Facilitating Undergraduates’ Online Self-Regulated Learning: The Role of Teacher Feedback

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Abstract Facilitating undergraduates’ self-regulated learning (SRL) is the key to successful online learning, and teachers’ various feedback plays an important role. Through an investigation on Chinese university students’ online learning experience, the study found students’ SRL strategies differences in terms of students’ gender, grades and achievement rank. The structural equation modeling analysis showed that different teacher feedback can influence different SRL strategies. Specifically, verification feedback, scaffolding feedback and teacher praise were positively related with students’ SRL, and teacher criticism also positively predicted three dimensions of SRL. Adopting verification and scaffolding feedback and the balance of teacher praise and criticism were suggested as they can enhance students’ online SRL strategies. Implications for university online teaching are further discussed.

Keywords Self-regulated learning · Teacher feedback · Online environment · Undergraduates · Quantitative research

Introduction

The COVID-19 pandemic has left no country or regions untouched. In early 2020, the outbreak of COVID-19 made Chinese educational system experience an unprecedented severe test. The Ministry of Education (MOE) of China issued the Guidance for Online Teaching in Colleges and Universities during the Pandemic, and 1454 colleges and universities across the country, 1.03 million teachers and 17.75 million college students were pushed to online teaching and learning suddenly (Ministry of Education, 2020). Since the end of April of 2020, many colleges and universities started the reopening of schools in an orderly manner as the preliminary control for the pandemic. Still, there were a number of universities which decided to adopt online teaching and learning for the whole semester.

Online teaching is one of the most effective tools in keeping student retention and maintaining access to learning. Before the pandemic, online learning and teaching has been practiced and discussed in higher education (Broadbent, 2017; Gikandi et al., 2011). However, many teachers still concern online teaching as occasional, and they may accidentally use technology as moderators or facilitators (Coll et al., 2014). The emergency large scale online teaching allows us to detect students’ online learning experience comprehensively. Even previous studies concerned various online learning systems or software (Mensink & King, 2020; Tian & Zhou, 2020), the interaction between the teachers and the students is the core issue for online teaching and learning (Espasa & Meneses, 2010; Evans, 2013; Yin et al., 2022). Existing research on online teaching and learning during COVID-19 mainly focused on students’ well-being and adaptation to the new learning environment (Yin et al., 2022), the study mainly focused on student learning experience and teachers’ online feedback.

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The crisis is a stress test challenging the resilience and equity of our education system (OECD, 2020). In addition, it’s a challenge for students at different stage to develop their self-regulated learning (SRL) capacity. According to a series of investigations during the school closure in China, scholars argued that the key to the quality was students’ SRL strategies (Hu & Xie, 2020; Wan et al., 2020). Beyond the pandemic, SRL has been consistently a core issue for university students’ learning, as ample evidence has shown its positive links with both academic and non-academic performance (Anthonysamy et al., 2020; Broadbent & Poon, 2015; Kizilcec et al., 2017). Comparing with face-to-face classroom teaching, the quality of online teaching and learning depends more on students’ self-regulated learning abilities (Anthonysamy et al., 2020; Zhu et al., 2016).

SRL can be influenced by multiple factors including individual, behavioral and environmental factors (Zimmerman, 2000, 2008), and scholars have consistently argued that SRL occurs in the interactions with social and situative contexts (Butler & Winne, 1995; Zimmerman, 2000, 2008). The interactions with teachers played a key role in facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008). Scholars have argued that the key challenges for online and blended learning include facilitating students’ SRL, and teacher feedback has been proved to be a powerful predictor of students’ SRL (Carless et al., 2011; Hattie & Timperley, 2007; Shuttle, 2008).

## Literature Review

### Students’ Online Self-Regulated Learning

In the past two decades, a large number of studies on SRL has been published and there is still no universal definition of SRL and different model had distinct emphasis. Winne and Perry (2000) highlighted two different conceptualizations of SRL: as aptitude and as event. Aptitude is essential to researching SRL, but “self-regulating learners may well transform an aptitude’s level or even its nature over the course of a learning episode” (Winne, 2010). Events are the “very actions learners perform rather than descriptions of those actions or of mental states that actions generate” (Winne, 2010, p.269). Zimmerman (2000) proposed a generally accepted triadic model of SRL: it is a triadic process of interaction between individual, behavior and environment, in which social situational factors play a key role (Zimmerman, 2008). According to social cognitive theory, self-regulated learning refers to “the self-directive processes and self-beliefs that enable learners to transform their mental abilities, such as verbal aptitude, into an academic performance skill” (Zimmerman, 2008, p.166). This means that self-regulated learning involves not only the learner’s willingness, but also a set of skills.

