

Integrating locus of control into RICOSRE-Flipped classroom for improved self-regulated learning



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Abstract: Self-regulated learning (SRL) is crucial for fostering student autonomy, critical thinking, and academic success, particularly in higher education. However, promoting SRL remains challenging due to variations in student motivation, learning habits, and perceptions of control over learning outcomes. This study investigates the impact of combining the RICOSRE learning model with the Flipped Classroom (FC) approach on SRL, with Locus of Control (LoC) examined as a moderating factor. The research objectives are: (1) to examine the effect of problem-based learning models on SRL, (2) to explore the impact of LoC on SRL, and (3) to assess the interaction between problem-based learning models and LoC on SRL development. A quasi-experimental pre-test-post-test non-equivalent control group design was employed. The study included 104 Applied Science students from an Animal Diversity course, which required complex cognitive processes, inquiry-based learning, and problem-solving. The intervention lasted for ten meetings, with SRL and LoC measured using the Motivated Strategies for Learning Questionnaire (MSLQ) and the Rotter Internal/External Scale, respectively. Data were analyzed using two-way ANCOVA to assess the interaction between the learning model and LoC. The findings indicate that the RICOSRE-FC model significantly enhances SRL compared to the PBL-FC and Conventional models. The structured stages of RICOSRE-FC provide a comprehensive framework that promotes active learning and metacognitive regulation. These results highlight the effectiveness of RICOSRE-FC in promoting SRL by combining structured learning with student-centered activities. The study demonstrates the potential of RICOSRE-FC as a valuable pedagogical strategy for enhancing SRL in higher education, especially for students with different LoC orientations, while fostering lifelong learning skills and academic resilience.

Keywords: flipped classroom, locus of control, RICOSRE, self-regulated learning

1. Introduction

College students often face difficulties in independent learning, especially in preparing learning topics in class. They are also often faced with the use of suboptimal learning strategies and often affect their learning behaviour (Boevé et al., 2017). A lack of skills in planning, monitoring, and evaluating learning processes is a major factor contributing to the low effectiveness of independent learning. This often results in students struggling to achieve optimal learning outcomes and relying heavily on instructors for assistance throughout the learning process (Corso et al., 2013). In the academic process, colleges play an important role in fostering students' independence in self-regulated learning (SRL) (Yot-Domínguez & Marcelo, 2017).

SRL is commonly associated with managing motivation, cognition, and behaviour to achieve learning goals (Callan et al., 2022; Pintrich, 2004). Research on SRL is concerned with how students exercise agency over their learning and use various ways to improve their learning outcomes (Yot-Domínguez & Marcelo, 2017). SRL is widely recognized as a critical factor in academic achievement in higher education, making it essential for student success (Schunk & Greene, 2017). SRL allows students to more deeply plan, monitor, and evaluate their learning process (Seban & Urban, 2024). Additionally, students with good SRL skills tend to better adapt to academic challenges and complete their assignments more effectively (Lawson et al., 2019).

Several studies have emphasized the importance of SRL in academic success. Students with low SRL also have low levels of motivation, attitude, and academic self-concept (Romero et al., 2022). Low SRL can hinder students' ability to manage time, set goals, and face academic challenges (Hyppönen et al., 2019; Won & Yu, 2018), thus emphasizing the need for learning strategies that support SRL to improve student achievement and independence. Low SRL is often associated with a reliance on instructor guidance and a tendency to prioritize grades over skills, causing students to give up easily when facing complex academic challenges (Seban & Urban, 2024). In addition, many students have difficulty managing independent learning due to procrastination and inability to manage time, as well as a lack of skills to utilize technological resources effectively to achieve learning goals (Hsu et al., 2023).



