

## PAPER

# Probing Scaffolding Self-Regulated Learning Responses, Resources Contribution and Target Achievements of University Students in Statistics Course

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## ABSTRACT

Scaffolding self-regulated learning is an emerging research agenda in higher education. However, scaffolding self-regulated learning in a relatively complex subject such as statistics is still understudied. The present study addresses this matter by observing university students' engagement in scaffolding self-regulated learning in a statistics course focusing on their scaffolding responses, resources contribution and target achievements. It was an exploratory case study with the participation of 26 private university students who are enrolled in the fifth semester as their third-year studies. The results indicate that university students are aware of statistics learning goals but overtargeting achievements, as they were less likely to achieve their decided targets. Students prefer to write a self-reflection than take notes. The different duration of watching videos and reading modules does not vary in quiz performance. The current findings add a novel understanding that self-regulated statistics learning requires advanced scaffolds to promote higher outcomes because of its characteristics as a complex and abstract subject.

## KEYWORDS

scaffolding, self-regulated learning, statistics course

## 1 INTRODUCTION

Scaffolding self-regulated learning is an emerging research agenda in higher education. Researchers are exploring the most effective ways to support these capabilities with an increasing emphasis on developing university students' self-regulated learning skills. There are two prevalent manners: running separate training programmes [1], [2] or integrating them into subject-matter courses. The latter approach seems more popular. Scholars establish self-regulated blended or online learning environments in regular lessons [3], [4] by certain interventions such as e-portfolio

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[5], quizzes [6] and peer assistance [3]. These efforts are beneficial for mastering independent learning competencies.

Scaffolding self-regulated learning in a relatively complex subject such as statistics is still understudied. It was highly challenging to motivate university students in the course although many university assignments require statistical analysis [7]. They tend to have a negative attitude toward statistics and other courses that involve mathematical calculations. Kim [8] also found that they studied mostly for facing course examinations only. Their access to asynchronous online statistics learning was considerably higher in the weeks before formative and summative evaluation times. Complex subjects demand live demonstrations [9] and interactive communications [10] for a better understanding. It is even harder to teach such subjects virtually.

Several studies have suggested investigating self-regulated learning supports in online educational environments. Besides developing the notion of self-regulated learning, Zimmerman [11] recommends expanding its strategies. It has great differences between traditional and more self-directed knowledge development activities. A systematic review of this issue by Wong [12] also indicates a critical need for facilitating and exploring this active learning process in various contexts, as different settings call for specific approaches. The present study addresses this matter by observing university students' engagement in scaffolding self-regulated learning in a statistics course focusing on their scaffolding responses, resources contribution and target achievements.

This study establishes novel comprehension of how university students responded to prompts, supported by multiple learning resources and defended their targets in self-regulated statistics learning. The rest of the structure of this article is as follows. Theoretical framework, literature review as well as detailed purpose and research questions in this study are presented in the next three sections. It is continued with methodological and result sections. Finally, it turns to the discussion section and finishes with concluding remarks.

## 1.1 Scaffolding self-regulated learning

This subsection defines self-regulated learning and scaffolding self-regulated learning. In addition, it also discusses various learner behaviours from cognition to motivation. The theoretical elaboration is useful to bring a better understanding of scaffolding for learning more independently.

Self-regulated learning refers to the process by which learners could manage independently their knowledge and skills acquisition activities. This action promotes more active and aware individuals toward learning goals, strategies and achievements [11]. Within this concept, students are expected to learn at their own pace by setting measurable objectives, monitoring progress timely and adjusting strategies as necessary to reach the best performances [13], [14]. In the earlier term, this type of learning activity is also called independent learning, as learning with minimum assistance from others [15]. Developing capabilities through a self-standing manner does not mean learning alone, but it rather reflects being minimally supported and more active learners.

