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The Effect of Online Self-Regulated Learning Process on Performance and Metacognitive Judgments

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Abstract

Metacognitive judgment enables individuals to evaluate their cognitive processes and is used to measure the outcomes of metacognitive monitoring. Research indicates that learners with monitoring difficulties tend to exhibit overconfidence, failing to correct inaccuracies in their knowledge, which negatively affects their performance. On the other hand, self-regulated learning is known to have lasting and positive effects on metacognitive skills. This study explores the impact of an online self-regulated learning process on students' performance and metacognitive assessments, including bias and absolute accuracy. Conducted using an explanatory sequential mixed-methods design, the study employs quantitative methods to analyze students' exam performance and metacognitive judgments, while qualitative methods are used to gain insights into students' experiences. The participants consist of 48 university students enrolled in an Instructional Design course. Data collection instruments include an achievement test, a metacognitive judgment test, interviews, self-regulated learning documents, project reports, and peer assessment forms. The findings indicate that online self-regulated learning positively influences students' performance and metacognitive assessments. Based on student feedback, the online self-regulated learning process was found to support cognitive and metacognitive skills such as planning, recognizing learning gaps, adjusting strategies based on feedback, tracking progress, and self-evaluation.

Keywords: Metacognitive judgment, self-regulation, self-regulated learning, overconfidence

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Introduction

Being aware of one's own cognitive processes and being able to regulate them requires metacognitive skills. When metacognitive monitoring and control skills are not sufficiently developed, learners may be overly confident about any test result, regardless of whether the information they possess is objectively correct and complete. It has been found that this situation, defined as overconfidence, causes learners to refrain from activities aimed at completing or revising incorrect and incomplete information, thereby negatively affecting performance (Bol, Hacker, O'Shea, & Allen, 2005; Lee, 2024; Lockl and Schneider, 2002; Loon, Bruin, Gog, and Merriënboer, 2013; Schneider and Löffler, 2016). Therefore, overconfidence poses a threat to both learners and the learning process. Although it is known that eliminating or reducing overconfidence is very important, there is limited evidence on how to do this successfully. Previous studies and educational initiatives on the subject have only been effective in the study environments in which they were conducted or have only improved monitoring accuracy but not improved performance (Bjork, Dunlosky, & Kornell, 2013; Kruger & Dunning, 1999). In line with these findings, empirical research has shown that overconfidence may persist even when learning outcomes improve, particularly in the absence of explicit support for metacognitive monitoring. For example, Mathabathe and Potgieter (2014) found that students who continued to overestimate their performance demonstrated lower learning gains, whereas those with more accurate metacognitive judgments achieved significantly better outcomes. Extending this line of evidence, recent research has further demonstrated that merely informing students about the risks of overconfidence is insufficient to improve performance and may even reduce the benefits of collaborative learning when metacognitive regulation is not explicitly supported (Kolić-Vehovec et al., 2022). Consistent with this line of research, recent findings indicate that students' learning outcomes are closely related to the accuracy of their metacognitive judgments, highlighting that effective learning depends on supported monitoring and regulation processes rather than confidence alone (Geraci et al., 2023).The literature suggests that self-regulated learning is effective in strengthening students' metacognitive judgments and improving their performance (De Bruin et al., 2017; Handel, Harder, & Dresel', 2020; Kostons, Gog, & Paas, 2012; Lee, 2024; Pieger, Mengelkamp, and Bannert, 2016; Roelle et al., 2017). In recent years, research on the potential of online learning environments to support metacognitive skills has gained attention. (Azevedo and Cromley, 2004; Broadbent and Poon, 2015; Dabbagh and Kitsantas, 2012). These environments have been found to positively support the learning process through factors such as offering flexibility, supporting individual differences, providing rich materials, and allowing learners to track their progress by offering a learning experience tailored to their preferences.In contrast to the risks associated with overconfidence, the work of Cloude et al. (2024) suggests that certain forms of metacognitive inaccuracy, specifically underplacement, may actually benefit performance. While novices often inaccurately monitor their work across tasks of varying difficulty, Cloude et al. (2024) found that students who underplaced their performance relative to their peers—believing their work was of lower quality than it actually was—achieved significantly higher exam grades compared to those who overplaced themselves. This finding suggests that perceiving oneself as performing below average may serve as a motivational driver, leading students to seek more help and utilize resources more effectively to bridge perceived knowledge gaps.In this study, a self-regulated learning process that could help students monitor their performance in an online environment was designed. The aim was to examine the effect of this process on performance and metacognitive judgments, and to determine student views on the process.

The next section presents the existing literature on metacognition, metacognitive judgments, overconfidence, and self-regulated learning. Subsequently, the research method and findings are explained, followed by the results, discussion, and recommendations.

Metacognition and Metacognitive Judgment

Metacognition is defined as knowing, knowing what one knows, and knowing how one knows (Knowing, Knowing About Knowing, and Knowing How to Know) (Brown, 1975). According to Nelson and Naren's (1990) Metacognitive Model, cognitive processes are monitored through metacognitive strategies, and control strategies are applied to regulate cognitive processes based on the judgments obtained. Accurate metacognitive monitoring has a significant effect on regulation activities and is thought to lead

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to better performance (Kostons, Gog, & Paas, 2012; Metcalfe & Finn, 2008; Narens & Nelson, 1990). For example, a student who is aware of their deficiencies in the course content and can anticipate potential difficulties can better understand and master the material by utilizing additional resources, allocating more time, and applying appropriate learning strategies. Conversely, a student who believes they already understand the content may not engage in further learning, which can result in poor performance if they do not actually possess the necessary knowledge. (Senko, Perry, & Greiser, 2022; Winne & Perry, 2000). Therefore, the development of metacognitive awareness plays a critical role in enhancing the effectiveness of the learning process and supporting academic achievement.

An important concept related to metacognitive monitoring is metacognitive judgment. Metacognitive judgment can be defined as a tool used to measure the results of metacognitive monitoring processes (Narens and Nelson, 1990). It enables individuals to evaluate themselves by monitoring and reflecting on their cognitive activities. Judgments of learning, the most commonly used form of metacognitive judgment in learning processes, are predictions regarding the correctness or incorrectness of items in a recently completed task (Dunlosky and Bjork, 2008). In this regard, judgments of learning play a crucial role in enhancing academic achievement by helping individuals evaluate their own learning processes and make the necessary adjustments.