One of the psychological factors that plays an important role in SRL is the Locus of Control (LoC). LoC refers to an individual's perception of their control over events, outcomes, and academic circumstances (Kurtović et al., 2018). It relates to how individuals understand the relationship between their actions (Kaiser, 2024). Students with an internal LoC tend to associate success with personal abilities and effort, while those with an external LoC are more likely to associate success or failure with external factors, such as luck, the influence of others, or the complexity of the task (Curtis & Trice, 2013). The combination of low SRL and external LoC can exacerbate students' difficulties in managing their learning process independently (Vandeveldt et al., 2015). Therefore, interventions that focus on developing both internal SRL and an internal LoC are critical in higher education, particularly through the use of technology.

Technology in education plays an important role in accommodating different learning styles (Uzunboylu & Karagozlu, 2015). One increasingly popular technology-based educational approach is the flipped classroom (FC). In FC, students access instructional content through digital platforms outside of the classroom, allowing in-class activities to focus on discussions and problem-solving tasks (Mulhim, 2021). This approach encourages students to take a more active role in their learning, fostering greater involvement and responsibility toward their educational goals (Chen et al., 2019). FC promotes independent learning, a central element of SRL, by requiring students to prepare learning topics outside of class and engage in problem-solving activities before class begins (Hardianto et al., 2023).

However, the implementation of FC in educational settings still faces several challenges, particularly due to the lack of technological proficiency among instructors and students (Rivera & Flores, 2024). To overcome this challenge, it is necessary to integrate FC into problem-based learning models, such as PBL (Chua & Islam, 2020; Wang et al., 2022) or RICOSRE (Hardianto et al., 2023, 2024). Students not only increase their knowledge of learning content but improve their understanding of technology also (Kusmahardhika et al., 2024). In addition, students develop the ability to manage learning independently, aligning with the concept of SRL (Hwang & Chen, 2023). Several studies have reported that integrating FC into problem-based models improves critical thinking (Hardianto et al., 2023), clinical skills (Wang et al., 2022), digital literacy (Hardianto et al., 2024), learning engagement (Chua & Islam, 2020), and learning performance (Hwang & Chen, 2023).

Although several studies have explored the impact of problem-based models, few have examined how these models affect other variables, such as the LoC, which plays a crucial role in SRL. This study aims to address this gap by focusing on how LoC interacts with problem-based learning models to influence SRL. The research objectives of this study are threefold: (1) to investigate the impact of problem-based learning models on students' SRL, examining how this model encourages active participation, critical thinking, and autonomous learning behaviors, (2) to examine the effect of LoC on students' SRL, exploring whether students with an internal LoC demonstrate more effective self-regulation strategies compared to those with an external LoC, and (3) to explore the interaction between problem-based learning models and LoC on students' SRL, considering how this interaction may influence the development of independent learning skills, academic resilience, and long-term motivation. Through these objectives, this study seeks to provide insights into how combining problem-based learning with an understanding of students' LoC can foster a more robust learning environment that promotes autonomy and academic success.

2. Materials and Methods

2.1. Research Design

The study conducted was quasi-experimental design with a pre-test-post-test non-equivalent control group design, and LoC played as a moderating variable. Three groups were involved in this study: Conventional (Group A), PBL-FC (Group B), and RICOSRE-FC (Group C). The study took place over 10 sessions, where, in the first session, students completed the SRL pre-questionnaire. From sessions 2 to 9, each group received a different treatment using the designated learning model. In the final session (session 10), the SRL post-questionnaire and LoC questionnaire were administered. A schematic framework of the study can be seen in Figure 1.

2.2. Participants

The research sample was selected using purposive sampling to choose three classes from the third semester of the Applied Science program. A total of 104 students participated in the study through the Animal Diversity course. The course was chosen because it requires students to engage in complex cognitive processes, such as classification, comparison, and analysis of various animal taxa (Burmeister & Liu, 2020). This subject also provides opportunities for inquiry-based and problem-solving activities, making it well-suited for implementing different learning models like RICOSRE-FC and PBL-FC. Additionally, understanding this course involves integrating multiple sources of information, aligning with the development of SRL skills (Minhas et al., 2012). To minimize data bias, we implement strict supervision and conduct a thorough review of respondents when they complete the SRL and LoC questionnaires.