Scaffolding self-regulated learning means the process of providing support and guidance to learners as they develop their knowledge and skills independently. These scaffolds could be prompts or feedback that are valuable to regulate and evaluate students' learning progress [16], [17]. It follows and notifies almost every single advancement. There are two prevalent structures of scaffolding: intentional (planned support) based on student characteristics or situational (responsive support)

based on student responses [18]. Both assistances are crucial to empower students in active and liberated educational environments. Scaffolding self-regulated learning can be categorised as the lowest self-paced learning as students are still pampered with relatively considerable scaffolds. The less support, the higher the level of self-regulated learning.

Scaffolding in self-regulated learning could address a variety of learner behaviours from cognition, affect, metacognition, and motivation which is also called CAMM [19]. Cognition relates to maximising prior knowledge, affect refers to emotion, metacognition is about progress monitoring for further actions, and motivation covers self-efficacy aspects. Each aspect features different functions in the way of assisting proactive learners. It depending on the instructional design and the focus of scaffolding. Taken together, scaffolding self-regulated learning in this study is described as supporting university students with several prompts to help them learn a relatively complex subject, namely statistics. Independently mastering this subject with minimum guidance and support must be highly stressful. Providing some scaffolds and further resources is perhaps useful for them to achieve their defined goals and targets.

## 1.2 Research on scaffolding self-regulated statistics learning

This subsection reviews relevant studies on scaffolding self-regulated statistics learning. First, it addresses the affordances of scaffolding to escalate learning performances in general and in particular for statistics courses. These benefits cover achievement, engagement, motivation and attitudes of students in statistics learning enhanced by multiple scaffolds.

Self-regulated learning scaffolds are by far effective to increase students' achievements. A meta-analysis by Zheng [20], conducted within computer-based learning environments, reveals the evidence from previous studies that support self-regulated learners with prompts or hints, concept maps, worked-out examples and integrated tools that have positive effects on academic performances. Not only domain-general but also domain-specific scaffolds are supportive of the whole learning processes and activities as well as target attainments. This meta-analysis study suggested integrating a variety of self-regulated learning scaffolds into independent but personalised classrooms to maximize efforts in facilitating learners to actualise their self-determined goals. It seems evident that the more assistance, the better the self-regulated learning achievements.

Particularly in a statistics course, inserting small scaffolds is useful for learners. With the purpose of testing the effectiveness of activity-driven intervention in promoting graduate learners' statistics efficacy and concept knowledge, Follmer [21] facilitated university students with weekly strategic planning and reflection activities on 10-week statistics lessons. He found that was beneficial to address three regulatory phases of self-regulated learning: self-efficacy (forethought), metacognitive monitoring (performance) and self-evaluation (self-reflection). Regular planning and reflection actions promote students' awareness of learning and subsequently elevate statistics efficacy and comprehension. Similarly, various strategies such as a linear system, a hypermedia program, and university-level classes implemented by Vollmeyer & Rheinberg [22] were likewise effective to trigger students' engagement and motivation in statistics self-managed learning.

Another study dealing with statistics anxiety of college students discloses that learners who practised multiple self-regulated learning strategies such as rehearsal, elaboration, organisation, critical thinking, metacognitive regulation, time and study

environment management faced lower computational anxiety and had more positive attitudes toward statistics [7]. From the available meta-analysis and research about scaffolding self-regulated learning and especially in statistics courses, it is worth noting that any interventions could support students to learn a complex subject in more independent ways. Exploring further interventions continues this research line and mature understanding of how to better support students in learning statistics using a self-monitored approach.

### 1.3 Purpose and research questions

The present study observes university students' involvement in scaffolding self-regulated learning focusing on their scaffolding responses, resources contribution, and target achievements. Threefold questions were posed in this study:

1. How were university students' responses to self-regulated learning prompts?
2. To what extent do specific resources contribute to university students' self-regulated learning performances?
3. How were university students' target achievements in scaffolding self-regulated learning?

After the methods section, these questions are carefully answered and critically discussed afterwards in the results and discussion sections.