Overconfidence

Overconfidence causes learners to anticipate higher performance than they actually achieve when making judgments of learning. Studies provide clear evidence of the direct detrimental effects of overconfidence on work behavior and learning outcomes. (Bol et al., 2005; Dunlosky and Rawson, 2012; Loon et al., 2013; Salem-Garcia, Palminteri, and Lebreton, 2023; Serra and DeMarree, 2016). Moreover, it has been determined that learners with low performance exhibit more overconfidence than others (De Bruin et al., 2017; Hacker, Bol, Horgan, & Rakow, 2000; Miller & Geraci, 2011).

Various educational approaches exist to eliminate or reduce excessive self-confidence that prevents learners from making accurate judgments about their performance. The first of these is to educate students about the dangers of decisions made with overconfidence (Kolić-Vehovec, Pahljina-Reinić, & Rončević Zubković, 2022; Roelle, Schmidt, Buchau, & Berthold, 2017). When students become aware of the negative consequences and significance of incorrect judgments, they may be motivated to strive for more accurate judgments. Roelle et al. (2017) found that informing students about the dangers of overconfidence increased monitoring activities, led to more cautious judgments, and promoted the acquisition of conceptual knowledge. However, Kolić-Vehovec et al. (2022) reported that informing students about the risks of overconfidence did not yield any significant benefits. Informing students about the hazards of overconfident decisions appears to be a promising approach, but it needs to be combined with other interventions (e.g., strategy training) to be effective in a classroom setting. Indeed, Huff and Nietfeld (2009) found that the group that received strategy and metacognitive judgment training before reading the text performed better and made more accurate predictions of their performance. While this approach helps learners recognize the negative effects of overconfidence and make more cautious judgments, it is not sufficient on its own. To be effective, it must be complemented with additional supportive methods, such as strategy training.

The second approach is to develop metacognitive monitoring through repeated testing. Studies have shown that, unlike repeatedly working on learning materials, repeated tests affect not only performance but also the accuracy of metacognitive monitoring (Fernandez and Jamet, 2017; Kenney and Bailey, 2021; Miller and Geraci, 2011; Roediger and Karpicke, 2006). On the other hand, studies using repeated testing have some limitations. The interventions in these studies typically consist of repeated tests and students' pre-test or post-test performance judgments, rather than improvements to the educational environment or learning process. In one study that collected only pre-test predictions, it was found that students' overconfidence did not decrease even after 13 tests (Foster et al., 2016). Similarly, a study by Handel, Harder, and Dresel (2020) found that repeated tests and individual feedback did not reduce overconfidence in students. Some studies, however, have been unable to clarify whether the decrease in overconfidence stems from repeated tests or repeated judgments (Barenberg and Dutke, 2018; Bol et al., 2005). While this approach demonstrates the potential of repeated tests to enhance metacognitive

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monitoring, it is not sufficient on its own to reduce overconfidence. Research shows that the effects of repeated tests and judgments cannot be clearly distinguished and must be supported by additional strategies such as individual feedback.

The third approach attempted to strengthen students' metacognitive judgments is to support them in making accurate assessments by enabling them to gain more knowledge about their learning processes through self-regulated learning (Narens and Nelson, 1990). Research shows that self-regulated learning helps students monitor their learning processes and make more accurate judgments about their own situations (De Bruin et al., 2017; Handel et al., 2020; Kostons et al., 2012; Lee, 2024; Pieger et al., 2016; Roelle et al., 2017). The ways in which self-regulated learning strengthens students' metacognitive judgments and its impact on learning processes will be discussed in more detail in the next section.

Self-Regulated Learning

Self-regulated learning is defined as an active and constructive process in which students plan, manage, and control their own learning processes (Zimmerman, 1990). Pintrich (2004), on the other hand, defined self-regulation as a process in which students set their own learning goals and attempt to regulate all their cognitive and affective activities, explaining that self-regulated learning encompasses many areas, including affective, cognitive, and metacognitive processes. Emotional processes involve students' emotions and how they regulate these emotions to contribute to learning. Cognitive processes refer to the use of strategies such as planning learning, setting goals, taking notes, summarizing, and making inferences during thinking, understanding, and problem solving. Metacognitive processes involve making judgments about learning during the learning process through self-monitoring and evaluation, as well as experiencing feelings of knowing what one knows. All of these aspects are enacted during the planning, monitoring, control, and reflection stages.

Students are expected to carry out their self-regulation processes based on metacognitive monitoring judgments. It is important for learners to be able to self-assess their own learning in order to organize what they have learned so far and what they will learn in the future (Dunlosky and Rawson, 2012). As a result of self-assessments, students can decide how much time to devote to studying and what their study environment should be like (Metcalfe and Finn, 2013). In both child and adult education, strong relationships have been observed between accurate self-assessment, the organization of learning, and academic achievement (Dunlosky and Rawson, 2012; Rinne and Mazzocco, 2014; Thiede, Anderson, and Therriault, 2003). Therefore, developing students' metacognitive monitoring and self-assessment skills can significantly contribute to their ability to regulate their learning processes more effectively and improve their academic achievement.

It is emphasized that self-regulated learning is effective in reducing and eliminating the effects of overconfidence, which causes students to have misjudgments about their learning processes. However, there are few studies supporting these judgments (de Bruin, Kok, Lobbestael, & de Grip, 2017; Pieger et al., 2016). Studies have generally focused on specific stages of self-regulated learning, but the entire self-regulated learning process has not been applied. Furthermore, the studies were conducted face-to-face, and the self-regulated learning process was spread over a semester, so the long-term effects of this intervention were not examined. Considering the widespread use of online learning environments today, it seems important to examine the effects of self-regulated learning processes designed for these environments on students' performance and metacognitive judgments over the course of a semester.