2.3. Intervention

The interventions provided to groups A, B, and C were conventional, PBL-FC, and RICOSRE-FC, respectively. Group A (Conventional Group): This group was designed as a negative control group and was taught using conventional learning

methods, including presentations and group discussions. The entire learning process was conducted in the classroom, with students actively involved in discussions. All information was presented by the instructor, who acted as the sole provider of the material.

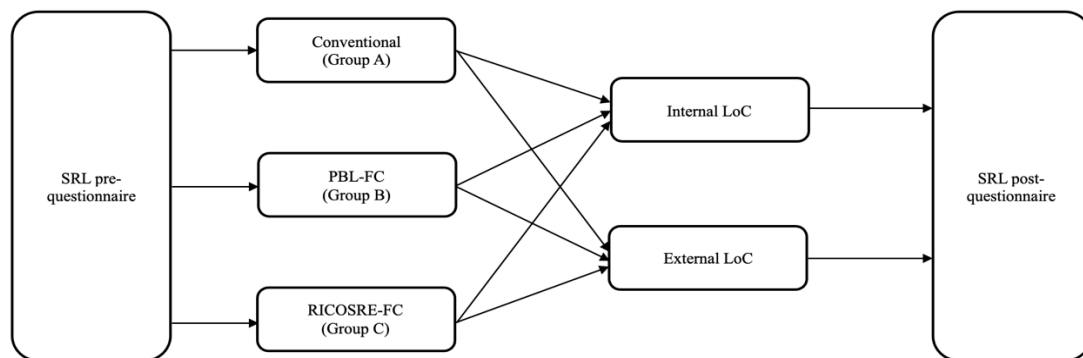


Figure 1 A schematic framework of the study.

Group B (PBL-FC Group): This group was taught using the PBL-FC model, following five stages: (1) Problem orientation—identifying and recognizing problems based on literature; (2) Student organization—identifying problems within groups; (3) Group investigation—collecting data and conducting experiments; (4) Presenting solutions—developing reports, videos, and models based on solutions; (5) Analysis and evaluation—analyzing and critiquing the results of problem-solving based on methodologies used (Arends, 2012).

Group C (RICOSRE-FC Group): This group was taught using the RICOSRE-FC model, consisting of seven stages: (1) Warm-up activities through literature reading to deepen understanding; (2) Q&A time, where learning videos were watched, and discussions occurred on online platforms to further knowledge; (3) Problem identification—identifying problems and formulating them clearly; (4) Constructing solutions—creating possible solutions; (5) Solving the problem—testing solutions for their advantages and disadvantages; (6) Reviewing the problem—presenting and gathering feedback on solutions; (7) Extending the problem-solving—analyzing solution effectiveness and considering alternative strategies (Hardianto et al., 2023).

2.4. Instrument

Questionnaires were used to measure SRL and LoC. SRL was measured using the Motivated Strategies for Learning Questionnaire (MSLQ) (Pintrich et al., 1991). The MSLQ consists of two scales: motivation (31 items) and learning strategies (50 items), assessed using a Likert scale (1-7). The MSLQ has shown reliable internal consistency, with Cronbach's alpha values of >0.70 for both scales in higher education settings (Cook & Skrupky, 2024; Duncan & McKeachie, 2005). The MSLQ was administered both before and after the intervention.

Meanwhile, LoC was measured using The Rotter Internal/External (IE) Scale (Rotter, 1966). The scale comprises two subscales—internal and external LoC—with 29 items, rated on a Likert scale (1-4). The Rotter IE scale has demonstrated acceptable internal consistency with Cronbach's alpha values of >0.60 (Fournier & Jeanrie, 1999; Schjoedt & Shaver, 2012). The LoC questionnaire was administered at the end of the learning intervention to assess students' internal or external LoC.