## 2 METHODOLOGY

The present investigation falls under the classification of an exploratory case study [23], which explores scaffolding self-regulated learning of university students in a statistics course. This method was administered owing to its flexibility and practicality to gain a deeper comprehension of how university students deal with independent learning in a relatively complex subject matter [24]. It was immensely convenient to apply this method to investigate the main concern of this study, namely scaffolding responses, resources contribution, and target achievements. As a result, holistic findings and in-depth discussions can be promoted, which are valuable for recommending greater practices, generating new hypotheses and developing more focused research in the future.

### 2.1 Participants

26 university students who are enrolled in the fifth semester for their third year of studies participated in this research. The majority of them are females: 17 or 65.38%, and the rest are male: 9 or 34.62%. They are aged between 22 and 25 years. These students were selected for the reason that they are in the middle of bachelor-degree years and with an assumption that they are already mature to take an active role in their learning, setting goals, monitoring progress and adjusting strategies. Regarding ethics for participating, the student's participation is voluntary, and this matter was informed at the beginning of this study. Further, their involvement would neither affect formative nor summative examination grades. Anonymity is guaranteed and all collected data are exclusively utilized for scientific purposes.

## 2.2 Procedures

This exploration was conducted over a learning management system (LMS) called Ontask, which was designed and developed to feature scaffolding self-regulated learning environments. Students were enrolled in the system to join a statistics course consisting of eight topics that lasted one week per topic. This study was undertaken on the topic of Paired Sample T-Test run with multiple self-regulated learning (SLR) prompts to control and regulate instructional processes. A 102-minute video and a 59-page electronic module book were provided as independent learning resources. In addition, a quiz was performed to measure their understanding and reflect on target achievements at the end of the course. This quiz comprises 14 multiple-choice questions. Detailed prompts and their types and instructions are summarised in Table 1.

**Table 1.** Characteristics of the SLR prompts

SLR Prompts	Types	Questions/Instructions
Goal understanding	Closed-ended	Do you understand the learning objectives?
Quiz score target	Open-ended	Please decide your quiz score target
Note-taking	Open-ended	Please make notes of important information
Reflection	Open-ended	Please write reflections on what you understand and do not understand

## 2.3 Data collection and analysis

Recorded students' activities in the system are the main data source. It means the data from this study were generated automatically from the system so that was not necessary to utilise any instrument to collect data. All collected data were descriptively analysed [25] and neatly visualised in tables and figures. The collected data are quantitative in nature, and were analysed by tabulating and visualising them according to their characteristics on a spreadsheet software programme.

## 3 RESULTS

This section presents the study findings. Respecting the defined research objectives, it presents three aspects, namely scaffolding responses, resources contribution and target achievements. Each of these concerns has a data visualisation complemented by careful description.

### 3.1 Scaffolding responses

University students were scaffolded with multiple prompts to support them in self-regulated learning. The prompts are concerning learning goals, target scores and further actions to promote better independent learning performances that include note-taking and reflection activities. Their responses to these prompts are presented in Table 2.

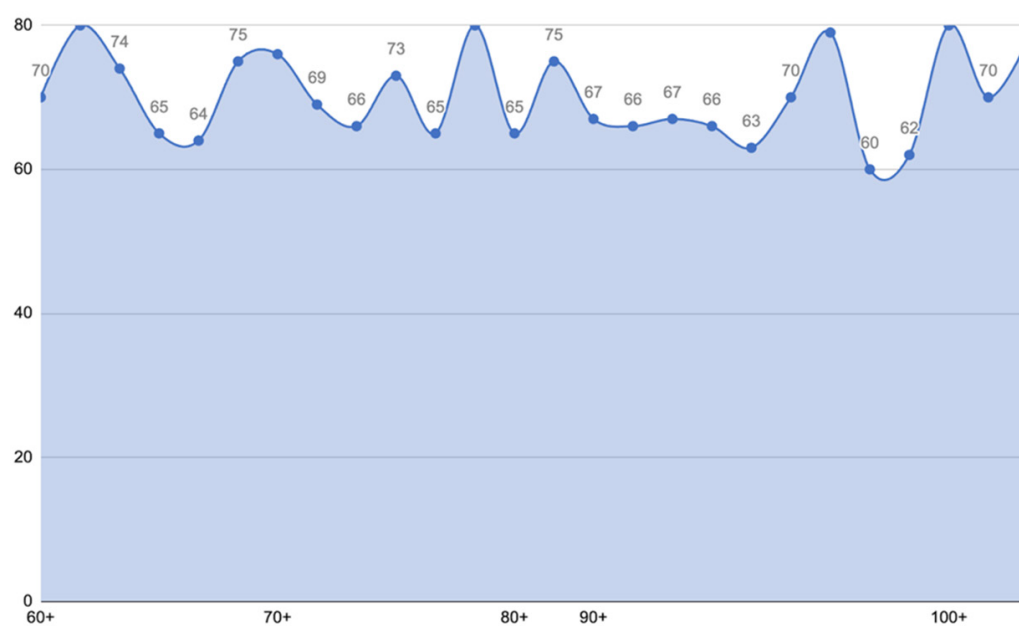
**Table 2.** Responses to self-regulated learning prompts