There are several measuring models of SRL. Roth et al. (2016) reviewed the measurement of SRL in higher education: (1) questionnaires: such as the Motivated Strategies for Learning Questionnaire (MSLQ; Pintrich et al., 1993) and the Learning and Study Strategies Inventory (LASSI; Weinstein & Palmer, 2002); (2) interviews, such as the Self-regulated Learning Interview Schedule (SRLIS, Zimmerman, 2008); (3) think-aloud technique; (4) learning diaries. One of the widely used model is provided by Pintrich (2004). According to Pintrich (2004), SRL consists of four stages: planning and goal setting, monitoring process, control and regulate, reactions and reflections. Specifically, planning and goal setting refer to activation of perceptions and knowledge of the task and context and the self in relation to the task. Monitoring processes concerns various represented meta-cognitive awareness of different aspects of the self and task or context. Control and regulation include efforts to control and regulate different aspects of the self or task and context. Reactions and reflections involve various kinds of reactions and reflections on the self and the task or context. Based on such framework, Pintrich’s developed the Motivated Strategies for Learning Questionnaire, which was one of the most widely used questionnaire measuring SRL. This questionnaire is composed of four major sections: motivation (task value; control beliefs), meta-cognitive (critical thinking; rehearsal), behavior (help seeking; time and effort planning), context (evaluation of context; peer learning) (Pintrich, 2004).
The COVID-19 pandemic pushed millions of students learning online. A number of scholars argued that SRL is the key of online learning (Anthonysamy et al., 2020; Broadbent, 2017; Kizilcec et al., 2017). As the online learning environment is characterized with autonomy, self-regulation turns into a critical factor for achievement in online learning (Barnard et al., 2009). Learners with stronger SRL skills were more likely to revisit previously studied course materials, especially course evaluations (Broadbent & Poon, 2015). Specifically, the tactics of time management, metacognition, effort regulation, and critical thinking were decidedly connected with academic results (Broadbent & Poon, 2015). More recently, goal setting and strategic planning have been discovered that predict accomplishment of individual course objectives, while help seeking for gave off an impression of being counterproductive (Kizilcec et al., 2017). Researches revealed that SRL emphatically relate with non-academic (student satisfaction; participation) outcomes (Anthonysamy et al., 2020).

However, self-regulated learning depends on the situation to some extent (Zimmerman, 2000). In this instance, measures of self-regulation of learning for traditional learning environment, such as MLSQ, may not be applicable in online learning environment (Barnard et al., 2009). For example, some items in MLSQ were situated in face-to-face learning environments, while online SRL strategies include items such as “share my problems with students online”. A measure of self-regulation of learning for the online and blended learning contexts would be particularly useful for researchers as contextualized to the online learning environments. Barnard et al. (2009) developed the Online Self-Regulated Learning Questionnaire (OSLQ) on the basis of Zimmerman’s and Pintrich’s theoretical framework. The questionnaire includes six strategies for online self-regulated Learning: goal setting (GS), environment structuring (ES), time management (TM), help seeking (HS), task strategies (TS) and self-evaluation (SE). The OSLQ was the most frequently used instrument in online environment (Roth et al., 2016).

**Teacher Feedback**

Teacher feedback is defined as information offered by teachers in response to students’ performance and understanding (Hattie & Timperley, 2007). Teacher feedback to students is one of the most crucial factors on students’ development of SRL as it can reduce the discrepancies between students’ current performance and their desired learning (Hattie & Timperley, 2007). Hattie (2008) made a comprehensive comparison of more than 800 studies, and found that among 138 influencing factors affecting students’ academic performance, the effect size of feedback was relatively large, reaching 0.73, ranking 10th among all factors. Research has generally identified four major levels and that the level at which feedback is directed influences its effectiveness (Evans, 2013; Hattie & Timperley, 2007; Shute, 2008): First, feedback can be about a task or product, for example, regardless of whether work is right or erroneous. Second, feedback aims at the process that creates a product or complete a task. Third, feedback to students can be focused at the self-regulation level, including greater skill in self-evaluation or confidence to engage further on a task (Butler & Winne, 1995). Fourth, feedback can be personal in the sense that it is directed to the “self” (Hattie & Timperley, 2007, p.90).

Based on the conceptual analysis (Butler & Winne, 1995; Hattie & Timperley, 2007; McMillan, 2014), Guo and her colleagues (Guo & Wei, 2019; Guo et al., 2019) distinguished five types of teacher feedback in the Chinese context. First is verification feedback, referring to the final judgment of a student’s response by affirming it as correct or incorrect, such as grades or marks. Second, directive feedback means providing students with the direct answer (e.g., right or wrong) to their questions or problems. The third is scaffolding feedback, which provides successive cues, hints, models, or partial solutions to students, help them to break tasks down into smaller or easier parts and to find out the correct answers by themselves. Fourth, teacher praise denotes the positive comments on students’ learning performance, attitudes, or outcomes. Fifth is teacher criticism, which delivers negative responses to students’ performance, attitudes, or behaviors via expressions of disgust, disapproval, or rejection.