2.5. Ethical Considerations

Ethical approval was obtained from the university (No. 18.8.40/UN32.3.1/TU/2022) and all participants involved. Prior to participation, students were informed about the study's purpose, procedures, and their right to withdraw at any time without penalty. Consent was obtained from all participants, ensuring they were aware that their responses would be used solely for research purposes and treated with confidentiality (Tauri, 2018). The anonymity of participant data was maintained throughout the study to protect their privacy (Walford, 2005).

2.6. Data Analysis

The collected data was analysed using several statistical techniques. First a descriptive analysis was conducted to provide an overview of the data characteristics, including value distribution, means, and standard deviations. An assumption test was carried out to assess the data's suitability. The normality test checked whether the data was normally distributed, and the homogeneity test ensured the variance between groups was homogeneous (Edmonds & Kennedy, 2017).

Hypothesis testing was performed using two-way ANCOVA to evaluate the effect of the RICOSRE-FC model on SRL with LoC as a moderating variable. Two-way ANCOVA controls for relevant covariates (Edmonds & Kennedy, 2017). After hypothesis testing, the Least Significant Difference (LSD) test was used for post-hoc analysis to identify significant differences between the groups.

3. Results

The assumption tests for normality and homogeneity of the SRL data were conducted prior to further analysis. The normality test returned a significance value of 0.200 ($p > 0.05$), indicating that the data were normally distributed. Additionally, the homogeneity test showed a significance value of 0.383 ($p > 0.05$), confirming that the variances were homogeneous across groups (Table 1). These results validate that the data meet the assumptions required for subsequent parametric testing.

Table 1 the Assumption Tests.

Data Analysis	Sig.	Notes
Test of Normality	0.200	distributed normally (sig > 0.05)
Test of Homogeneity	0.383	homogeneous variance (sig > 0.05)

The research hypotheses were examined using a two-way ANCOVA, and the results are summarized in Table 2. The analysis for the first hypothesis, which investigated the effect of the learning model on students' self-regulated learning (SRL), yielded an F-value of 20.156 and a significance level of 0.000 ($p < 0.05$). This result led to the rejection of the null hypothesis (H0) and the acceptance of the alternative hypothesis (H1), indicating that the learning model significantly affected students' SRL.

Table 2 the Effect of the Research Treatment on SRL.

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	2932.484	6	488.747	11.795	.000
Intercept	10107.355	1	10107.355	243.916	.000
XSRL	105.515	1	105.515	2.546	.114
Model	1670.481	2	835.240	20.156	.000
LoC	914.288	1	914.288	22.064	.000
M * LoC	296.260	2	148.130	3.575	.032
Error	4019.477	97	41.438		
Total	639376.000	104			
Corrected Total	6951.962	103			

a. R Squared = .422 (Adjusted R Squared = .386).

Similarly, for the second hypothesis, which examined the influence of Locus of Control (LoC) on SRL, the ANCOVA result produced an F-value of 22.064 with a significance level of 0.000 ($p < 0.05$), supporting the conclusion that LoC has a significant effect on SRL. The interaction between the learning model and LoC revealed an F-value of 3.575 and a significance level of 0.032 ($p < 0.05$), indicating a significant interaction effect. These findings suggest that both the learning model and LoC, individually and interactively, influence students' SRL (Table 2).

Based on the results of the hypothesis testing and LSD test in Table 3, there was a significant difference in the mean SRL scores among the three treatment groups. The highest mean score was achieved by the RICOSRE-FC group, with a value of 82.774, indicating a substantial increase of 22.746% from the pretest score. This was followed by the PBL-FC group, which demonstrated a mean score of 77.118 with an 11.908% increase. The conventional group showed the lowest mean score, with a post-test value of 72.935, reflecting a modest increase of 6.701%. These results clearly highlight the superiority of the RICOSRE-FC model in enhancing students' SRL compared to both the PBL-FC and conventional methods.