SLR Prompts	Responses		
Goal understanding	No	Yes	
	0 0%	26 100%	
Quiz score target	80	90	100
	9 34.62%	10 38.46%	7 26.92%
Note-taking	No	Yes	
	16 61.54%	10 38.46%	
Reflection	No	Yes	
	10 38.46%	16 61.54%	

Table 2 describes university students’ responses to self-regulated learning prompts. Overall, students declared that they are aware of learning objectives and have a high target in quiz scores. There is a reversing figure between note-taking and reflection activities. All students rated themselves that they understand the study goals and targeted quiz scores from 80 to 100 points. While over half of them did not take notes, they did reflect on their learning.

### 3.2 Resources contribution

Video and learning materials were provided in the session as instructional media to facilitate students’ learning in a more independent manner. Their engagement with these resources was recorded to track their watching and reading durations. In Figures 1 and 2, the duration they spent is compared to their quiz scores.



**Fig. 1.** Duration of watching video in relation to quiz scores

Figure 1 describes the watching video duration of university students and their quiz results. Generally speaking, students spent over 60 to 100 minutes learning from the provided video and reached a maximum quiz score of 80 points. It is also noticeable from the figure that the watching durations are not in line with the quiz scores. These scores are fluctuating over the durations. For example, the highest point was recorded not only in the students who spent over 100 minutes but for those who spent over 60 and 70 minutes as well. Likewise, the lowest ones were surprisingly recorded in the students who spent almost a hundred minutes watching the instructional video.