Teacher’s online feedback has captured increasing attention in recent years. There were studies focused on teachers’ online feedback with technologies (Nicol, 2009), using different online learning systems or software (Chong, 2019; Mensink & King, 2020), feedback according to different learning content (Espasa & Meneses, 2010; Tian & Zhou, 2020). Some scholars used the term e-feedback to refer to the feedback given in online learning environments (Chong, 2019; Coll et al., 2014). Both face-to-face and online feedback had their advantages and disadvantages. Online communication permits learning and teaching to occur anytime and anywhere, while face-to-face counterpart cannot provide such flexibility (Evans, 2013; Gikandi et al., 2011; Leibold & Schwarz, 2015). Face-to-face feedback includes both verbal message and nonverbal cues such as tone of voice, gestures and facial expressions (Yin & Shi, 2022). The language use of online feedback can be accurate, formal and longer in utterances (Yin & Shi, 2022). Concerning that online feedback lacks nonverbal communication, such as tone and expression, scholars have suggested the need for well-designed online feedback in the form of written, audio, video, or web-based real-time synchronous meetings (Leibold & Schwarz, 2015). Online feedback helps students to have sufficient time to reflect upon the learning materials.
and to prepare formal feedback, enabling students to generate more in-depth and thorough thinking about the materials (Watts, 2016; Yin & Shi, 2022). Online communication may reduce the uneasiness during face-to-face contacts, and the feedback can focus more on the content (Comer & Leneghan, 2013; Yin & Shi, 2022).

**Relationship Between Teacher Feedback and Students’ SRL Strategies**

Based on the social cognitive theory, students’ self-regulated learning is influenced by individual learners and environment, so teachers can regulate learners’ learning behavior through feedback (Guo et al., 2019; Zimmerman, 2008). For all self-regulated activities, feedback is an inherent catalyst (Butler & Winne, 1995). Feedback, as a formative evaluation, is a key factor in promoting online or offline self-regulated learning (Guo & Wei, 2019). A meta-analysis by Hattie and Timperley (2007) indicates that the effect of computer-aided instructional feedback on student learning is 0.52. Specifically, there was evidence that online formative assessment had a potential to engage both teachers and learners in significant educational experiences (Gikandi et al., 2011). However, there is little systematic empirical evidence on what type of feedback is best for what situations and contexts (Evans, 2013).

In terms of the type of feedback and its influence on SRL, studies have showed inconsistent findings. For example, Azmat and Iriberri (2010) found that verification feedback such as high marks or grades can enhance students’ self-efficacy and extrinsic motivation. While, some studies showed that marks, grades, or rank had negative effects on students’ intrinsic motivations both for high and non-high achieving students (Lipnevich & Smith, 2009). Directive feedback can help students correct themselves and adjust their learning process (Shute, 2008). Scaffolding feedback was found to positively related to students cognitive strategies, metacognitive strategies, source-management strategies and motivation (Finn & Metcalfe, 2010; McMillan, 2014). Teachers providing cues, hints and instructions, instead of the right answers, help students to explore the answers by their own. Generally, studies showed that verification, directive and scaffolding feedback were positive for students learning. However, the influences of teacher praise and criticism are inconsistent. Teacher praise was found positive for students intrinsic motivation and self-efficacy (Guo & Wei, 2019), other studies showed that praise is ineffective (Macelllan, 2005). Teacher criticism is seen as negative while some studies showed its positive influences for student’ learning (Guo & Wei, 2019; van Egmond et al., 2013). In online setting, previous studies have showed that feedback during the continuous assessment process (answering student doubts) and feedback after an assignment can enhance students’ learning and their self-regulation (Espasa & Meneses, 2010). Yin and Shi’s (2022) recent investigation on undergraduates during the pandemic revealed the high association between the online interactions and student autonomy, and they argued that online interaction may enhance self-regulated and student-centered learning. In sum, the influences of feedback on SRL strategies vary, depending on the type, mode, and timing of the feedbacks and the learning environments (Evans, 2013; Hattie & Timperley, 2007). The complex relationships between feedback types and SRL strategies should be further explored in online setting. Based on these above studies, Fig. 1 briefly summarizes the hypothesis, which showed the general relationships between feedback types and SRL strategies. The study based on the investigation of Chinese undergraduates’ learning experience during the pandemic, attempted to uncover the complex relationships.

**Methods**

**Participants**

The participants in this study were college students from more than 40 universities in China. The investigation was conducted during May to Late June of 2020, when most Chinese universities students have experienced more than 3 months online teaching and learning due to the pandemic. All of them voluntarily completed the online questionnaires of this study. We collected 3228 responses. We deleted these respondents’ whose answering time was less than 4 min according to the time test. Eventually 2667 (82.6%) were valid. There were more female students (1780, 66.7%) than

![Fig. 1 The hypothetic relationships among teacher feedback types and SRL strategies. Note: ‘+’ refers to positive significant correlation, ‘-’ refers to negative significant correlation](image-url)
Facilitating Undergraduates’ Online Self-Regulated Learning: The Role of Teacher Feedback

male students (887, 33.3%) in the sample. 832 students (31.2%) were from “Double First-Class” universities and 1835 students (68.8%) came from ordinary colleges or universities that offer degree programs. In terms of major distribution, 710 students majored in humanities and social sciences (mainly literature, pedagogy, law and management), 661 students majored in science and engineering, and 1,296 students majored in medicine and agriculture. In terms of grade distribution, there are 762 students in the fresh year (28.6%), 1018 students in the sophomore year (38.2%), 500 students in the junior grade (18.7%), and 387 students in the senior grade or above (14.5%).