Further analysis in Table 4 reveals that LoC also played a significant role in influencing SRL outcomes. Students with an internal LoC achieved a higher mean post-test score of 80.849, representing a 20.399% increase, compared to those with an external LoC, who had a mean score of 75.000 and an 8.296% increase. This indicates that students with an internal LoC were more adept at improving their SRL, potentially due to their greater sense of personal control and responsibility in managing their learning processes.

Table 5 presents the interaction effects between the learning model and LoC on SRL. The highest mean score was observed in the RICOSRE-FC internal LoC group, with a post-test mean of 83.095, demonstrating a 27.745% improvement. However, this score was not significantly different from those achieved by the RICOSRE-FC external LoC (mean: 82.333) and PBL-FC internal LoC (mean: 81.176) groups. These findings suggest that while the RICOSRE-FC model is highly effective for students with both internal and external LoC orientations, it is particularly beneficial for those with an internal LoC, likely due to the model's emphasis on self-regulation and reflective learning.

Table 3 the Effect of the Learning Model on SRL.

Learning Model	Mean		Dif.	Total Mean	Increase	LSD Notation
	Pre-	Post-				
Conventional	68.355	72.935	4.581	73.052	6.701%	a
PBL-FC	68.912	77.118	8.206	77.042	11.908%	b
RICOSRE-FC	67.410	82.744	15.333	82.774	22.746%	c



Table 4 the Effect of LoC on SRL.

Locus of Control	Mean		Dif.	Total Mean	Increase
	Pre-	Post-			
External (Ex)	69.255	75.000	5.745	74.628	8.296%
Internal (Int)	67.151	80.849	13.698	80.617	20.399%

Table 5 the Effect on Learning Model and LoC Interaction on SRL.

Interaction	Mean		Dif.	Total Mean	Increase	LSD Notation
	Pre-	Post-				
Conventional (Ex)	67.500	68.813	1.313	68.884	1.944%	a
PBL-FC (Ex)	69.941	73.059	3.118	72.875	4.458%	a b
Conven (Int)	69.267	77.333	8.067	77.220	11.646%	b
PBL-FC (Int)	67.882	81.176	19.584	81.208	19.584%	b c
RICOSRE-FC (Ex)	70.167	82.333	12.167	82.126	17.340%	c
RICOSRE-FC (Int)	65.048	83.095	18.048	83.423	27.745%	c

Based on the results of the hypothesis testing and LSD test in Table 3, there was a significant difference in the mean SRL scores among the three treatment groups. The highest mean score was achieved by the RICOSRE-FC group, with a value of 82.774, indicating a substantial increase of 22.746% from the pretest score. This was followed by the PBL-FC group, which demonstrated a mean score of 77.118 with an 11.908% increase. The conventional group showed the lowest mean score, with a post-test value of 72.935, reflecting a modest increase of 6.701%. These results clearly highlight the superiority of the RICOSRE-FC model in enhancing students' SRL compared to both the PBL-FC and conventional methods.

4. Discussion

4.1. Effect of the Learning Model on Students' SRL

This study revealed that students using the RICOSRE-FC learning model showed the greatest increase in SRL compared to those using the PBL-FC and conventional models. This suggests that the RICOSRE-FC model provides a more structured and effective approach to fostering SRL. The RICOSRE-FC model offers several advantages over PBL-FC and conventional models, particularly through its structured stages. A key difference is the initial reading phase in RICOSRE-FC, requiring students to engage in literature review before addressing the subject matter, fostering deeper understanding and critical thinking from the outset (Mahanal et al., 2022). This preparatory stage is absent in PBL-FC and conventional models, where students typically begin with problem orientation, potentially limiting their ability to grasp complex issues. Another unique advantage of RICOSRE-FC is the extending the problem solution stage, encouraging students to evaluate their solutions and exploring alternative strategies for future challenges. This reflective process allows for continuous learning and improvement, while PBL-FC tends to focus only on immediate problem-solving. By incorporating these additional stages, RICOSRE-FC not only enhances problem-solving skills but strengthens students' ability to generalize their learning and apply it to new contexts, making it a more comprehensive approach to fostering long-term SRL (Mahanal et al., 2022).

