student stage requires full mastery of self-regulated learning competencies, which is a central manifestation of effective engagement in the learning process. Despite the lack of a unified definition of self-regulated learning in extant models or frameworks (Butler & Winne, 1995; Pintrich, 2000; Schunk & Zimmerman, 1997), researchers are largely consistent in summarizing the core points involved in self-regulated learning. "Self-regulated learning" has been defined as the combination of a set of learner's abilities to actively monitor, manage, and utilize cognitive strategies, metacognitive strategies, and learning motivation to achieve learning goals in response to the interactions of social situations. Self-regulated learners generally have a high sense of self-efficacy and motivation to learn, and are able to effectively employ cognitive and metacognitive strategies to successfully decode and encode new information, thereby generating internal feedback, self-evaluation, and self-reward and punishment (Adie, van der Kleij, & Cumming, 2018). In China, the contemporary education system focuses on both students' academic achievement and competency development, and views the development of self-regulated learning as central to the development of all competencies. Adolescence is widely regarded as a critical period for the development of self-regulated learning (Andrade & Brookhart, 2016). Therefore, it is necessary to explore in depth the self-regulated learning ability of secondary school students.

Perception of Feedback
Feedback perception refers to how students understand, perceive, and value feedback, as well as how they experience and receive feedback from cognitive and affective perspectives (Van der Kleij & Lipnevich, 2020). This concept focuses on students' subjective cognitive and affective experiences of feedback rather than on the interpretation of feedback in a generalized sense. The study noted that students' perception of feedback is considered one of the most influential factors in determining the feedback effectiveness (Havnes, Smith, Dysthe, & Ludvigsen, 2012; Mayordomo, Espasa, Guasch, & Martínez-Melo, 2022; Winstone et al., 2016). The importance of positive feedback perceptions as the first step towards students' successful participation in the teacher feedback process also reflects students' sense of responsibility in the feedback process. However, studies at different learning stages have found that students do not perceive teacher feedback as positively as teachers expected

(Havnes et al., 2012; Jónsson, Smith, & Geirsdóttir, 2018). When confronted with specific feedback, students may accept it positively and perceive it as objective, relevant, and helpful, or they may display an attitude of criticism, deconstruction, or rejection. More specifically, the manner in which teachers provide feedback has a limited impact on students' attitudes toward perceived feedback. Even if the feedback is perfect, it will not be effective in improving academic performance if students are not able or willing to use it (Van der Kleij & Lipnevich, 2020). Therefore, there is a need to investigate feedback perceptions.

Relationship Between Formative Feedback and Perception of Feedback
Formative assessment is recognized as one of the most promising approaches to improving learning (Rakoczy et al., 2019; Schildkamp, van der Kleij, Heitink, Kippers, & Veldkamp, 2020). There are at least two dozen critical models and reviews describing the essential role of formative feedback in the learning process (Lipnevich & Panadero, 2021; Panadero & Lipnevich, 2022). Numerous empirical studies have shown that students prefer feedback that contains practical information, and that scaffolding that provides more hints and modeling has a more positive predictive effect on student use of feedback (Hattie & Timperley, 2007; Klapp & Jönsson, 2021; Kyaruzi, Strijbos, Ufer, & Brown, 2019; Lipnevich et al., 2016). There was also a significant positive correlation between verification and directive feedback and students' perceptions of the feedback (Wang & Zhang, 2020). Students generally preferred verification feedback that gave time for independent thinking despite only providing right and wrong judgments than directive feedback that provided the correct answer immediately.
Finally, involving both types of motivational feedback, teacher rewards are generally thought to be significantly related to student perceptions, involvement, and achievement. Lipnevich and Smith (2009) concluded that praise promotes student emotions and motivation, which in turn positively affects feedback perceptions, but does not directly promote learning. Compared to being praised by the teacher, students are more concerned about being criticized in public, and the negative impact of criticism on students' evaluation of the teacher may even be magnified, which in turn decreases subsequent engagement in feedback processing (Thompson, Wiedermann, Herman, & Reinke, 2021). In conclusion, despite the existence of a large body of research on different types of feedback, more research has explored the relationship between teacher feedback and student ability or achievement. There is clearly a gap in systematic research on the relationship between different types of feedback and students' perceptions. Therefore, there is a need for further research on the relationship between different types of formative feedback and corresponding student perceptions.