Measures

Teacher Feedback Questionnaire (TFQ)

The Teacher Feedback Questionnaire developed by Guo et al. (2019) was used to assess teachers’ use of different types of feedback, which includes teachers’ feedback on students’ classroom performance, homework and exams. The original questionnaire included five types of feedback and 24 items, which were developed for high school students in a face-to-face learning environment (Guo & Wei, 2019). We adapted the questionnaire to undergraduates’ online learning environments. First, we invited ten undergraduates to complete the items and asked them if the items were appropriate in their current online learning setting. Several face-to-face items were deleted (“the teacher would tell me in face where I did the homework well or badly”). Then, items that are not suitable for college learning were deleted. For example, Chinese high school students have frequent exams (monthly, mid-term, final), while students in this study were still learning online at that time. Therefore, several items were related with feedback on the exams (e.g., teachers would criticize us when our class underperformed other classes in the exams) were deleted. The final question was composed of 19 items and all items begin with “During the online teaching and learning”. After the data collection, we conducted a confirmatory factor analysis to examine the construct validity of the 19-item scale. A sample item for verification feedback is “My teacher provides marks or grades for our performance on daily assignment”. A sample item for directive feedback is “The teacher points out and corrects my mistakes directly in class”. A sample item for scaffolding feedback is “My teacher gives us some hints or clues through internet to help us to solve difficult problems”. A sample item for teacher praise is “When my answer to a difficult problem is right, my teacher praises me”. Finally, a sample item for teacher criticism is “My teacher criticizes me when my answers to simple questions are wrong”. Students rated the frequency in which teachers gave each feedback on a 6-point Likert scale (1 = never, 6 = always).

Online Self-Regulated Learning Questionnaire (OSLQ)

A modified version of Online Self-Regulated Learning Questionnaire (OSLQ) was used to measure students’ SRL strategies in online environment (Barnard et al., 2009), covering six dimensions: goal setting (5 questions), environment structuring (4 questions), time management (3 questions), seeking help (4 questions), task strategies (4 questions), and self-evaluation (4 questions). A sample item for the goal setting is “I set standards for my assignments in online courses”. A sample item for the environment structuring is “I choose the location where I study to avoid too much distraction”. A sample item for the task strategies is “I read aloud instructional materials posted online to fight against distractions”. A sample item for time management is “I work extra problems in my online courses in addition to the assigned ones to master the course content”. A sample item for help seeking is “I find someone who is knowledgeable in course content so that I can consult with him or her when I need help”. Finally, a sample item for self-evaluation is “I ask myself a lot of questions about the course material when studying for an online course”. The scale has a total of 24 questions. Students rated the frequency in which teachers gave each feedback on a 6-point Likert scale (1 = never, 5 = always).

Data Analyses

SPSS 24.0 and Mplus 7.0 were used for data processing. First, SPSS was used for calculating the descriptive data (e.g., the mean, standard deviation), internal consistencies and Pearson correlation of each dimension. Second, using Mplus 7.0, we conducted confirmatory factor analysis (CFA) to validate the measurement model of teacher feedback and OSLQ, and used structural equation modeling (SEM) to analyze the relationship between teacher feedback and students’ SRL strategies. A number of indices, including the chi-square statistic ($\chi^2$), the root mean square error of approximation (RMSEA), the Tucker–Lewis index (TLI), and the comparative fit index (CFI), were used to indicate the robustness of fit. According to Schreiber et al. (2006), the data fit is acceptable when CFI and TLI are no less than 0.90 (the higher, the better). For the mediation analysis, bootstrapping was used to detect indirect effects (Hayes, 2009).

Results

Scale Validation and Descriptive Statistics

The reliabilities of six SRL strategies dimensions are shown in Table 1, ranging from 0.79 to 0.90. The CFA showed good data fit for the six factor

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analysis ($\chi^2 = 3383.53$, $df = 237$, $p < 0.01$, RMSEA = 0.071; CFI = 0.92; TLI = 0.91), with factor loadings ranging from 0.58 to 0.85. For teacher feedback scale, the first CFA showed good data fit ($\chi^2 = 2715.61$, $df = 142$, $p < 0.01$, RMSEA = 0.082; CFI = 0.93; TLI = 0.92). However, one item (I will ask teachers to solve the puzzles) had low factor loading with 0.36. We set the cutoff criteria as 0.40, so this item was deleted. The revised 18 items showed better data fit ($\chi^2 = 2231.81$, $df = 125$, $p < 0.01$, RMSEA = 0.079; CFI = 0.94; TLI = 0.93). The reliabilities of five dimensions ranged from 0.81 to 0.90. These two scales showed good reliability and construct validity.