The *first* stage of the RICOSRE-FC model, the literature review, requires students to read and summarize key knowledge that will be explored in class. This process fosters a reading culture essential for lifelong learning, as strong reading habits enable continuous self-development (Kugathanan et al., 2019). Reading also plays a pivotal role in SRL by helping students independently locate and synthesize relevant information, thereby promoting autonomy in learning. Improving reading proficiency requires internal commitment to specific goals, such as understanding, connecting new material with prior knowledge, and making inferences. These activities enhance SRL by encouraging goal-setting, self-monitoring, and reflection (Cirino et al., 2016). Thus, the literature review stage not only prepares students academically but cultivates key SRL skills.

The *second* stage of the RICOSRE-FC is the Q&A session, designed to deepen students' engagement with the topic. In this stage, students are instructed to watch a video on the online platform, providing a foundation of knowledge on the topic. Afterward, they are encouraged to engage in discussions with their peers outside regular class hours, focusing on key concepts and issues presented in the video. This process helps students identify any areas of misunderstanding or confusion, allowing them to clarify these points before attending class (Garces et al., 2024). As a result, when students participate in class sessions, they come prepared with specific questions and a clearer understanding of the content. This independent learning process is further reinforced by tasking students with not only watching the videos but formulating meaningful questions for classroom discussion also. The structured nature of this stage fosters self-directed learning by promoting active involvement and accountability in their own educational journey (McKee, 2015).

The *third* stage is the problem identification. The RICOSRE-FC model plays a critical role in fostering SRL by engaging students in the process of recognizing and analyzing issues from the reading topics. Problem identification is the process of recognizing and conceptualizing a problem from various angles, considering opportunities that may arise from these various conceptualizations, and analyzing the root of the problem before engaging in problem solving (Abdulla et al., 2020). This



process improves self-regulation by requiring students to filter problems and determine which ones are significant for further discussion (Arreola & Reiter-Palmon, 2016). Therefore, problem identification is a foundation for developing appropriate solutions to related issues (Arreola & Reiter-Palmon, 2016).

In the *fourth* stage, constructing the solution, students are encouraged to develop problem-solving strategies based on insights from the previous stage. This phase promotes independent exploration, as students must actively seek solutions to address complex problems (Cavicchi et al., 2009). Students refine their ability to formulate effective and practical solutions by identifying and analyzing relevant information (Schukajlow et al., 2019). A well-designed solution is not only thoughtful but also feasible (Corazza, 2016), requiring students to engage deeply with the learning topics. These activities inherently foster SRL by promoting critical thinking, decision-making, and self-reliance as students independently work to resolve issues.

In the *fifth* stage, solving the problem, students apply the solutions developed in the previous stage. This process not only tests their reasoning abilities but also reinforces the self-directed strategies needed to tackle daily problems (Ince, 2018). Overcoming obstacles in problem-solving requires students to employ various techniques to address the barriers they encounter. They develop crucial SRL skills through this process, such as evaluating, testing, and refining solutions to achieve desired outcomes (Ince, 2018). Effective SRL demands that students accurately assess their performance and determine the most appropriate next tasks (Pieplenbosch et al., 2024). This enables them to independently and effectively direct their learning processes, helping them become more self-directed and adaptive learners in problem-solving.

In the *sixth* stage, reviewing the problem, students present their findings from the problem-solving phase to evaluate the effectiveness of the strategies they implemented and receive feedback from their peers. This activity not only assesses the outcomes but also provides an opportunity for students to deepen their understanding based on their investigations (Llewellyn, 2013). Along with presenting their results, students must select the most effective solution from the alternatives they have developed. By evaluating the benefits and drawbacks of each solution, students identify the most effective means of resolving the issue at hand. This process strengthens their SRL skills by fostering critical evaluation, decision-making, and the application of feedback (Thiede et al., 2017).