Overconfidence refers to the tendency for individuals to hold confidence judgments about their decisions, estimates, or abilities that are higher than what is warranted by their actual accuracy or performance (Hoffrage, 2022). Self-regulated learning plays an important role in reducing and preventing overconfidence by enabling learners to monitor and adjust their judgments more accurately. In this study, a self-regulation process designed to help students monitor their own performance in an online environment was developed, and the effects of this process on performance and metacognitive assessments were examined; additionally, students' perspectives on this process were explored. The research questions are as follows:

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1. What is the effect of the online self-regulated learning process on university students' performance?
2. How does the online self-regulated learning process affect university students' metacognitive judgments regarding their performance?
3. What are university students' perspectives on the online self-regulated learning process?

Method

Research Model

This research was conducted using an explanatory sequential mixed-methods design. The explanatory sequential mixed-methods approach is a research design in which quantitative data are first collected and analyzed to identify specific patterns, followed by the collection of qualitative data to understand or further explore these findings in greater depth. A single-group pre-test-post-test experimental design was used as the quantitative method. Within this framework, the self-regulated learning process was conducted with a single group. The primary reason for conducting the study with a single group was that the implementation would continue throughout the semester, making it impractical to divide the students into two groups. In the context of distance education, forming two separate groups and carrying out a long-term implementation would have been difficult to manage in terms of coordination, interaction, and data collection. Therefore, it was decided to conduct the study with a single group.

In the qualitative phase of the research, students' experiences and opinions regarding the self-regulated lesson were examined in depth. Semi-structured interviews were employed to collect the qualitative data.

Sample

The participants in this study were second-year students enrolled in the Instructional Design course offered by the Department of Computer and Instructional Technologies Education at a state university. As the research was conducted within the scope of the course, all the students participated. Sixty students who enrolled in the course at the beginning of the semester and continued attending were included in the self-regulated learning process. Data from 9 students who repeated the course and 3 graduate level students were excluded from the analysis due to their differences in background knowledge. Thus, the research participants consisted of 48 students in total. Participants comprised 27 female students (56.25%) and 21 male students (43.25%).

In accordance with the structure of the Instructional Design course, students taking the course have been organized into project groups. A total of 10 groups, each consisting of 5 to 7 students, have been formed. These groups are named Group A, B, C, D, E, F, G, H, J, and K. Group A consisted of seven students retaking the course, while Group K included two students retaking the course and three students from the scientific preparatory program. The other groups were formed by randomly selecting second-year students taking the course for the first time. The data from students retaking the course and from those in the preparatory program were not included in the analyses or interpreted.

Data Collection Tools

The Instructional Design course achievement test, metacognitive judgment test, group and individual interview questions, Self-Regulated Learning Documents (Planning, Monitoring, and Reflection documents), Peer Assessment Form, and Project Reports were used to collect data for the study.

Instructional Design Course Achievement Test. To measure students' achievement in the course, an achievement test consisting of 35 questions covering the course topics was used by the instructor responsible for the course. This test was administered as a pre-test at the beginning of the process and as a post-test at the end of the process. The maximum score that could be obtained from the multiple-choice test was 35. To ensure the content validity of the questions, feedback was obtained from two Computer Education and Instructional Technology (CEIT) experts. Based on the feedback received,

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minor adjustments were made to the questions. Subsequently, a Measurement and Evaluation expert was consulted to assess the alignment of the questions with measurement and evaluation standards, and the questions were revised according to their recommendations. Finally, a pilot application was conducted with four undergraduate students to evaluate the clarity of the questions, and necessary adjustments were made to finalize the test.

Metacognitive Judgment Test. Following Schraw's (2008), method of measuring metacognitive judgment, the question "Are you sure you answered this question correctly?" was asked after each question in the achievement test to assess the confidence level of the participants' responses to the pre-test and post-test questions. Students indicated their answers by selecting either "Yes" or "No."

Semi-structured Interview Form. Semi-structured individual and focus group interviews were conducted as part of the current study. In developing the interview questions, an educational technology expert initially prepared a set of questions for both the focus group and individual interviews based on the research objectives. These questions were then reviewed by two subject-matter experts for content validity and appropriateness, and necessary adjustments were made based on their feedback. Subsequently, a pilot study was conducted with three undergraduate students to assess the clarity and comprehensibility of the questions. Minor revisions were then made based on the pilot results, and the questions were finalized. A total of 14 open-ended questions were asked in the focus group interviews to explore the groups' perspectives on the self-regulated learning process and its impact on their projects. In the individual interviews, six open-ended questions were asked to gain insight into each student's views on the self-regulated learning process and group work.

Self-Regulated Learning Documents. As part of the implementation of the self-regulated learning process, groups were asked to complete Planning, Control, and Reflection documents for each cycle. The Planning document is where they determine the objectives, manage their time, and distribute tasks for the activities in their cycle. The Control document is used to verify whether time was used effectively and whether group work was completed according to the assigned task distribution. The Reflection document, completed at the final stage of the cycle, allows students to indicate their confidence in the accuracy of the tasks completed, the amount of time spent, the effectiveness of the methods used, and any problems encountered during group work. The items for the Planning, Monitoring, and Reflection stages were developed based on the models of Zimmerman (1990) and Pintrich (2004) for self-regulated learning documents. These items were then reviewed by two field experts experienced in self-regulated learning, and the documents were finalized with revisions based on their feedback.

Peer Assessment Form. At the end of the process, students were asked to fill out a peer assessment form consisting of 5 questions to evaluate their group members. Each student evaluated the members of their group according to the following dimensions: a) Regular and timely participation in group work related to the project, b) Completion of assigned tasks on time, c) Contribution of useful ideas to the project, d) Work rate for the project, and e) Quality of work performed, assigning scores between 1 (below average) and 4 (excellent). During the form's development process, peer assessment forms in the field literature were reviewed to create a list of items. Subsequently, these items were presented to two experts who had conducted research on group work in the field of CEIT, and their opinions were sought. Necessary adjustments were made based on the experts' feedback, and the form was finalized.

Project Report Evaluation Form. Groups were expected to present a teaching design related to the given project topic at the end of the semester. Groups submitted a total of 3 reports to document the teaching design process. The reports, structured to represent the stages of the design process, are as follows: a) Needs analysis report, b) Design report, and c) Development, implementation, and evaluation report. The submitted reports were graded using the Project Report Evaluation Form prepared by the course instructor and researcher, and these grades were also taken into consideration when determining the end-of-term performance grades. During the form creation process, the course instructor reviewed instructional design evaluation tools in the literature and prepared a draft form. This draft form was then sent to two instructional design experts in the field of CEIT for their feedback. Necessary adjustments were made based on their suggestions, and the form was finalized.