Relationship Between Formative Feedback and Self-Regulated Learning
Formative feedback plays an integral role in shaping students' ability to self-regulate their learning. According to social cognitive theory, self-regulated learning is influenced by the social environment (Bandura, 2014). For adolescents in the learning stage, teacher feedback is considered to be one of the most important environmental factors influencing students' self-regulated learning (Hattie & Timperley, 2007). Numerous empirical studies have shown that scaffolding feedback is the most effective type of teacher feedback for promoting student learning ability (Finn & Metcalfe, 2010; Wenjuan Guo et al., 2019). Scaffolding feedback encourages students to find answers to questions on their own. It helps students gradually master certain learning tools and cognitive and metacognitive strategies by providing them with certain clues and hints to solve difficult problems in learning, so as to

gain the ability to learn independently (Shvarts & Bakker, 2019). Research has shown that scaffolding feedback is effective in increasing students' use of cognitive and metacognitive strategies and improving their intrinsic motivation and self-efficacy in learning (Kyaruzi, Strijbos, Ufer, & Brown, 2018).

Different from scaffolding feedback, studies on the effects of verification and directive feedback are not consistent. Both may have a hindering effect on learning motivation due to providing only scores or direct answers, which mainly promote the development of students' cognitive and metacognitive abilities (W. Guo, 2020; Wenjuan Guo & Wei, 2019). Additionally, teachers' sincere praise can significantly increase students' motivation and self-efficacy. Research suggests that if students perceive teacher feedback as positive, its negative impact on other aspects of student learning may be attenuated (Harris, Brown, & Dargusch, 2018). Thus, teacher praise following success may be associated with more self-regulated learning skills (W. Guo, 2020). In contrast, teacher criticism typically decreases students' intrinsic motivation and self-efficacy (Atlas, Taggart, & Goodell, 2004), especially for students who are sensitive to the fact that teacher criticism may even prevent them from developing other strategies for self-regulated learning. However, these results are more likely to come from the West, and it needs to be further explored whether they would be different in a collectivist culture in China, particularly in some of the more resource-poor areas.

Relationship Between Self-Regulated Learning and Perception of Feedback

Self-regulated learning is recognized as an irreplaceable personal characteristic associated with learning and a necessary skill for lifelong learning. Several studies suggest that self-regulated learning determines whether and how students perceive and use feedback (Adie et al., 2018; Van der Kleij & Lipnevich, 2020; Vattøy & Smith, 2019). Nicol and Macfarlane (2006) have concluded that implementing feedback requires proficient self-regulation skills. Beginning learners who lack the necessary learning skills not only have difficulty making accurate judgments about the quality of feedback, but also often fail to accept external feedback in a timely manner in order to improve future academic performance (Eva et al., 2012). Orsmond and Merry (2013) further concluded that high-achieving students exhibit more self-regulatory behaviors when receiving feedback compared to lower-achieving students. They were adept at integrating teacher feedback into their goals, were able to develop self-motivation, and appropriately used cognitive and metacognitive strategies for self-assessment. Engaging in the feedback process also further facilitated the relationship between self-regulated learning and feedback perception.

Several studies have also explored the relationship between components of self-regulated learning and perceptions of feedback. Correlation analyses have shown significant positive correlations between students' perceptions of the usefulness of feedback and students' motivation, self-efficacy, goal orientation, and self-management (Van der Kleij & Lipnevich, 2020; Vattøy, 2020). Students with higher levels of self-efficacy (Rakoczy et al., 2019; Zumbrunn, Marrs, & Mewborn, 2016), intrinsic motivation (van der Kleij, 2019), and self-management were more willing to learn from feedback, which in turn resulted in more positive feedback perceptions. Furthermore, Zhang and Zheng (2018) argued that learners with different learning characteristics perceive feedback differently and that it is necessary for students to be aware of their role as agents. Shortly after, Van der Kleij (2019) also demonstrated that students' self-reported self-efficacy, intrinsic value, and self-regulation predicted their perceptions of feedback quality. Rakoczy and his colleagues (2019) noted that as long as German secondary school students perceived feedback as useful, their self-efficacy

and motivation to learn will increase. However, reviewing research on feedback perception, the role of the student is often overlooked and the effect of student self-regulation of learning is not emphasized. Therefore, this study will also explore the relationship between self-regulated learning and perception of feedback.