The *last* stage of RICOSRE-FC is extending the problem solution. At this stage, students assess the effectiveness of their selected solution and explore alternative methods that might better address similar issues. By receiving feedback from peers, students learn to discern the most suitable approach for analogous situations. This activity enhances SRL by engaging students in evaluating solutions, preparing presentation materials, communicating their results, and applying their solution to new problems (Liu et al., 2024). SRL is crucial, as it serves as the foundation for a wide range of educational endeavors (Seban & Urban, 2024). Additionally, SRL helps students avoid excessive reliance on external support, fostering independence in completing tasks and taking on responsibilities (Akhmedjanova, 2024).

The RICOSRE-FC model has proven highly effective in fostering students' SRL by providing a structured framework that encourages active engagement, critical thinking, and independent problem-solving. The model supports the development of key SRL skills, including goal-setting, self-monitoring, reflection, and adaptation. By emphasizing student-centered learning, the model enhances motivation and self-confidence, enabling students to become more resilient learners. These advantages, compared to PBL-FC and conventional models, highlight the importance of structured learning in promoting long-term educational strategies. As students progress through these stages, they gain greater ownership of their learning, refine their strategies, and apply their knowledge in new contexts, making the RICOSRE-FC model a powerful tool for enhancing SRL and equipping students with the skills needed for lifelong learning and success.

4.2. Effect of LoC on Students' SRL

The findings from the current study indicated that students with an internal LoC are more responsible for their independent learning, highly motivated, and less reliant on their teachers. This aligns with Arsini & Rusmana (2023), who found that students focusing on internal factors tend to be more resilient and better equipped to overcome difficulties. Students with an internal LoC actively engage in organizing their learning activities, which demonstrates a strong sense of independence and self-reliance (Bukhteeva et al., 2022). Their understanding of the benefits and drawbacks of their learning strategies allows them to make more informed decisions about their learning, including when to seek assistance. These students tend to believe their actions directly impact outcomes, thereby boosting their motivation and involvement in SRL (de Bruin et al., 2023). Consequently, they are better prepared for self-directed learning by exhibiting higher levels of readiness and capability to manage their own learning (Alkorashy & Alotaibi, 2023).

Furthermore, students with an internal LoC show more positive attitudes toward challenging learning strategies, such as desirable difficulties, which are essential for effective SRL (de Bruin et al., 2023). They view complex tasks as opportunities for growth, leading to the development of advanced cognitive and metacognitive strategies. This mindset not only improves their learning outcomes but also correlates with higher academic achievement (Arsini & Rusmana, 2023). These students are more proactive in learning and demonstrate strong self-efficacy (Shepherd et al., 2006). Ultimately, their ability to control their academic journey promotes perseverance, efficient time management, and goal-setting, all of which lead to academic success and the development of lifelong learning skills.

In contrast, students with an external LoC often feel they have limited control over their success and rely on external factors, such as teachers, peers, or their environment, to guide their learning (Hsia, 2016). Students often face difficulties in taking ownership of their learning, instead relying extensively on external guidance for direction and feedback. This lack of SRL presents significant challenges, particularly in learning environments that demand a high degree of independence, such as online courses (Chang et al., 2014). Students with an external LoC may struggle to adapt to the demands of independent learning strategies, as they typically lack the initiative and self-regulatory skills necessary for managing their learning without constant external support (Hsia et al., 2014).

Furthermore, students with an external LoC tend to struggle with adapting to the challenges of unfamiliar or complex tasks. Their reliance on external guidance often limits their ability to develop problem-solving skills autonomously. This dependency on external factors can inhibit the development of critical thinking and metacognitive skills, as these students may not regularly engage in self-reflection or adjust their learning strategies independently. Without a strong sense of internal control, they may find it difficult to navigate tasks that require innovative thinking and self-directed problem-solving (Arsini & Rusmana, 2023). Consequently, their growth in self-regulated learning (SRL) is impeded, as they are less likely to actively seek improvement or adapt their strategies to new learning contexts (Curtis & Trice, 2013; Vandavelde et al., 2015).