Process / Data Collection

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This study was conducted over 16 weeks in the Instructional Design course within the CEIT program. Students were expected to develop instructional design projects addressing specified instructional problems.

During the first week of the course, ten groups of 4–5 students were formed, and project topics were randomly assigned. Students were provided with guidance on Microsoft Teams, the online platform used for the course. In the second week, students completed the pre-test via Moodle and viewed the video entitled "What is Overconfidence?" prepared by the researchers to enhance their awareness of overconfidence.

Starting from the fourth week, the course was divided into three main cycles. The first cycle, the Needs Analysis Cycle, took place between weeks 4-7, the Design Cycle between weeks 8-11, and the Development, Implementation, and Evaluation Cycle between weeks 12-15. Each cycle lasted four weeks, and the Planning, Monitoring, and Reflection processes were applied based on Pintrich's (2004) Areas and Stages of Self-Regulated Learning model. In each cycle, the groups completed both instructional design tasks (e.g., writing learning objectives, content analysis, creating storyboards, interface design, etc.) and self-regulated learning documents.

At the end of the twelfth week, the groups' views on the self-regulated learning process were collected, and 15-minute online interviews were conducted with each group separately. The interviews were recorded and transferred to a computer environment. At the end of the process, individual interviews were also conducted with six randomly selected students.

In the sixteenth week, the Achievement Test administered in the second week of the course was re-administered as a post-test via Moodle. Students also evaluated their group peers by filling out a Peer Evaluation Form. At the end of the term, students uploaded their instructional design projects and reports prepared as part of their group work to the online system.

Data Analysis

SPSS 22 software was used to analyze the quantitative data obtained in the study. Descriptive statistics and the dependent groups' t-test were used to analyze the data obtained. Before selecting the test to be used for the analysis, the data was examined to see if it showed a normal distribution. For this purpose, the kurtosis and skewness coefficients (-2 to +2) were used, as well as the Shapiro-Wilk test. When examining the Skewness and Kurtosis Values and Shapiro-Wilk Values for the students' pre-test and post-test success, bias, and absolute accuracy scores, it was determined that the skewness and kurtosis coefficients were within the ±2 range and that the significance value according to the Shapiro-Wilk test results was greater than .05, it was determined that the data showed a normal distribution. Therefore, the dependent groups' t-test was used to compare the students' pre-test and post-test success scores, bias scores, and absolute accuracy scores.

Metacognitive judgment was calculated based on the bias and absolute accuracy values in the pre-test and post-test. Bias reflects insufficient confidence (negative bias values) or overconfidence (positive bias values). Success is the answers given to the questions in the pre-test and post-test and is expressed as pi. Judgment is the confidence in the accuracy of the answers and is expressed as ci. Bias is calculated by taking the difference between success pi and judgment ci, then taking the average over n items (Schraw, 2008):

Prejudice = $$\frac{1}{n}\sum_{i=1}^{n}(c_i - p_i)$$

Prejudice assesses the degree to which an individual shows excessive or insufficient confidence when determining their confidence level. Prejudice ranges from -1 (insufficient confidence) to 1 (excessive self-confidence). Considering that the prejudice value can change in both positive and negative directions, it provides information about the direction and magnitude of the mismatch between confidence and success. When confidence is high and success is low, overconfidence occurs. When confidence is low and success is high, underconfidence occurs. The direction of the inconsistency provides information about underconfidence versus overconfidence. The magnitude of the inconsistency

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(i.e., distance from zero) provides information about the magnitude of the judgment error (Schraw, 2008).

Absolute accuracy, the absolute value of bias, indicates the consistency between performance and judgment. For example, if a student answers a question correctly and is 100% confident that the answer is correct, it is concluded that the student has made a correct judgment. If the student answers a question correctly but is 0% confident, it is concluded that the student has made a largely incorrect judgment. Values close to zero indicate correct judgments, while values close to one indicate incorrect judgments:

Absolute accuracy = $\frac{1}{n}\sum_{i=1}^{n}|c_i - p_i|$

According to Schraw (2008), these two different metacognitive monitoring scores may be difficult to interpret together because they contain information about two different types of cognitive processes. Furthermore, again according to Schraw (2008), very few studies in the literature have evaluated the different scores together, and since metacognitive monitoring processes generally contain more information, it is unclear whether evaluating the scores together is more beneficial. Therefore, in this study, bias and absolute accuracy scores were evaluated separately.

The qualitative data in the study were collected online. These data consist of the collective responses of all group members to the group interview questions during the online sessions. The responses provided by the groups were compiled into qualitative data sets, and the individual interview questions were similarly answered through online interviews. In addition, the reports completed by the groups were uploaded to the online environment. Content analysis was used in the analysis of qualitative data. Within this scope, all qualitative data was first brought together, and the documents were read 3-4 times at specific intervals to obtain a general overview before coding. The purpose of this process was to make predictions for the classifications to be made. The coding process was initiated using table structures. In the first stage, the data was divided into two categories: common and different responses. Similar responses were then color-coded to form specific concepts. These concepts were brought together to form themes and categories, and the relationships between ideas were determined. Finally, common ideas were grouped in a meaningful way, while different opinions were noted separately and analyzed.

Each section of the project reports was assigned to students as tasks in cycles and they were asked to complete them within the specified time. After each task, the groups received feedback from the researchers and were asked to make the necessary adjustments and re-upload their work to the online learning environment. At the end of the term, the final reports uploaded by the groups to the system were evaluated using the Project Report Evaluation Form. Ten percent of the reports were analyzed by two researchers, and the consistency rate was calculated as Cohen's Kappa = 0.83. This indicates a high level of consistency between the evaluators. After discussing and resolving any differences in the analyses, the remaining reports were analyzed by one researcher.

Validity and Reliability

Various methods were applied to ensure the validity and reliability of the data collection tools used in this study.