Research Questions and Hypotheses

There have been a large number of studies investigating the relationship between formative feedback and self-regulated learning, but few studies have explored the relationship between formative feedback, self-regulated learning, and feedback perceptions from the perspective of students receiving feedback. It is meaningful to understand the intrinsic relationship between them for effective assimilation of feedback to promote students' learning and enhance their sense of responsibility. However, the relevant literature is very sparse and even somewhat disjointed, and thus there is an urgent need to take action to fill this gap. Therefore, this study aims to explore the following issues:

(1) What is the perceived level of teacher formative feedback types, self-regulated learning, and perception of feedback among Chinese public middle school students?

(2) Is there any significant relationship between teacher formative feedback types, self-regulated learning, and perception of feedback among Chinese public middle school students?

The research hypotheses of this study are as follows:

H1: There is a significant relationship between teacher formative feedback types and perception of feedback among Chinese public middle school students

H2: There is a significant relationship between teacher formative feedback types and self-regulated learning among Chinese public middle school students

H3: There is a significant relationship between self-regulated learning and perception of feedback among Chinese public middle school students

Methodology

Research Design

The purpose of this study was to determine the relationship between five types of formative feedback, self-regulated learning, and perceptions of feedback among Chinese public middle school students. Therefore, this study utilized a correlational research design to investigate the possibility of a relationship between these variables without attempting to influence or manipulate them.

Sampling Technique

In this study, 558 students were selected from four public secondary schools in Kazuo County, Liaoning Province, China by using proportional stratified random sampling method. After stratified sampling, the sample sizes of the four schools were calculated to be 122, 127, 150 and 159 respectively. The final valid questionnaires were 546 (97.8% recovery rate). Of these, 48% (262) were girls and 52% (284) were boys with a mean age of (13.30±1.13) years ranging from 11 to 17 years. There were 181 students (33.2%) in grade seven, 184 students (33.7%) in grade eight and 181 students (33.2%) in grade nine. Finally, the four schools had 121 (22.2%), 124 (22.7%), 145 (26.6%), and 156 (28.6%) students, in that order.

Instruments

Assessment Experience Questionnaire (AEQ)

Assessment Experience Questionnaire (AEQ) will be adopted investigate students' perceptions of feedback in Mathematics (Gibbs & Simpson, 2003; Gibbs, Simpson, & Macdonald, 2003; Van der Kleij & Lipnevich, 2020). This questionnaire has six dimensions. According to the purpose of this study, only two of these dimensions, including the quality of feedback and the use of feedback, will be selected. The questionnaire has 12 items, six of which are related to the quality of feedback (QF) and six of which are related to the use of feedback (FU). Students rated the level of agreement for each item on a five-point Likert scale (1=strongly disagree, 5=strongly agree). Of these, items 5, 6,9, 11, and 12 are reversed items. The mean of each component will be used to measure perceptions of feedback, with higher scores indicating stronger perceptions of feedback. After confirmatory factor analysis (CFA), the model fit statistics ($\chi 2/df$ = 3.478; GFI = 0.969; AGFI = 0.941; CFI = 0.974; IFI = 0.974; TLI = 0.961; RMSEA = 0.067) were good. The reliabilities of the QF and the FU were 0.81 and 0.85, respectively. Overall feedback perceptions of the Cronbach's alpha coefficient were 0.83. Thus, the validity and reliability of the scale met the measurement requirements.