Table 1 also displays the descriptive statistics and correlations of all the dimensions. All the six dimensions of SRL strategies scored higher than 3.0. Specifically, environment structuring scored the highest ($M = 3.86$, $SD = 0.77$), followed by time management ($M = 3.56$, $SD = 0.81$) and help seeking ($M = 3.56$, $SD = 0.82$). Goal setting ($M = 3.53$, $SD = 0.81$), self-evaluation ($M = 3.43$, $SD = 0.82$) scored relatively low, and task strategies ($M = 3.25$, $SD = 0.83$) had the lowest score among all the dimensions of SRL strategies. In terms of teacher feedback, verification feedback ($M = 4.70$, $SD = 0.92$) and directive feedback ($M = 4.70$, $SD = 0.90$) were most frequently reported. Scaffolding feedback scored 4.65 ($SD = 0.88$) and teacher praise scored 4.49 ($SD = 1.01$). Teacher criticism was least frequently reported ($M = 3.64$, $SD = 1.26$).

Table 1 shows the correlation analysis results, and the 11 subdimensions are significantly correlated.

### Comparison of Gender, Discipline Grade and Achievement Rank

Two-way ANOVA was used to examine the gender, discipline, and institution type differences. Table 2 displays the comparison results for the factors means.

The results showed that, significant gender differences were found on goal setting and environment setting, and female students were found to score higher than male students. Significant differences were detected for grade difference in terms of three factors, namely goal setting, task strategies and help seeking. For all the three factors, senior students scored the lowest.

There were no significant differences for different disciplines, excluding help seeking. Science and engineering students scored significantly higher than A&H and social science and medicine and agriculture students.

All the six SRL strategies showed significant differences in terms of students achievement rank. Students’ who rank the first 20% scored higher than other rank types, and students with the last 20% had the lowest score for all the five factors. Normally, students had higher rank, they had better SRL strategies.

### SEM Results

To explore the relationships among different types of feedback and SRL strategies, a SEM was construct and the results are displayed in Fig. 2. The explained variance was shown on the right of each dependent variable. The
Facilitating Undergraduates’ Online Self-Regulated Learning: The Role of Teacher Feedback

SEM model showed good data fit ($\chi^2 = 6311.49$, $df = 764$, $p < 0.01$, RMSEA = 0.052, $CFI = 0.93$, $TLI = 0.92$). The different dimensions of feedback had distinct influences on SRL strategies. Specifically, for goal setting, verification feedback ($\beta = 0.13$, $p < 0.001$) and scaffolding feedback ($\beta = 0.22$, $p < 0.001$) were positive predictors. For environment structuring, teacher criticism had negative influence ($\beta = -0.08$, $p < 0.01$), while directive feedback ($\beta = 0.12$, $p < 0.01$), scaffolding feedback ($\beta = 0.13$, $p < 0.01$), teacher praise ($\beta = 0.12$, $p < 0.01$) were positive predictors. For task strategies, verification feedback ($\beta = 0.11$, $p < 0.05$), scaffolding feedback ($\beta = 0.24$, $p < 0.001$), and teacher praise ($\beta = 0.11$, $p < 0.01$) were positively correlated with students seeking help strategies.

In terms of self-evaluation, verification feedback ($\beta = 0.08$, $p < 0.01$), scaffolding feedback ($\beta = 0.23$, $p < 0.001$) and teacher criticism ($\beta = 0.06$, $p < 0.05$) can facilitate students’ time management behaviors. Further, verification feedback ($\beta = 0.11$, $p < 0.05$), scaffolding feedback ($\beta = 0.24$, $p < 0.001$), and teacher praise ($\beta = 0.11$, $p < 0.01$) were positively correlated with students seeking help strategies.

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Table 2: Undergraduates’ SRL comparison across gender, grade, discipline and achievement rank