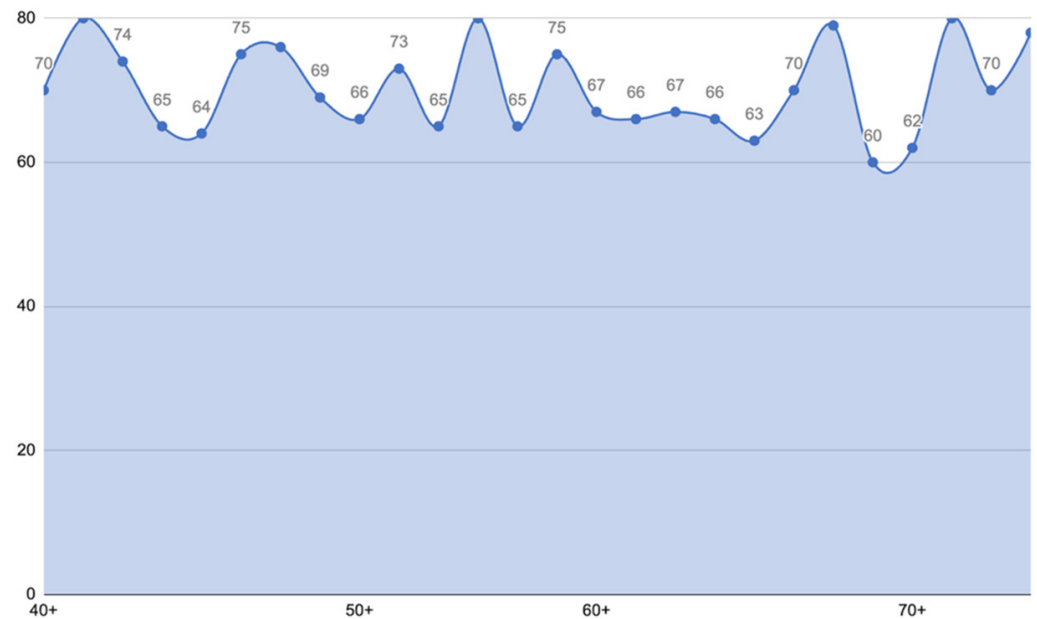


Fig. 2. Duration of reading learning materials in relation to quiz scores

Figure 2 describes university students’ reading duration of learning materials and their quiz results. In general, students spent over 40 to 70 minutes reading provided learning material and achieved a maximum quiz score of 80 points. It is also noticeable from the figure that the reading durations are not in line with the quiz scores, as these scores are fluctuating over the durations. For instance, the highest point was recorded not only in the students who spent over 70 minutes but also for those who spent over 40 and 50 minutes. Unexpectedly, the lowest ones were recorded in the students who spent almost 70 minutes reading the instructional material.

### 3.3 Target achievements

University students were asked about their quiz target scores at the very beginning of the learning session. This part tries to compare the decided target and the actual achievement of quiz scores. The disparity is visualised in Figure 3.

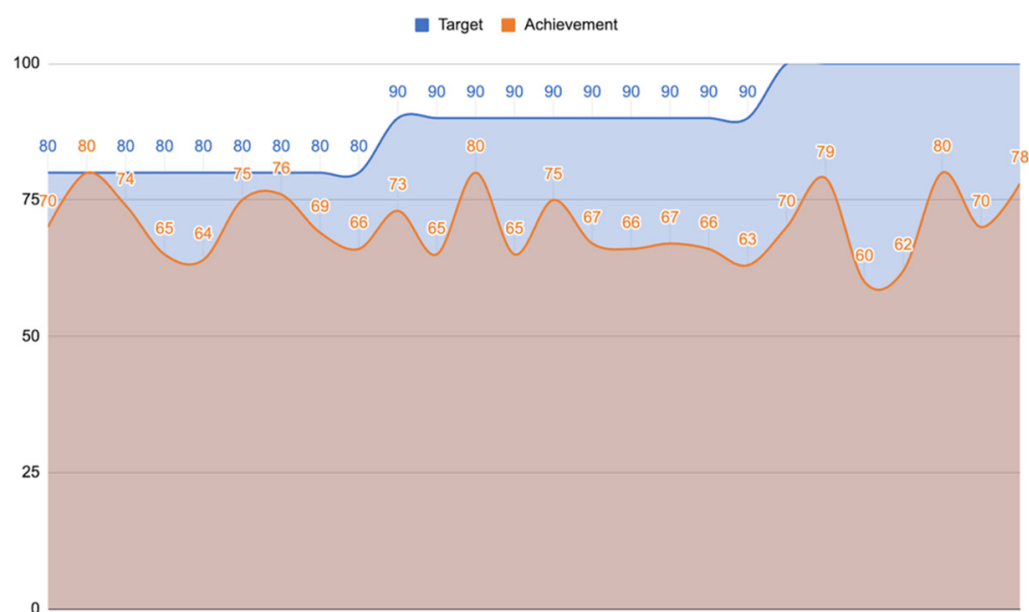


Fig. 3. Quiz score targets and achievements

Figure 3 compares the defined targets and actual achievements of quiz scores by university students. All in all, it is clear that the vast majority of students could not meet their quiz score target that they decided by themselves. The one who could meet this target is at the lowest target point, and, interestingly, the lowest achievement was found in the highest target. Over the great target points from 80 to 100, it is clear that merely one student could achieve the target of 80 points. Two students targeted the maximum point of 100, but they scored minimally at only 60 and 62 points.