Teacher Feedback Questionnaire (TFQ)

The Teacher Feedback Questionnaire (TFQ) will be used to measure the students' perceived frequency of each type of feedback given by students in math (Wenjuan Guo, 2017). The questionnaire consists of 24 items which include five types of formative feedback, 5 items for verification feedback (VF), 5 items for directive feedback (DF), 4 items for scaffolding feedback (SF), 5 items for teacher praise (TP) and 5 items for teacher criticism (TC). Students rated the frequency of feedback on a 6-point Likert scale (1 = never, 6 = always). The mean of each feedback type item will be calculated separately, with larger numbers indicating a higher frequency of using the formative feedback type. After confirmatory factor analysis (CFA), the model fit statistics ($\chi 2/df$ = 2.587; GFI = 0.923; AGFI=0.900; CFI = 0.939; IFI = 0.940; TLI = 0.929; and RMSEA = 0.054) were good. The reliabilities of VF, DF, SF, TP and TC were 0.81, 0.87, 0.79, 0.80, and 0.81 respectively. Thus, the validity and reliability of the scale met the measurement requirements.

Motivated Strategies for Learning Questionnaire (MSLQ)

The revised version of the Motivated Strategies for Learning Questionnaire (MSLQ) adjusted by Guo (2017) will be adopted to measure students' self-regulated learning in mathematics (Wenjuan Guo, 2017; Pintrich, 2000). The questionnaire has 36 items, 16 items for cognitive strategies (CS), 10 items for metacognitive strategies (MS), and 10 items for motivation (M). Students rated the level of agreement for each item on a 7-point Likert scale (1 = strongly disagree, 7 = strongly agree). The mean of the items for each dimension will be calculated separately, with larger numbers indicating greater use of self-regulated learning strategies or greater motivation to learn. After confirmatory factor analysis (CFA), the model fit statistics ($\chi 2/df$ = 2.469; GFI = 0.885; AGFI=0.865; CFI = 0.915; IFI = 0.916; TLI = 0.906; and RMSEA = 0.052) were good. The reliabilities of CS, MS and M were 0.89, 0.88, and 0.88 respectively. The Cronbach's alpha coefficient for overall Self-regulated learning was 0.95. Thus, the validity and reliability of the scale met the measurement requirements.

Data Collection Procedure

The researcher collected the data from September to December 2022 after obtaining ethical approval from the Ethics Committee of the Graduate School of Universiti Putra Malaysia (JKEUPM). During the questionnaire collection process, the researcher first explained the purpose, process, anonymity and confidentiality of the study to the respondents. Students, as volunteers, decided whether or not to participate in the study. Only students who agreed to participate in the study were allowed to complete the questionnaire. The researcher then supervised the respondents as they took the tests. It took approximately 15 minutes to complete the three questionnaires. Finally, all questionnaires were collected immediately after completion. After all questionnaires were distributed, the researcher entered them into the computer.

Data Analysis

There were seven variables in this study, including verification feedback, directive feedback, scaffolding feedback, teacher praise and teacher criticism, self-regulated learning, and perceptions of the feedback. In the data analysis, each of the seven variables was represented by a latent variable with its corresponding item as an indicator. Descriptive and Pearson correlation analyses were conducted using the SPSS 22. Prior to the correlation analyses of the latent variables, confirmatory factor analyses of the seven factors mentioned above were conducted by AMOS 24 in order to test the measurement models of the latent variables. Any items that did not meet the standardized factor loading criteria (values less than 0.5 or values greater than 1) needed to be removed or linked to items with higher modification indices (MI). In the confirmatory factor analysis of the three constructs, 11 items were removed from the CFA model due to low factor loading or high correlations with other items, including four items on perceptions of feedback (items POF5, POF6, POF11, and POF12), three items on formative feedback (items VF1, TP5, and TC5), and four items on self-regulated learning (Item SRL16, Item SRL19, Item SRL26 and Item SRL27). The remaining items will be followed up with descriptive statistics and correlation analysis.