| Variable | N  | GS | ES | TS | TM | HS | SE |
|----------|----|----|----|----|----|----|----|
| Gender   |    |    |    |    |    |    |    |
| Male     | 887| 3.47 | 3.81 | 3.25 | 3.54 | 3.58 | 3.46 |
| Female   | 1780| 3.56 | 3.89 | 3.25 | 3.57 | 3.55 | 3.42 |
| t(sig)   | −2.41(.02) | −2.37(.02) | 0.08(.94) | −0.81(.42) | 0.96 (.34) | 1.30(.19) |
| Grade    |    |    |    |    |    |    |    |
| Y1       | 761 | 3.49 | 3.83 | 3.27 | 3.55 | 3.63 | 3.46 |
| Y2       | 1018| 3.55 | 3.90 | 3.28 | 3.56 | 3.55 | 3.43 |
| Y3       | 500 | 3.59 | 3.90 | 3.28 | 3.59 | 3.60 | 3.45 |
| Y4       | 387 | 3.48 | 3.80 | 3.10 | 3.54 | 3.41 | 3.37 |
| F(sig)   | 2.73(.03) | 1.91(.11) | 4.15(.00) | 0.55(.70) | 5.06(.00) | 0.79(.53) |
| Discipline |    |    |    |    |    |    |    |
| A&H&S    | 710 | 3.54 | 3.86 | 3.31 | 3.52 | 3.53 | 3.41 |
| S&E      | 661 | 3.49 | 3.85 | 3.25 | 3.53 | 3.66 | 3.45 |
| M&A      | 1296| 3.54 | 3.88 | 3.22 | 3.59 | 3.52 | 3.44 |
| F(sig)   | 0.94(.39) | 0.27(.77) | 2.70(.07) | 2.30(.10) | 7.34(.00) | 0.41(.66) |
| Achievement rank in class |    |    |    |    |    |    |    |
| Last 20% | 298 | 3.20 | 3.71 | 3.09 | 3.31 | 3.34 | 3.23 |
| 60%–80% | 445 | 3.41 | 3.81 | 3.18 | 3.47 | 3.48 | 3.38 |
| 40%–60% | 588 | 3.53 | 3.82 | 3.31 | 3.57 | 3.56 | 3.47 |
| 20%–40% | 607 | 3.56 | 3.90 | 3.24 | 3.58 | 3.57 | 3.44 |
| First 20% | 729 | 3.70 | 3.97 | 3.32 | 3.69 | 3.68 | 3.51 |
| F(sig)   | 24.26 | 7.88 | 5.43 | 13.47 | 10.40 | 7.13 |

Fig. 2: The influences of teacher feedback on SRL dimensions. Note: Only significant paths ($p < .05$) are showed.

For environment structuring, teacher criticism had negative influence ($\beta = -0.08$, $p < 0.01$), while directive feedback ($\beta = 0.12$, $p < 0.01$), scaffolding feedback ($\beta = 0.13$, $p < 0.01$), teacher praise ($\beta = 0.12$, $p < 0.01$) were positive predictors. For task strategies, verification feedback ($\beta = 0.13$, $p < 0.01$), scaffolding feedback ($\beta = 0.17$, $p < 0.01$) and teacher praise ($\beta = 0.10$, $p < 0.001$), and teacher criticism ($\beta = 0.10$, $p < 0.001$) would enhance students to seek appropriate learning strategies. To be noted, teacher praise and criticism had the same positive influences.

FIG. 2 THE INFLUENCES OF TEACHER FEEDBACK ON SRL DIMENSIONS

Note: Only significant paths ($p < .05$) are showed.

$N=2667$. A&H&S Art, Humanities and Social Science, S&E Science and Engineering, M&A Medical and Agriculture
Discussion

The emergency pandemic made the online teaching widespread and required for many universities, and which offered us an opportunity to examine two key factors in online learning environment: teacher feedback and students’ SRL strategies. Previous studies have documented the positive role of general feedback in students’ SRL, while few studies have examined different types of feedback and their influences on multiple SRL strategies in online setting. Through an investigation of Chinese undergraduates during the pandemic, the study uncovered the situation of undergraduates’ online SRL strategies, and it also revealed the complex relationships between teachers’ five types of feedback and SRL strategies.

Attend to Students’ Different Use of SRL Strategies

Students in this study reported a moderate level of SRL strategies. Environment structuring had the highest score, and task strategies and self-evaluation had lower score. During the outbreak of COVID-19, most students studied at home, and their learning environment is relatively simple. Due to the lack of face-to-face communication with teachers and classmates, maybe it is difficult for students to monitor and reflect on their learning progress and grasp the situation through comparison and observation (Wang et al., 2013).

The gender differences results also remind that females tend to have higher levels of goal setting and environment structuring use than males. Further, teachers should attend to the “fourth-year undergraduate phenomenon” (Wen et al., 2014) as the results showed that senior year undergraduates scored the lowest for three SRL strategies. The “Chinese College Students Survey” revealed that the fourth-year undergraduate students had lower challenging courses and requirements from the teachers and departments. Fourth-year students put more emphasis on job-hunting, graduate school entrance application, and non-curriculum activities (Wen et al., 2014).

To be noted, significant differences had been found in terms of students’ achievement rank, and high achieving students reported higher self-regulation for learning than low achieving students, which was consistent with some previous studies (Broadbent, 2017; Orsmond et al., 2013). Students whose academic performance is in the first 20% or 40% of the class were significantly higher than those who rank the last 20% or 40%. The result was similar with the investigation of some large undergraduate surveys, such as the “Chinese Undergraduate Teaching and Learning Survey”, which found that the top 40% of students performed well in terms of their learning initiative and self-regulation (Yan, 2020). Promoting SRL strategies for lower-ranked students is a challenging issue in traditional classroom, but online teaching environment may make a difference (Anthonysamy et al., 2020). Compared with traditional face-to-face teaching, teachers can hardly care about each students especially for the big class size, and teachers are more likely to obtain individual student’s data, such as student’s basic information, achievement rank and learning process information (Evans, 2013). Technology affords immediacy and “anytime, anywhere, anyhow approaches” and is suitable for use with large numbers of students (Evans, 2013; Gikandi et al., 2011). For example, teachers can use some technical tools to conduct a survey on students’ learning needs and current situation, and they can pay more attention to diverse learning needs and those students with lower achievement rank in the class.

