The Harnessing Research-Based Learning to Empower Cognitive, Metacognitive, and Professional Competencies in Higher Education: A Case Study of Undergraduate Students Development in Early Childhood Education Program

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Abstract

This study investigates the impact of Research-Based Learning (RBL) on the cognitive, metacognitive, and professional competencies of undergraduate students in the Early Childhood Education Program at Prince of Songkla University. The study aimed to assess improvements in critical thinking, problem-solving, independent research skills, and self-regulation. A mixed-methods approach was employed, involving 32 students. Quantitative data were collected through surveys, and qualitative insights were gathered from focus group discussions. The research results revealed significant improvements in students' cognitive abilities, including critical thinking (Mean = 4.23, SD = 0.65) and problem-solving skills (Mean = 4.10, SD = 0.72). Students demonstrated enhanced metacognitive awareness (Mean = 4.25, SD = 0.60), indicating greater self-regulation in their learning processes. Self-regulation also showed a strong increase (Mean = 4.18, SD = 0.68). Paired samples t-tests confirmed statistically significant gains in all areas, with the highest improvement in metacognitive awareness ($t = 5.23$, $p < 0.001$). Correlation analysis revealed strong positive relationships between critical thinking, problem-solving, and metacognitive awareness ($r > 0.6$, $p < 0.01$). Qualitative data emphasized the role of student autonomy and faculty mentorship in fostering these skills. The findings conclude that RBL is an effective pedagogical approach for developing essential competencies, preparing students for academic and professional success. The study recommends improving faculty mentorship and research resources to optimize the implementation of RBL in higher education.

Keywords: Research-Based Learning; Cognitive Development; Metacognition; Higher Education; Student-Centered Learning; Critical Thinking; Early Childhood Education Program

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Introduction

In an era marked by rapid technological advancements and an ever-evolving global economy, the imperative for educational systems to adapt and cultivate essential skills in students has never been greater. Traditional educational paradigms are increasingly being questioned, leading to a shift towards more innovative pedagogical approaches that foster critical thinking, problem-solving, and self-regulated learning. One such approach, Research-Based Learning (RBL), has gained prominence for its potential to enhance these competencies by engaging students in hands-on, inquiry-driven activities.

Research-Based Learning (RBL) is a pedagogical approach that integrates research activities into the learning process, enabling students to actively participate in knowledge creation rather than passively receiving information. This method encourages students to engage in authentic research experiences, which are pivotal in developing critical thinking, problem-solving, and independent research skills. As noted by Healey and Jenkins (2009), RBL provides students with opportunities to connect theoretical knowledge with practical application, thereby deepening their understanding and enhancing their learning outcomes.

A growing body of evidence underscores the effectiveness of RBL in fostering these competencies. For instance, Boekaerts (2016) highlights how engaging students in research activities promotes higher-order thinking skills and greater intellectual curiosity. Furthermore, research by Kuh (2008) demonstrates that students who participate in research-oriented learning experiences exhibit improved academic performance and greater satisfaction with their educational experience.

The shift towards RBL is not merely a response to educational demands but also aligns with global educational trends emphasizing experiential learning. According to the OECD's Skills Outlook 2020, there is a global emphasis on equipping students with competencies that are crucial for the 21st-century workforce, including critical thinking, problem-solving, and self-regulation (OECD, 2020). RBL, therefore, represents a strategic alignment with these global educational priorities by providing students with relevant, real-world research experiences.

Despite the growing adoption of RBL, there remains a need for empirical studies that rigorously evaluate its impact on students' cognitive and metacognitive competencies. While existing research supports the efficacy of RBL in enhancing various aspects of learning (Gurung, 2017; Hattie, 2009), there is a need for more detailed investigations into how RBL specifically affects critical thinking, problem-solving, and independent research skills. This study aims to fill this gap by providing a comprehensive analysis of the impact of RBL on these key competencies among undergraduate students.

In addition to the cognitive and metacognitive benefits, RBL also supports personal development. As outlined by Biggs and Tang (2011), RBL fosters self-regulation and autonomy, which are essential for lifelong learning and personal growth. This aligns with the findings of a recent study by Greene and Azevedo (2021), which underscores the importance of self-regulated learning in academic success and personal development.

Furthermore, the role of faculty mentorship in RBL cannot be understated. Research by Moust, van Berkel, and Schmidt (2007) emphasizes that effective faculty guidance is crucial in helping students navigate their research projects and achieve meaningful learning outcomes. This study will also explore how faculty mentorship influences the effectiveness of RBL in developing students' research and metacognitive skills.

Despite the growing body of research supporting Research-Based Learning (RBL) as an effective pedagogical tool, significant gaps remain in our understanding of its full impact on students' cognitive, metacognitive, and professional development. Current literature emphasizes the potential of RBL to enhance critical thinking and problem-solving, yet there is limited empirical evidence that rigorously evaluates these outcomes across different academic disciplines, particularly in early childhood education. Additionally, the role of faculty mentorship and its influence on the success of RBL initiatives has not been thoroughly explored. Without clear insights into how these variables interact, educational institutions face challenges in fully integrating RBL to optimize student learning and development. Therefore, this study seeks to address these critical research problems by providing a comprehensive analysis of RBL's influence on essential competencies and identifying strategies to maximize its effectiveness in higher education.