Results

Descriptive Statistics

The descriptive statistics were displayed in Table 1. As shown in the table, the overall level of teacher feedback is moderately high. Verification feedback (M=4.88, SD=0.88) dominated in the actual teaching and learning environment, with scaffolding feedback (M=4.62, SD=0.87) following closely behind. Next, directive feedback (M=4.25, SD=0.88) and teacher praise (M=4.33, SD=1.07) were both moderate and very close in frequency. Lastly, teacher criticism (M = 3.71, SD = 1.23) was the least used type of feedback. In addition, according to Oxford (1990), students' self-regulated learning (M = 4.35, SD = 1.06) was moderate level. Among the three corresponding dimensions, motivation (M = 4.60, SD = 1.17) was at the highest level, followed by metacognitive strategies (M = 4.41, SD = 1.19) and cognitive strategies (M = 4.17, SD = 1.10). Finally, perceptions of feedback (M = 3.78, SD = 0.58) were also at a moderately high level, with similar levels of the quality of feedback (M = 3.82, SD = 0.64) and use of feedback (M = 3.74, SD = 0.74) dimensions.

Table 1
Descriptive Statistics for Each Component of the Variable

	Minimum	Maximum	M	SD	Skewness	Kurtosis
Cognitive strategies (CS)	1.00	7.00	4.17	1.10	-0.05	-0.29
Metacognitive strategies (MS)	1.00	7.00	4.41	1.19	-0.06	-0.35
Motivation (M)	1.00	7.00	4.60	1.17	-0.30	-0.42
Quality of feedback (QF)	1.00	5.00	3.82	0.64	-0.58	0.71
Use of feedback (FU)	1.50	5.00	3.74	0.74	-0.59	0.27
Verification feedback (VF)	1.75	6.00	4.88	0.88	-0.85	0.33
Directive feedback (DF)	1.60	6.00	4.25	0.88	-0.33	-0.41
Scaffolding feedback (SF)	2.00	6.00	4.62	0.87	-0.50	-0.24
Teacher praise (TP)	1.00	6.00	4.33	1.07	-0.63	0.22
Teacher criticism (TC)	1.00	6.00	3.71	1.23	-0.12	-0.76

Pearson Correlation Analyses

The bivariate associations between study variables were displayed in Table 2. There was a significant positive correlation between verification feedback, directive feedback, scaffolding feedback, teacher praise, self-regulated learning and perceptions of feedback, while teacher criticism was not significantly relevant to self-regulated learning and perceptions of feedback. Specifically, verification feedback, directive feedback, scaffolding feedback, and teacher praise was positively correlated with students' self-regulated learning (r = .45; p<.05), (r = .35; p<.05), (r = .42; p<.05), and (r = .27; p<.05) respectively. Additionally, verification feedback, directive feedback, scaffolding feedback, and teacher praise was positively correlated with students' perceptions of feedback (r = .39; p<.05), (r = .19; p<.05), (r = .39; p<.05), and (r = .23; p<.05) respectively. Finally, students' self-regulated learning was also positively correlated with perceptions of feedback (r = .45; p<.05).

Table 2
Means, Standard Deviations and Correlations between Key Variables

Variables	M	SD	VF	DF	SF	TP	TC	SRL	POF
VF	4.88	0.88	-						
DF	4.25	0.88	.381**	-					
SF	4.62	0.87	.608**	.414**	-				
TP	4.33	1.07	.396**	.303**	.519**	-			
TC	3.71	1.23	.085*	.154**	.090*	0.059	-		
SRL	4.35	1.06	.453**	.349**	.418**	.267**	-0.013	-	
POF	3.78	0.58	.388**	.192**	.394**	.230**	-0.026	.446**	-

Note. n = 546. **p < .01. (two-tailed), *p < .05. (two-tailed).

VF = Verification feedback; DF = Directive feedback; SF = Scaffolding feedback; TP = Teacher praise; TC = Teacher criticism; SRL = Self-regulated learning; POF = Perceptions of feedback

Discussion
This study explored level of teacher formative feedback types, self-regulated learning, and perception of feedback in mathematics and the relationship between these three constructs among Chinese public middle school students. The results demonstrate that all three hypothesized relationships are validated.