Adopting Multiple Types of Feedback to Facilitate Students’ SRL Strategies

The descriptive results showed that teachers provided verification feedback and directive feedback most frequently, which echoes previous studies (Guo et al., 2019; Shute, 2008). The findings indicate that teachers tend to provide scores or grades, and to provide students directly with the right answers (Guo et al., 2019; Shute, 2008). Verification feedback is a simple but effective interactional style, and it can help students realize where they are, and inform the learner about the correctness of one’s response, such as right/wrong or overall percentage correct (Shute, 2008). Espasa and Meneses (2010) also found that verification and directive feedback were frequently reported by students in online classrooms. With the help of online learning system of software, teacher can provide promptly verification feedback to each student (Chong, 2019; Mensink & King, 2020). For example, when correcting assignment, teacher can give the automated feedback instead of handwritten feedback (Tian & Zhou, 2020).

For all the five feedbacks, scaffolding feedback is the only significant predictor of all six SRL strategies. The more scaffolding feedbacks were given, students tend to have clear goals, to manage their time, tasks and resources better, and to reflect more on their learning. According to Hattie and Timperley (2007), providing cues for students had large effect size for students achievement (effect size = 1.10). Cues are most useful when “they assist students in rejecting erroneous hypotheses and provide direction for searching and strategizing” (Hattie & Timperley, 2007, p.93). Scaffolding feedback serving as specific feedback, was used to clarify goals and reduce or remove uncertainty in relation to how well learners are performing a task, in order to guide students’ to adjust learning objectives and resource management strategies (Hattie & Timperley, 2007; Shute, 2008). In online setting, teachers elaborating or answering students’ doubts is welcome by students, and “this type of feedback fulfills a formative or regulatory role—it not only provides a
solution, but also helps to improve a student’s work” (Espasa & Meneses, 2010, p.289).

The SEM results showed that adopting multiple types of feedback may better enhance students’ learning, which support the argument of complex feedback (Shute, 2008) or sustainable feedback (Carless et al., 2011). The four positive hypothetic relationships in Fig. 1 supports, while different types of feedback had different influences. Providing both verification and scaffolding feedback may be powerful for online learning, in terms of enhancing students’ SRL strategies. Students preferred exploratory feedback rather than directive feedback, and as some students described, “feedback is not just the feedback you give to students in written forms. Feedback is a kind of support which gives a sense of scaffolding...is a tool to get students involved in interactive learning” (Carless et al., 2011, p.402). Hattie and Timperley (2007) also stressed the need for teachers to provide more evaluative information in their feedback as a means of providing specific feedback. They proposed three major questions for learning from feedback, “how am I doing?” “what to next?” and “how am I going”, “how am I doing?”, “what to next?”. The adoption of verification and scaffolding feedback can been seen as the response to these three questions. Verification make students to realize where they are, and scaffolding feedback as such as providing cues, giving suggestions and strategies to help them move on, help students to think about the future learning and how they can get there (Hattie & Timperley, 2007; Orsmond et al., 2013). Teachers can fully take advantage of the online platform, providing prompt verification feedback and then give students comments and learning materials, so students can have sufficient time and resource to reflect and in-depth thinking (Hrastinski, 2008).

**Criticism Feedback Can Be Positive in Some Contexts**

Teacher criticism and praise were seen as two types of motivational feedback, through which teachers can facilitate students’ learning motivations (Guo & Wei, 2019; Guo et al., 2019). Many studies have argued for the role of praise in enhancing students’ intrinsic motivation and self-efficacy (Droe, 2013; Guo & Wei, 2019). Criticism was often seen as undermining students’ motivation and self-efficacy (Maclellan, 2005). In our study, teacher praise was found positively related with environment structuring, task strategies, time management and self-evaluation, which was similar with previous studies (Droe, 2013; Guo & Wei, 2019; Maclellan, 2005).

Surprisingly, teacher criticism was found to positively predict task strategies, time management and self-evaluation. Among all the hypothetic relationships, only the path between teacher praise and SRL strategies was not supported. The results were inconsistent with previous studies which pointed out that criticism has a negative effect on students’ learning (Maclellan, 2005). The results may be partly attributed to the Chinese contexts and the online learning environments. Some studies conducted in Chinese contexts were supportive for the results. For example, in a study conducted by Guo et al. (2019) in Chinese low achieving schools, they found that teacher criticism had a positive effect on students’ deep learning strategy use. Due to the Chinese culture (e.g., Confucian tradition, collectivism culture) that emphasize obedience and respect for teachers, Chinese teachers are expected to assume a parental orientation with their students, and one that emphasize promoting children’s all-round development rather than only concerning their study (Bear et al., 2016). Thus, Chinese students often see teachers’ criticism or strictness as acceptable and reasonable (Bear et al., 2016; Guo & Wei, 2019), and through these strategies students can better reflect their problems, adjust their learning task and strategies. Yin (2018) also argued that, in Chinese universities, both bright and less bright students would take full advantage of their opportunities to learn, and negative feedback on one’s learning process would be seen as “an opportunity for improvement” (van Egmond et al., 2013, p. 213).