Expert opinions were sought to ensure the content validity of the measurement tools used in the study. The Instructional Design Course Achievement Test was reviewed by subject matter experts and revised after evaluating its compliance with measurement and evaluation standards. In addition, a pilot study was conducted with four undergraduate students to test the comprehensibility of the questions, and necessary adjustments were made based on the feedback. The Metacognitive Judgment Test was structured according to Schraw's (2008) method and was developed to measure the confidence level of students' responses to each question.

The content validity of the interview forms was ensured by obtaining feedback from subject matter experts, and the questions were adapted to suit the purpose of the research. Pilot interviews were

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conducted with three undergraduate students to test the level of comprehensibility, and necessary adjustments were made. Self-Regulated Learning Documents were developed based on the models of Zimmerman (1990) and Pintrich (2004) and revised in line with the evaluations of field experts. The Peer Assessment Form and Project Report Assessment Form were created by examining assessment tools in the literature and made appropriate in terms of content in line with expert opinions.

Different methods were applied to evaluate the reliability of the measurement tools used in the study. Project Reports, which were evaluated independently by two evaluators, were analyzed using Cohen's Kappa Coefficient to measure inter-rater consistency. The reliability coefficient obtained (0.83) indicates that the evaluation process was conducted in a systematic and consistent manner.

To ensure reliability between codings in the analysis of semi-structured interviews, the codings made by two independent researchers were compared, and Miles & Huberman's (1994) reliability coefficient was calculated. The value obtained from the analysis of the group interviews (0.82) and the value obtained from the analysis of the individual interviews (0.86) indicate that the qualitative data analysis is reliable. Self-regulated learning documents were analyzed to ensure the consistency of the group and individual processes and were supported by student feedback.

Findings

The research findings are presented sequentially according to each research question. Accordingly, the findings concerning the effects of the online self-regulated learning process on students' achievements and metacognitive judgments (bias and absolute accuracy) are followed by those related to students' perspectives on the learning process.

The Effect of the Online Self-Regulated Learning Process on University Students' Achievement

A dependent groups' t-test was used to test whether there was a difference between the pre-test scores of students before self-regulated learning and their post-test scores after self-regulated learning. Information regarding the test score results is presented in Table 1. The students' post-test mean ($\bar{X}$ post = 19.44) was higher than the pre-test mean ($\bar{X}$ pre = 13.61); the difference ($p < .001$) was statistically significant and in favor of the post-test. Based on these results, it can be said that the implemented self-regulated learning process led to an increase in students' achievement.

Table 1

Comparison of Students' Pre-Test and Post-Test Scores Using the Paired-Samples t-Test

	$\bar{X}$	*N*	*SS*	*t*	*p (two-tailed)*
Pre-test	13.61	43	2.84	-8.25	.000
Final Test	19.44		4.56		

The Effect of the Online Self-Regulated Learning Process on University Students' Metacognitive Judgments Regarding Their Success

Separate analyses were conducted for bias and absolute truth to examine changes in students' metacognitive judgments. A dependent groups t-test was used to test whether there was a difference between students' bias scores before self-regulated learning and their bias scores after self-regulated learning. Information regarding the test results is presented in Table 2. The students' post-self-regulated learning bias average ($\bar{X}$ ST-Bias = .22) was higher than the pre-self-regulated learning bias average ($\bar{X}$ OT-Bias = .1); the difference ($p<.001$) was statistically significant. The increase in the average bias score in the final test indicates that students' levels of overconfidence increased at the end of the process.

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Table 2

Comparison of Students' Bias Scores Using the Paired-Samples t-Test

	$\bar{X}$	*N*	*SS*	*t*	*p (two-tailed)*
OT-Bias	.1	43	.24	-4,059	.000
ST-Bias	.22		.16		

Similarly, a dependent groups' t-test was used to test whether there was a difference between students' absolute accuracy scores before self-regulated learning and after self-regulated learning. Information about the test results is presented in Table 3. The mean absolute accuracy score of students before self-regulated learning ($\bar{X}$ OT-AbsoluteAccuracy = .43) was lower than the mean absolute accuracy score after self-regulated learning ($\bar{X}$ ST-AbsoluteAccuracy = .37); and the difference between them ($p<.001$) is statistically significant. The lower mean absolute accuracy in the final test indicates that the students performed more accurate monitoring.

Table 3

Comparison of Students' Success Absolute Accuracy Scores Using a Paired-Samples t-Test

	$\bar{X}$	*N*	*SS*	*t*	*p (two-tailed)*
OT-Absolute Accuracy	.43	43	.09	2.71	.001
ST-Absolute Accuracy	.37		.11		

University Students' Views on the Online Self-Regulated Learning Process

Groups completed project reports over three cycles: Needs Analysis Report, Design Report, and Development, Implementation, and Evaluation Report. During the process of completing these project reports, the confidence levels (%0-100) they indicated in the Planning and Reflection documents in response to the question "How confident are we that we will/have conducted a correct needs analysis/design/development, implementation, and evaluation?" were compared with the grades they received on the reports.

The confidence levels indicated by the groups in the self-regulated learning documents they filled out in Cycle 1, Planning and Reflection, and the scores they received from the Needs Analysis Report they submitted at the end of the cycle are given in Table 4. Confidence levels are expressed as values out of 100, while the Needs Analysis Report is evaluated out of 100. When examining the confidence levels reported by all groups, it is observed that the confidence level in Planning is in the 60-100 range for all groups except Group B. Similarly, it is noteworthy that the confidence levels in Reflection are also between 60 and 100 for all groups. While some groups (Groups C, D, E, G, K) expressed lower confidence levels in Reflection than in Planning, the opposite was determined for some groups (Groups B and H). One group (Group F) indicated the same confidence level in both reports. It was found that the confidence levels of the group that received the highest score in the Needs Analysis report (Group H) increased from Planning to Reflection. It was observed that Group K, which received the lowest score in the report, indicated a higher confidence level in the Planning phase, and this confidence level decreased in Reflection. It was determined that other groups received average scores from the report despite indicating confidence levels above 50%.