Level of Formative Feedback, Self-Regulated Learning, and Perceptions of Feedback
The study showed that all five types of formative feedback, feedback perception, and students' self-regulated learning were at moderate levels, while the first two variables were at upper-moderate levels. First, as shown in the table, consistent with previous hypotheses, verification feedback was the most common type of formative feedback used by teachers during instruction (Wenjuan Guo et al., 2019; Wenjuan Guo & Wei, 2019). Guo (2020) suggested that this phenomenon may be related to the its brevity and the class size of Chinese classrooms. It is difficult for teachers to take care of every student within the class, but providing only right or wrong answers not only reduces the teacher's workload, but also promotes students to think independently to find the answers, especially in math teaching.
Next, it is exciting that scaffolding feedback comes in second place in terms of frequency of occurrence, which is also consistent with Guo et al. (2019). This may be attributed to the fact that teachers realize that providing hints within the students' the "zone of proximal development" in the writing of L.S. Vygotsky is more conducive to students' learning as a result of the deepening education reform (Shvarts & Bakker, 2019). Therefore, it is necessary to allow students to actively search for answers based on models or clues provided by the teacher during the regular teaching and learning process. In addition, the frequency of directive feedback is at a moderate level, which is higher than expected. It may be because this study investigates the subject of mathematics, which is the study of concepts such as quantity, structure and space and their variations. Unlike other social sciences, mathematical problems are supported by logically rigorous correct answers. Therefore, providing directive feedback clarifies students' conceptualization of knowledge. Surprisingly, the extent of directive feedback and teacher praise was almost the same. Inconsistent with previous conclusions, the researcher argues that teachers are more inclined to praise students to improve learners' motivation (Shute, 2008). Finally, in line with expectations and previous research, teacher criticism was the least used type of feedback (Wenjuan Guo et al., 2019).
In this study, students in this school district had moderate levels of self-regulated learning. Students had the highest level of intrinsic motivation and self-efficacy, followed by metacognitive strategies and cognitive strategies. This indicates that students' mastery of cognitive and metacognitive strategies is insufficient. Moreover, it is worth noting that the Likert scale measures the frequency of formative feedback on a 6-point scale, while students rated the self-regulated learning scale on a 7-point scale, but both measured about the similar score. The reported mean values for scaffolding feedback and verification feedback were also higher than all dimensions of self-regulated learning. This may be due to the fact that the study was conducted in a resource-poor area where self-regulated learning is relatively weak (Wenjuan Guo et al., 2019).
Finally, students' personal perceptions of teacher feedback were at a medium-high level, indicating that students recognized and held positive attitudes toward teacher feedback.

When comparing the two dimensions, students' perceptions of the quality of feedback were slightly higher than their perceptions of facilitating the use of feedback. This may be due to students' lower perceptions of their self-regulated learning ability, which in turn affects the future use of facilitative feedback (Vattøy & Smith, 2019). Therefore, the results of this study suggest that students rated the instructor's feedback higher than they rated their level of learning ability. Students were more concerned with the feedback provided by their teachers and neglected their own competence. Therefore, there is a need to enhance students' ability to self-regulate their learning.

Relationship between Formative Feedback and Perception of Feedback
The hypothesis one of this study is to prove the significantly relationship between five teacher formative feedback types and perception of feedback among Chinese public middle school students. The results concluded that verification feedback, directive feedback, scaffolding feedback, and teacher praise were each significantly and positively correlated with students' feedback perceptions, except that the correlation was not strong, while there was no significant correlation between teacher criticism and perception of feedback. Thus, hypothesis one was partially accepted. Next, a two-by-two comparative discussion based on the frequency of perceived feedback is presented here.