#### 4 DISCUSSION

An exploratory case study was conducted to observe scaffolding self-regulated learning of university students in a statistics course focusing on their scaffolding responses, resources contribution and target achievements. The next passages discuss this focus with additional concerns on the limitations of this study and recommendations for future studies.

University students involved in this study are by far mindful of their learning aims and confident with their achievements as they targeted high quiz scores. According to Follmer [21], it indicates students’ maturity in self-regulated learning regulation for self-efficacy, or forethought, which refers to the individual capability to be self-motivated [26]. Nevertheless, it was unexpected to notice that many students could not meet their targets. This evidence reveals a lack of metacognitive performance monitoring and self-evaluation measures. Setting realistic goals and realising them is pivotal for successful self-paced learning. Students need to set measurable objectives, monitor progress timely and adjust strategies as necessary to reach top performance [13], [14]. The background idea is that they should be able to learn with minimum assistance from peers or lecturers.

Students’ responses to self-regulated learning prompts are interesting. It seems that written reflection is preferable to note-taking for improving their understanding. These activities are relatively similar and still related to writing but address



different pedagogical features. Written reflection prompts students to think about their thinking [27], [28]. It encourages them to reflect on their learning process and strategies as well as to become aware of their strengths and weaknesses in learning. Note-taking encourages active listening during lectures, discussions, or presentations [29]. By actively engaging with the information being presented, students can better process and understand learning materials. This preference denotes difficulties in note-taking for abstract content like statistics, and so they opted for reflecting on themselves. The note-taking approach may be more suitable for scaffold social learning such as sociology, history, geography and so on.

It is surprising that the duration of watching and reading learning materials has a minor impact on quiz performances. One explanation might be related to statistics subject complexities that require face-to-face and communicative demonstrations [9], [10]. Another reason is due to the learning material itself, the video and module, which are probably less appealing. Further, the quiz scores are fluctuating over the duration. This reflects that the determination of their achievement was likely to be influenced by other factors such as prior knowledge, cognitive abilities, learning styles, and other socio-cultural and environmental factors [30]. These are interrelated aspects that influence learning. Scaffolding by learning materials could be categorised as planned support [18] and responsive support based on students' feedback, which may help them better with this matter.

In a nutshell, university students' responses to self-regulated learning prompts disclose that they are aware of learning goals but overtargeting achievements. Rather than taking notes, students prefer to write a learning reflection. Specific resources such as videos and modules do not contribute significantly to their self-regulated learning performances. Students were less likely to achieve their learning targets. It can be concluded that self-regulated statistics learning requires advanced scaffolds as it has greater complexity and abstraction to support students in achieving maximum performances. This evidence indicates that university student education should promote self-regulated learning skills, either integrated or as a standalone subject [31], [32], [33], [34], [35]. Scaffolds for the more abstract subject could be enhanced respecting their characteristics. The present study was focused on observing scaffolding responses, resources contribution and target achievements by one parameter from quiz results. Students' attitudes and overall self-regulated statistics learning experience could not be concluded from this study. These matters may be further investigated by more quantitative or mixed-method studies in the future.

## 5 CONCLUSIONS

The present study has investigated scaffolding self-regulated learning of university students in the setting of a statistics course with several concerns on scaffolding responses, resources contribution and target achievements. In this exploration, the more specific aims were to investigate how were university students' responses to prompts, to what extent specific resources contributed to performance and how were university students' target achievements in scaffolding self-regulated learning. The results showed that university students are aware of learning goals but overtarget achievements, as they were less likely to achieve their learning targets. Students prefer to compose a self-reflection than take notes. The different durations of watching videos and reading modules does not vary in performance. The current findings add to a growing body of literature that self-regulated statistics learning requires advanced scaffolds to promote higher outcomes because of its characteristics as a

complex and abstract subject. Scaffolding that presents live demonstrations and interactive communications may be more powerful than non-interactive videos and reading materials in this regard. It could not be recapitulated from this study regarding the students' attitudes and overall learning experience. Researchers may work with quantitative or mixed-method studies to reveal attitude and self-regulated statistics learning experiences in the future.

## 6 ACKNOWLEDGEMENT

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