Table 4

Groups' Confidence Levels in Cycle 1 and Scores for the Needs Analysis Report

CYCLE 1

	Planning Document	Reflection Document	Needs Analysis Report

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	(How confident are we that we will conduct an accurate needs analysis?) %	(How confident are we that we have conducted an accurate needs analysis?) %	Score
Group B	0-10	60-70	42
Group C	70-80	60-70	76
Group D	70-80	60-70	57
Group E	70-80	60-70	62
Group F	80-90	80-90	42
Group G	80-90	60-70	42
Group H	60-70	70-80	86
Group K	80-90	70-80	34

The confidence levels expressed by the groups in the self-regulated learning documents they completed in Cycle 2 for Planning and Reflection, and the scores they received from the Design Report they submitted at the end of the cycle are presented in Table 5. Looking at the confidence levels of all groups, only one group (Group D) reduced the confidence level it stated in Planning in Reflection. The confidence levels stated by half of the groups (Groups B, C, K) in Planning did not change in Reflection. Four groups (Groups E, F, G, H) expressed a higher level of confidence in Reflection than they had indicated in Planning. The only group with a lower level of confidence in Reflection than in Planning (Group D) received the lowest score on the Design Report. Again, the confidence levels of the groups that received the highest scores on the Design Report (Groups C, F, and G) increased or remained unchanged from Planning to Reflection. Compared to Cycle 1, fewer groups lowered their confidence levels in Reflection from those in Planning, and more groups did not change their confidence levels.

Table 5
Groups' Confidence Levels in Cycle 2 and Design Report Scores

CYCLE 2

	Planning Document (How confident are we that we will create a correct design?) %	Reflection Document (How confident are we that we have created a correct design?) %	Design Report Score
Group B	60-70	60-70	67
Group C	70-80	70-80	86
Group D	70-80	60-70	33
Group E	60-70	80-90	76
Group F	70-80	80-90	76
Group G	10-20	80-90	67
Group H	70-80	80-90	57
Group K	70-80	70-80	48

The confidence levels indicated in the self-regulated learning documents completed by the groups in Cycle 3 for Planning and Reflection and the scores they received from the Development, Implementation, and Evaluation Report they submitted at the end of the cycle are given in Table 6.

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Looking at the confidence levels of all groups, it is seen that the confidence level of half of the groups has increased, while the confidence level of the other half has not changed. The confidence levels of the groups that received the highest scores on the report (Groups F and G) increased or remained unchanged in Reflection. The group that received the lowest score on the report (Group D) increased its confidence level in Reflection. The average score on the report was 73.9, which increased in Cycle 3.

Table 6

Groups' Confidence Levels in Cycle 3 and Scores for the Development, Implementation, and Evaluation Report

CYCLE 3

	PLANNING			REFLECTION			
Groups	Planning Document (How confident are we that we will develop correctly?) %	Planning Document (How confident are we that we will implement correctly?) %	Planning Document (How confident are we that we will conduct an accurate evaluation?) %	Reflection Document (How confident are we that we have made the right development?) %	Reflection Document How confident are we that we are implementing correctly? %	Reflection Document How confident are we that we have made an accurate assessment? %	Development, Implementation, and Evaluation Report Score
Group B	70-80	70-80	80-90	80-90	80-90	90-100	75
Group C	70-80	70-80	70-80	80-90	70-80	70-80	67
Group D	70-80	60-70	50-60	70-80	80-90	70-80	33
Group E	70-80	60-70	70-80	90-100	90-100	90-100	63
Group F	70-80	80-90	70-80	80-90	90-100	80-90	92
Group G	80-90	80-90	80-90	90-100	90-100	90-100	88
Group H	80-90	80-90	70-80	70-80	80-90	70-80	67
Group K	70-80	70-80	80-90	70-80	80-90	70-80	63

The average score from the Needs Analysis Report was 59.3, the average score from the Design Report was 69.5, and the average score from the Development, Implementation, and Evaluation Report was 73.9. Accordingly, considering the scores obtained from the reports, it can be said that the groups' success increased and their self-regulation skills developed according to the change in their confidence levels during the process from Cycle 1 to Cycle 3.

Group Opinions on the Learning Process. The groups' opinions on the learning process (e.g., what they thought, which aspects of the process they liked or disliked, and their experiences) are summarized

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below under two headings: instructional design process and self-regulated learning process. Under the heading of instructional design, the subheadings of Problem Identification, Needs Analysis, Environment Analysis, Writing Learning Objectives, Creating Story Sheets, Group Work, and Report Writing are discussed, while under the heading of self-regulated learning process, the subheadings of Planning, Monitoring, and Reflection are discussed. Table 7 provides the relevant headings and subheadings, along with examples of group discussions related to them.

Instructional Design Process. Regarding the process of identifying the problem situation related to the project topic, all groups stated that they had difficulty identifying the problem situation because they had not previously designed instruction and because the project topics were comprehensive or general. The groups stated that they tried to identify the problem after narrowing down the topic. In addition, two groups (Groups D and F) stated that the feedback they received was useful in the process. Regarding their experiences with the needs analysis process, the groups generally stated that they did not encounter any problems in conducting the needs analysis process, but had difficulty reaching the target audience to collect data. During the environmental analysis phase, most groups stated that they did not encounter difficulties in the process because they made joint decisions and used the data collected in the needs analysis after understanding the task. Some groups (Groups B, F) stated that they had difficulty writing learning objectives due to problems encountered in clarifying the problem. Three groups (Groups B, C and H) stated that they had difficulty in the storyboard creation process. Regarding how group decisions were made during the project work process, all groups stated that they made joint decisions through online discussions and that all group members were equally involved in the process. Regarding the report writing process, some groups (Groups C, E, G, and K) stated that they had difficulty because there were no examples in the assignments and the explanations were insufficient.

Self-Regulated Learning Process. Regarding the planning process for the needs analysis, all groups stated that they did not encounter any problems during the planning phase of the needs analysis. They stated that the planning document made a positive contribution in terms of planning, was very useful when distributing tasks, and that they made an effort to adhere to the plan.