The more frequent verification and scaffolding feedback were explored first. The results of this study showed that the higher the frequency of verification and scaffolding feedback, the more positive students' attitudes towards receiving feedback, the more they recognized the quality of the feedback, and the more they promoted its future use. Although the correlation coefficients were very close, it can still be determined that scaffolding feedback has a slightly higher correlation, especially when verification feedback dominated the actual teaching process. This result is consistent with the research results of Kyaruzi et al. (2019) and Klapp et al. (2021), which believe that scaffolding feedback is more conducive to students' active perception and use of feedback. This result confirms previous research indicating that students prefer scaffolding feedback that provides more detailed instructions, hints, and references (Andrade & Brookhart, 2016). This result also can be better understood by the theory of students' zone of nearest development (Shvarts & Bakker, 2019). Scaffolding feedback makes teacher feedback out of reach, easier to manipulate, and achieves more tangible results. Similarly, verification feedback plays an equally important role in learning, with clear consequential information helping students to clarify their current level of knowledge and providing direction for further improvement.

Next, directive feedback and teacher praise were compared. Both were weakly and positively correlated with students' perceptions of feedback, but the correlation was greater for teacher praise. Consistent with previous research, even though teacher praise rarely provides knowledge-related information, students still prefer to receive rewards from external sources (Faulconer, Griffith, & Gruss, 2021; Lipnevich & Smith, 2008). In addition, the findings suggest that students still need directive feedback from teachers, even if the correlation is low. This result is different from previous research, which usually considers that this kind of feedback is often not fully understood by students (Muliyah, Rekha, & Aminatun, 2020). This may be because that directive feedback that provides correct answers can promote rigor in students' mathematics learning. Finally, regarding the relationship between teacher criticism and perception of feedback, the results of this study are different from most studies, showing that there is a negative but not significant correlation between the two. This may have something to do with China's latest education reform, which explicitly calls for less criticism in the

classroom. Further, Guo (2019) pointed out that currently Chinese teachers usually provide negative feedback in a softer way to protect students' self-esteem. Thus, although the students felt uncomfortable with the teacher's criticisms, they did not show any obvious strong negative reactions.

Relationship between Formative Feedback and Self-Regulated Learning

The hypothesis two of this study is to prove the significantly relationship between five teacher formative feedback types and self-regulated learning among Chinese public middle school students. The results showed that verification feedback, directive feedback, scaffolding feedback, and teacher praise were each significantly and positively related to students' self-regulated learning, while again there was no significant correlation between teacher criticism and self-regulated learning. Thus, hypothesis two was also partially tested.

Similarly, the more frequent verification feedback and scaffolding feedback were explored first. Both the verification and scaffolding feedback were positively correlated with self-regulated learning at a moderate strength, suggesting that they promote the development of students' self-regulated learning. The more frequent that both types of feedback are provided, the more self-regulated learning students demonstrated. Interestingly, the results were in contrast to the correlation with feedback perception, with verification feedback being more highly correlated with self-regulated learning. That is, verification feedback may have a stronger positive effect on self-regulated learning. Although previous studies have found that verification feedback and scaffolding feedback have positive effects on self-regulated learning, it is generally believed that scaffolding feedback is more meaningful to improve students' learning (Andrade & Brookhart, 2016; Finn & Metcalfe, 2010). It also could be explained by the specificity of math. Math problems commonly examine only certain knowledge points and have clear answers. Verification feedback provides both the correct answer and the space for students to think independently. Scaffolding feedback, on the other hand, provides relatively vague guidance, and too much scaffolding may slow down students' progress in independent exploration (Lipnevich et al., 2016; Shute, 2008).

In addition, directive feedback and teacher praise were compared. Both showed positive and weak correlations with students' self-regulated learning, with directive feedback showing a greater correlation. Although they were both positively correlated with students' self-regulated learning, directive feedback that provided task-specific information was shown to be more conducive to improving students' competence. Lipnevich and Smith's (2009) argument that praise positively affects mood and motivation but does not directly contribute to the development of learning competence was validated. Finally, the relationship between teacher criticism and self-regulated learning is also negative but not significant. Guo (2019) also came to the same conclusion, arguing that teacher criticism has no significant negative predictive effect on self-regulated learning. In addition to teachers' tendency to provide negative comments in a gentler manner, it might also be explained by cultural differences between China and the West. In a collectivist culture, teachers' public criticism may cause Chinese students to feel a strong sense of shame, but this discomfort instead learning is facilitated (Wong & Tsai, 2007). The negative impact of teacher criticism and the positive impact of promoting students' active learning form an offsetting relationship, resulting in no significant negative relationship between teacher criticism and students' self-regulated learning.