4.3. Interaction between the Learning Model and LoC on Students' SRL

To ensure learning is compatible and meaningful for all students, instructors must design the learning environment to accommodate the unique needs and characteristics of each individual (Tayebinik & Puteh, 2013). Achieving this requires an understanding of diverse learning styles and preferences, as well as creating adaptable spaces that encourage student engagement. One significant factor influencing learning is LoC, which relates to students' perception of their ability to control and influence their achievements and setbacks (Rotter, 1966). Studies have shown that traditional learning environments often fail to address these individual learning differences, leading to disengagement for many students (Uzunboylu & Karagozlu, 2015). As a result, modern educational approaches must be more inclusive to accommodate various student needs.

Educational technology plays a crucial role in bridging this gap by accommodating different learning styles (Uzunboylu & Karagozlu, 2015). FC is one such approach that emphasizes the use of technology to foster student-centered learning. In this model, students access course material through computer-mediated resources and review lecture content outside the classroom (Chen et al., 2019; Herlambang et al., 2024). This method allows both internal and external LoC students to take more control of their learning processes, supporting individualized learning objectives. The FC model enhances students' comprehension of course material, helping them build a stronger foundation for academic success (Mulhim, 2021). By integrating technological tools into education, it ensures that students with different LoC orientations can effectively regulate their learning journeys and reach their full potential.

The integration of the RICOSRE-FC significantly enhances students' SRL, especially when LoC serves as a moderating factor. The RICOSRE-FC model promotes independent learning through various stages that require active engagement, such as conducting literature reviews, reviewing the problems, and extending the problem solutions. These activities are especially suited to students with an internal LoC, who are motivated by autonomy and naturally take charge of their learning, gaining greater control over their educational journey (Sun et al., 2017). However, students with an external LoC benefit, as RICOSRE-FC's structured stages encourage them to progressively build independent learning skills by engaging more deeply with the learning topics and taking responsibility for their progress (Schraw et al., 2006). Each stage of the RICOSRE-FC process helps students to develop critical SRL competencies, such as identifying problems, generating solutions, and evaluating outcomes, thereby enhancing learning for both internal and external LoC students. Therefore, the integration of RICOSRE-FC not only strengthens SRL but also helps to balance the learning needs of students with different LoC, ultimately improving their academic achievements.

4.4. Limitation and Further Research

This study has several limitations that should be addressed in future research. First, the sample size was limited to a specific group of university students in a single academic program, which may affect the generalizability of the findings to other disciplines or educational levels. Expanding the study to include a more diverse population across different academic fields would provide a broader understanding of the impact of the RICOSRE-FC model. Second, the study only measured short-term SRL improvements. So, longitudinal studies are needed to examine the long-term effects of the RICOSRE-FC model on SRL development over time.

Additionally, while this research considered LoC as a moderating variable, other factors, such as motivation, cognitive abilities, and prior knowledge, may also influence SRL outcomes. Future research should explore the interaction between these factors and SRL. Lastly, qualitative methods such as interviews or focus groups could provide deeper insights into students' experiences with the RICOSRE-FC model, offering a more comprehensive understanding of its effectiveness.

5. Conclusions

The integration of the RICOSRE-FC significantly enhanced students' SRL, with LoC serving as a moderating factor. The structured steps of RICOSRE-FC, which include literature reviews, identifying the problem, and reviewing the solution, are especially beneficial for students with an internal LoC, who tend to take greater responsibility for their learning. The research confirmed that the RICOSRE-FC model not only promotes SRL by fostering active and independent learning strategies but also helps bridge the gap between students with varying LoC orientations, leading to improved academic outcomes. These findings suggest that the RICOSRE-FC is an effective educational strategy for enhancing SRL in university students, making it a valuable tool in modern education.

Ethical considerations

This study complies with ethical writing guidelines.

Conflict of Interest

The authors declare no conflicts of interest.

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