When indicating their confidence level in conducting a good needs analysis, some groups (Groups B, E and G) stated that they gave approximate answers, while some groups (Groups C, D, F, H, and K) stated that they were confident that they would analyze the feedback correctly. When asked whether they had conducted a proper needs analysis, some groups (Groups F and H) stated that they had conducted the needs analysis well. Other groups stated that they did not think they had conducted a proper needs analysis due to difficulties encountered in the data collection process (number of participants, inability to frame the issue as a problem).

The groups stated that the control document was useful in terms of evaluating the learning processes. The document was found to be useful in terms of understanding what had been done, comparing it with the plan, identifying deficiencies, controlling the process, seeing the current situation, and serving as a motivating factor. The majority of the groups (Groups B, D, G) stated that they found the reflection document useful. They stated that the reflection document was more useful than the plan document, helped them see where they stood, and gave them an idea of what was expected of them.

Table 7

Codes Related to Group Responses and Group Opinions Associated with These Codes

Categories	Codes	Example Group Opinion
Instructional Design Process	Identifying the Problem Situation	"It was easy to identify the problem after clarifying the issue, as we didn't understand what was required at first."
	Needs Analysis	"Since it was an online data collection process, we can say it went smoothly. Because data was collected

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		before narrowing down the topic, we didn't encounter any data-related issues after narrowing it down."
	Environment Analysis	"While conducting the environment analysis, we decided as a group that it would be better to create animations through online meetings. We thought that the video would be accessible from anywhere during the distance learning process."
	Writing Learning Objectives	"Although we struggled at first, the feedback on how to write learning objectives was helpful."
	Creating Story Leaves	"We had difficulty understanding the story sheet. We struggled because our topic did not involve concepts or facts. The difficulties we experienced were resolved with feedback."
	Group Work	"We discussed and decided on all stages as a group. The entire group worked on and reviewed the combinations, edits, and final version."
	Report Writing	"We did not have difficulty writing the reports. We struggled because there was no example to help us understand what was required."
Self-Regulated Learning Process	Planning	"It made a positive contribution in terms of planning. It facilitated the distribution of tasks."
	Monitoring	"It had a significant impact in helping us see the shortcomings in each document. We considered it a self-assessment form because it allowed us to see whether we had planned the process properly or not."
	Reflection	"These documents motivated us to see ourselves. It was like a checklist."

Individual Opinions on the Learning Process. The answers given by students to each question asked to obtain their opinions on the self-regulated learning process implemented are summarized below. The question headings and sample opinions for each are given in Table 8. Regarding the impact of the learning process they underwent in the online environment on their course success, most students stated that the online learning process had a positive effect on their success. They stated that due to the way the course was taught, it was a course that could be easily followed remotely, and that they generally could not fully focus on the course in the classroom environment, but that they focused on the courses and worked regularly during the distance learning process, had more time to do research, and felt that their responsibilities had increased (Students 4, 5, and 6).

All students stated that planning before completing tasks had a positive effect on their learning. All students stated that planning before completing tasks had a positive effect on their learning. They stated that planning supported effective learning by enabling them to be aware of their progress and use time more efficiently, and that it motivated them (Students 1, 3, 4, and 6). One student also stated that planning made them feel more connected to the learning environment (Student 5).

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All students mentioned the positive effects of monitoring the process and evaluating themselves. They stated that monitoring and evaluating the process helped them be aware of what they were doing, see what level they were at, notice mistakes made during the process, and empathize (Students 1, 2, 4, and 5). One student (Student 6), however, stated that monitoring the process increased their participation and follow-up in the course but that self-evaluation did not contribute to their learning.

While some students stated that they made correct predictions about their answers in the test given at the beginning of the process, other students stated that they did not think their predictions were correct because they did not know the answers to the questions at the beginning of the process. All students stated that they made more accurate predictions about their answers to the questions in the test given at the end of the process. They stated that the reason they made accurate predictions at the end of the process was that they had more knowledge about the lesson (Students 1, 4, and 5).

Some of the students stated that the video explaining the negative effects of overconfidence contributed to determining their level of confidence regarding the questions (Students 3, 4, and 6), while others (Students 1, 2, and 5) stated that the video did not contribute.

Table 8

Codes Related to Student Responses and Student Opinions Associated with These Codes

Category	Codes	Example Student Opinion
Instructional Design Process	The impact of online learning on success	"I think it has positively affected my academic performance. Because in a classroom setting, I usually couldn't fully focus on the lesson, so I couldn't follow it completely, but in the distance learning process, since I listen to the lessons on my own, I can focus solely on the lesson and understand it. And since I'm at home, I can study regularly."
	Making Plans	"Making a plan and outlining the main draft of the projects we needed to do in advance gave us information about how to proceed."
	Monitoring the process and self-assessment	"Actually, making plans and working systematically has always motivated me, and knowing that I would be doing something at that specific time encouraged me to engage more with the lesson. In this regard, it significantly impacted my learning."
	Performance estimation	"I think my performance at the end of the process has improved compared to the beginning. Because I think I have gained something for myself during this process."
	Overconfidence training	"Yes, I can say it happened to some extent."

Peer Evaluation. In the peer evaluation form, each group member was asked to evaluate other group members on the following dimensions: regular and timely participation in group work related to the project, timely completion of assigned tasks, contribution of useful ideas for the project, work rate for the project, and quality of work performed, using a scale from 1 (below average) to 4 (excellent) at. In addition, they were expected to distribute 100 points among the group members, including themselves. When comparing the findings based on the scores given in the peer assessment forms, it is seen that some groups (E, F, G, and K) worked harmoniously because all group members gave each other above-

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average scores. On the other hand, it is seen that some groups (B, C, D, and H) did not work harmoniously throughout the process because they gave each other below-average scores.

Table 9
Distribution of Peer Evaluation Scores by Group

Group	Number of Members with Below-Average Scores (1–2)	Number of Members with Above-Average Scores (3–4)	Overall Group Functioning
B	2	3	Low harmony
C	3	3	Low harmony
D	1	4	Low harmony
E	0	All members	High harmony
F	0	All members	High harmony
G	0	All members	High harmony
H	1	4	Low harmony
K	0	All members	High harmony

Discussion and Conclusion

This study aimed to examine the effect of the online self-regulated learning process on students' achievements and their metacognitive judgments about their achievements; it also aimed to determine students' views on the online self-regulated learning process.