Relationship between Self-Regulated Learning and Perception of Feedback

The hypothesis three of this study is to prove the significant relationship between self-regulated learning and perception of feedback among Chinese public middle school students. The results of the study showed that there was a significant moderate correlation between students' self-regulated learning and feedback perception. Thus, hypothesis three was confirmed. This result suggests that the higher the level of students' self-regulated learning, the more positively they perceive teacher feedback, which is consistent with previous studies (Rakoczy et al., 2019; van der Kleij, 2019; Vattøy & Smith, 2019; Winstone et al., 2016). That is, high level self-regulated learners tend to recognize the quality of teacher feedback, can extract useful information from the feedback according to their own situation and incorporate it into their set goals, and make full use of the feedback in their future learning process. Furthermore, according to social cognitive theory, self-regulated learners are good at observing, imitating, and learning from their environment, and ultimately transform external feedback into internal feedback and are ready to engage in the learning of new knowledge (Bandura, 2014; Butler & Winne, 1995; Schunk & Zimmerman, 1997). In this process, students regard themselves as agents of learning, actively seek feedback from teachers, and feel the role and value of feedback information. While self-regulation of learning ability is improved, students will also have a deeper feeling of the teacher's feedback information, so that they can make a more positive evaluation of the teacher's feedback information.

Of interest is the fact that the correlation between teacher feedback and self-regulation was overall higher than its correlation with feedback perception. Moreover, the correlation between self-regulated learning and feedback perception was significantly higher than the correlation between all formative feedback types and feedback perception. Thus, it can be inferred from these findings that there may be some indirect predictive relationship between teacher feedback, self-regulated learning, and feedback perception. It may be that teacher feedback predicts self-regulated learning, which further predicts feedback perception. There may be some mediating effect between the three variables, which requires more research in the future (van der Kleij, 2019; Van der Kleij, Adie, & Cumming, 2019).

Implication Of Studies

This study explored the intrinsic mechanisms of effective feedback from the perspective of processing feedback. According to the results of this study, verification feedback is still dominant in mathematics learning, but both verification and scaffolding feedback are closely and positively related to students' feedback perception and self-regulated learning. Therefore, teachers should appropriately increase scaffolding feedback that provides clues. In addition, students rated teachers' praise more favorably, and the frequency of praise also could be increased in daily instruction. It is worth noting that teacher praise combined with task-related information may be doubly effective. Students rate teacher criticism poorly, implicating that instructors should appropriately reduce the frequency of criticizing students. In addition, students' self-regulated learning is low in this area, and teachers should focus on the development of students' self-regulated learning skills, especially the instructional teaching of cognitive and metacognitive strategies. Meanwhile, the results demonstrated that self-regulated learning has a higher positive correlation in perceived teacher feedback, and that the process of self-regulated learning may further promote the utilization of teacher feedback and create a more positive attitude toward teacher feedback (Andrade & Brookhart, 2016). Therefore, teachers should emphasize the development of students' sense of

responsibility and strengthen students' ability to fully utilize their self-regulated learning to cope with various challenges in learning. Finally, the study proved that there is a significant positive correlation between formative feedback, self-regulated learning and feedback perception. The three are more conducive to learning by promoting each other. Therefore, it is suggested that a more equal dialogical relationship between teachers and students (Hansen, 2020), where teacher feedback and student engagement are used as daily conversations between teachers and students, may yield incredible results.

Conclusion
This study focused on exploring the levels of five types of formative feedback, self-regulated learning, perceived feedback, and the correlations among them among Chinese secondary school students. This study concluded that math teachers mainly provide verification feedback, followed by scaffolding feedback. Students perceived the feedback at a higher level and perceived their self-regulated learning at a lower level. In addition, there was a significant positive correlation between verification feedback, scaffolding feedback, directive feedback and teacher praise with self-regulated learning and perception of feedback, while there was no significant relationship between teacher criticism and self-regulated learning and perception of feedback.

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