In face-to-face classroom, teacher’s criticism on one student may lose his/her face in front of classmates, and thus brings further emotional problems (Yin & Shi, 2022). The online criticism feedback may reduce students’ uneasiness during face-to-face contacts and the feeling of “lose face” in public (Comer & Lenaghan, 2013; Yin & Shi, 2022). In addition, comparing with face-to-face criticism, teachers’ criticism through internet may be more formal, better crafted, and they can focus more on the learning content rather than the emotional responses to students.

**Conclusion and Implications**

SRL is the core issue for both face-to-face and online learning, and teacher feedback is one of the most important interactions that would influence students’ learning. The study, based on an investigation on Chinese undergraduates’ online learning experience during the COVID-19, explored the types of online feedback and their influences on students’ SRL strategies. The results showed the significant differences among students’ with different achievement rank, which calls for teachers’ attention to those low-performing students (Broadbent, 2017; Orsmond et al., 2013). In addition, in terms of some dimensions, teachers are suggested to attend the Year-4 students’ SRL (Wen et al., 2014), teachers’ interactions with senior year students can focus more on vocational guidance, emotional communication, project-based assignment (Wen et al., 2014). Teachers can use online teaching platform or software to grasp student learning information and accurate understanding of the students’
learning needs and difficulties (Evan, 2013). According to different students, teachers can use different feedback strategies, such as verification feedback and scaffolding feedback, so as to improve the online learning effect of the students (Boelens et al., 2017; Carless et al., 2011).

Further, the study explored the influences of feedbacks and SRL strategies. The results showed that different dimension of feedback had different effects on SRL strategies. Among them, scaffolding feedback, verification feedback and teacher praise showed positive influences on several dimensions including self-evaluation, task strategies, seeking help. Teacher criticism was also found positively related with task strategies, time management and self-evaluation. The results imply an adoption of various types of feedback for online teaching context. For example, verification is mostly reported by students, and the results suggest the adoption of verification and scaffolding feedback. Therefore, judging students by affirming their response is correct or incorrect, or using grades or marks is not enough, teachers are further suggested to give them cues, to provide directions to scaffold students to tackle the problems. Online platform or software can help teachers to give prompt verification feedback, and the online classroom can be set to provide automated feedback for specific assignments (Leibold & Schwarz, 2015; Tian & Zhou, 2020). After verification feedback, teachers’ scaffolding feedback that communicates specific and personalized information enables students to improve their work and to know what to do next.

Further, for Chinese students, the results suggest teachers to utilize praise and criticism feedback appropriately, even criticism is always seen as negative (Macelllan, 2005). We agree with Leibold and Schwarz (2015) argument for the balanced level of positive and negative online feedback. Even the study revealed the positive role of teacher criticism in a Chinese context, we should be aware of the way how teachers criticize students. Properly criticism online may play a positive role for students SRL strategies, especially for their self-evaluation and task strategies. Chinese students concern teachers’ criticism as acceptable and as teachers’ caring for their development, and thus students consider the criticism as an opportunity to reflect and improve themselves (Bear et al., 2016; Sun et al., 2019; Yin, 2018). When students perceived their teacher’s language as negative criticism (e.g., sarcasm, comparison with others, and aggression), it had a negative impact on their self-esteem and learning (Ding et al., 2013). On the other hand, positive critical language (such as tactfully pointing out mistakes, expressing expectations and constructive opinions) can positively predict the level of self-esteem of students (Miyamoto et al., 2000). In Chinese collectivist culture, if the teacher criticizes a student in front of the whole class, it may cause stress or discomfort. In the online environment, teacher criticism can be more targeted on the learning content and more private through internet, which may facilitate students learning. The results may be influenced by collectivism values, and may illuminate educators in societies with similar culture (Bear et al., 2016; Sun et al., 2019). Future studies can further compare the influence of teacher online criticism on student learning across different cultures.

Some limitations of the study should be noted. First, the measurement of SRL strategies and teacher feedback was students’ self-reported questionnaires. Although self-report measurement is an effective method to measure teachers’ feedback and students’ SRL (Roth et al., 2016), it is susceptible to response bias. In the future, interviews, classroom observation or teachers’ reports may be used as supplements, so as to draw more comprehensive and objective conclusions and provide more powerful empirical basis for the research results. Second, the sample size of the study is relatively small compared with China’s large population of undergraduate students. The study adopted convenient and random sampling strategy to improve the representativeness of the sample. Third, casual conclusions cannot be drawn from this cross-sectional study. Future studies could adopt a longitudinal or mixed-method design to uncover the complex relationships between teacher feedback and students’ learning process.

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