In the study, the final test score related to students' success was found to be statistically significantly higher than the pre-test score, thus indicating that the applied self-regulated learning process led to an increase in students' success. This result supports studies showing that online self-regulated learning has a positive effect on student achievement (Azevedo & Cromley, 2004; Broadbent & Poon, 2015; Dabbagh and Kitsantas, 2012; de Bruin et al., 2017; Jansen, Leeuwen, Jasnssen, Conjin, and Kester, 2020). Similarly, other studies have shown that self-regulated learning increases students' knowledge about the learning process (Narens and Nelson, 1990), the development and improvement of metacognitive skills (De Bruin and van Gog, 2012; Lee, 2024), and enabling students to decide how long and on which topics to study (Roger et al., 2011), thereby positively impacting performance (Kolić-Vehovec et al., 2022). The current study also shows that qualitative findings support the increase in success. In other words, in individual interviews, students stated that the online self-regulated learning process positively affected their success, that they found it easier to focus compared to face-to-face education, that they had more time to do research, and that they felt their responsibilities had increased. In group interviews, although most groups indicated that they struggled with problem-solving the

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project topic, writing learning objectives, creating storyboards, and writing reports during the instructional design process, they stated that they overcame these difficulties with the feedback they received. Looking at the information obtained from peer assessment forms, it is seen that groups working harmoniously, even if they had low scores at the beginning, increased their scores from Cycle 1 to Cycle 3 compared to groups working less harmoniously. It was determined that groups experiencing difficulties in harmony, even if they received high scores at the beginning, had a decline in their scores towards the end of the process.

In the study, when looking at their metacognitive judgments regarding their success, it was determined that students performed more accurate monitoring at the end of the process. This finding is consistent with the finding in the study by Roelle et al. (2017) that self-regulated learning and informing students about the dangers of overconfidence increases metacognitive monitoring activities and leads to more cautious judgments. The reason for the increase in the average bias from the pre-test to the post-test is that a long period of time has passed from the beginning to the end of the process and that students' prior knowledge has increased during this period, also due to the effect of self-regulated learning activities. This finding supports the result of the study conducted by Somyürek et al. (2020), which found that overconfidence is not observed when prior knowledge is very low. Looking at the students' views on the online self-regulated learning process and the document analysis data, it can be stated that the qualitative findings support the quantitative findings. For example, in individual interviews, when asked about their predictions regarding their answers on the tests given at the beginning and end of the process, students stated that they did not think their predictions were correct at the beginning of the process because they did not know the answers to the questions, but that they made more accurate predictions about their answers on the test given at the end of the process. They stated that the reason they made accurate predictions at the end of the process was that they had more knowledge about the course. When comparing the grades, the groups received on their project reports throughout the process and the confidence levels they indicated in the Planning and Reflection documents, the fact that the confidence levels of the groups whose performance increased from Cycle 1 to Cycle 3 also increased or remained stable supports the quantitative findings that they monitored more accurately. Again, when the confidence levels determined in the Planning and Reflection documents were compared with the grades obtained from the project reports, the fact that the groups had better self-regulation skills from Cycle 1 to Cycle 3 also supports the lower absolute accuracy average in the post-test and the students' more accurate monitoring, as revealed in the quantitative findings.

According to the research results, the confidence levels and performance of the groups consisting of students who stated that they struggled less in the self-regulated learning process, received more feedback, and found this process meaningful were consistent. The confidence levels and performance of the groups consisting of students who stated that they struggled in these processes and found the self-regulated learning process less meaningful were inconsistent, with high confidence levels and low performance. These results are consistent with the findings of Miller and Geraci (2011), who found that students with lower performance levels exhibited excessive self-confidence compared to students with higher performance levels.

According to another finding of the study, the learning materials provided in the online self-regulated learning process supported students in monitoring their learning processes and increased their awareness of overconfidence. According to group opinions obtained regarding the self-regulated learning process, students stated that they found the Planning, Control, and Reflection documents useful in organizing and developing different stages of their learning processes. In addition, they stated that the video explaining the negative effects of overconfidence contributed to determining their confidence levels, that they realized they had overconfidence after watching the video, and that eliminating it would positively affect the learning process. This finding supports the finding presented by Handel, Harder, and Dresel (2020) that monitoring accuracy and performance can be improved through judgment training.

This study is considered quite instructive in terms of observing the long-term effects of applying self-regulated learning in an online environment on metacognitive judgments. On the other hand, the research has some limitations. For example, although the online self-regulated learning process has

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been shown to have positive effects on performance and metacognitive judgments, it is not possible to claim that the online self-regulated learning process is the only factor affecting success and metacognitive judgments (bias and absolute accuracy) because the study was conducted with a single group. Therefore, comparing an experimental group in which self-regulated learning processes were applied and a control group in which these processes were not applied could more clearly reveal whether these effects stemmed from the applied self-regulated learning process.

In the study, guidelines were provided through written documents to support the self-regulated learning process. However, integrating self-regulated learning tools into the online environment may be beneficial to make the process more effective and accessible. For example, by providing students with a digital or printed tool such as a "Learning Journal," they can be encouraged to evaluate their learning processes at the end of each lesson. In this journal, students can record what topics they have learned, where they struggled, and how they should plan their next steps. Thus, by participating more actively in the self-regulated learning process, they can consciously manage their learning strategies. Furthermore, the environments planned for use during the online self-regulated learning process can be made available to students beforehand to gather feedback. If students find the online environment usable, they will expend less effort understanding the learning environment throughout the process, which can make the self-regulated learning process more efficient.

Research and Publication Ethics

This study complies with all rules specified in the "Higher Education Institutions Scientific Research and Publication Ethics Guidelines." None of the actions listed under the heading "Actions Contrary to Scientific Research and Publication Ethics" in the second section of the guidelines have been carried out. (Mandatory statement)

Disclosure Statements

Name of the committee conducting the ethical review: Hacettepe University Ethics Committee

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Conflict of Interest

As authors, we declare that there is no financial or non-financial conflict of interest that could influence this study.

CRediT Authorship Contribution Statement

In this article, the 1st author contributed 50%, the 2nd author contributed 25%, and the 3rd author contributed 25%.

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