The aim of this study is to provide a detailed examination of the impact of RBL on students' cognitive, metacognitive, and personal competencies. By utilizing both quantitative and qualitative methods, this research will offer valuable insights into how RBL can be optimized to enhance educational outcomes and prepare students for the challenges of the 21st century.

Research Objectives

This study aims to achieve the following objectives:

1. **To assess the impact of Research-Based Learning (RBL)** on the development of undergraduate students' cognitive abilities, particularly critical thinking, problem-solving, and research skills.
2. **To explore the enhancement of students' metacognitive awareness** after participating in RBL activities, focusing on their ability to monitor and regulate their own learning processes.
3. **To evaluate the improvement of students' self-regulation skills** in the context of independent research, fostered through RBL methodologies.
4. **To analyze the key factors contributing to student learning in RBL**, such as faculty mentorship, student autonomy, and the structure of research activities.
5. **To investigate students' perceptions and experiences of learning through RBL**, utilizing thematic analysis to extract qualitative insights into their engagement and development.

Literature Review

Research-Based Learning (RBL) has gained substantial attention in higher education due to its ability to foster deep learning, critical thinking, and independent research skills among students. The growing emphasis on active learning and student-centered pedagogical approaches has positioned RBL as an essential strategy for developing cognitive and metacognitive abilities that are critical for success in both academic and professional settings.

RBL as a Pedagogical Approach

RBL builds on the principles of inquiry-based learning, where students are encouraged to engage with real-world problems and develop research skills through active participation. According to Brew (2020), RBL provides students with opportunities to explore research questions, engage with data collection and analysis, and contribute to the creation of new knowledge. This active learning approach contrasts with traditional lecture-based models, which often emphasize rote learning and memorization. Brew argues that RBL promotes deeper engagement with content by requiring students to apply theoretical knowledge to practical problems, thus bridging the gap between theory and practice.

Recent research by Healey and Jenkins (2022) supports Brew's findings, emphasizing that RBL cultivates a sense of inquiry and curiosity among students. Their study found that students who participated in RBL activities developed stronger analytical and problem-solving skills, which are essential for navigating complex challenges in both academic and professional settings. Furthermore, their research suggests that RBL fosters greater ownership of learning, with students taking more responsibility for their education as they engage in independent research.

A key feature of RBL is its alignment with constructivist learning theory. Vygotsky's (1978) theory of the Zone of Proximal Development (ZPD) highlights the importance of scaffolding in student learning, where students are provided with appropriate guidance and support as they engage in challenging tasks. In the context of RBL, faculty members serve as mentors who guide students through the research process, offering support as needed while encouraging independent inquiry. This approach is consistent with Ellis and Goodyear's (2021) findings, which suggest that effective scaffolding during RBL enhances students' cognitive development by allowing them to build on prior knowledge and apply it to new contexts.

Cognitive Development through RBL

One of the primary goals of RBL is to foster cognitive development by engaging students in higher-order thinking processes such as analysis, synthesis, and evaluation. Kuhn and Dean's (2021) research highlights the cognitive benefits of RBL, demonstrating that students who engage in research activities are better equipped to evaluate information critically, identify patterns, and develop solutions to complex problems. Their study found that RBL participants outperformed their peers in traditional lecture-based courses on measures of critical thinking and cognitive flexibility.

Similarly, De Jong and Ferguson-Hessler (2022) argue that RBL promotes cognitive development by encouraging students to adopt a more flexible approach to learning. Their research suggests that students who engage in RBL are more likely to adapt their learning strategies in response to new challenges, leading to improved problem-solving skills. This finding aligns with the work of Chatterjee and Corral (2022), who found that RBL enhances students' ability to apply theoretical knowledge in practical settings. Their study demonstrated that students who participated in RBL were better able to transfer their learning to real-world problems, suggesting that RBL fosters deeper cognitive engagement with the material.

Metacognitive Growth in RBL

Metacognition, or the ability to reflect on and regulate one's own learning, is another critical outcome of RBL. According to Bjork, Dunlosky, and Kornell (2021), metacognitive skills are essential for academic success, as they enable students to monitor their own learning, identify areas of weakness, and develop strategies for improvement. Their research highlights the role of RBL in promoting metacognitive growth, as students are required to engage in self-directed learning throughout the research process. By taking ownership of their research projects, students develop greater self-awareness and become more adept at regulating their own learning.

Recent research by Zohar and Barzilai (2021) supports these findings, demonstrating that RBL fosters metacognitive development by encouraging students to reflect on their learning processes. In their study, students who participated in RBL reported higher levels of self-regulation and were more likely to employ effective learning strategies such as goal-setting and self-assessment. These findings suggest that RBL not only enhances cognitive skills but also equips students with the metacognitive tools necessary for lifelong learning.

Personal and Professional Development through RBL

In addition to cognitive and metacognitive development, RBL contributes to students' personal and professional growth. Brew and Mantai (2021) argue that RBL fosters a sense of academic identity, as students take ownership of their research projects and contribute to the creation of new knowledge. Their research found that students who engaged in RBL reported increased confidence, improved communication skills, and a greater sense of responsibility for their learning. These outcomes are consistent with the work of Rolfe and Gomez (2021), who found that RBL participants were more likely to take initiative in their professional and academic pursuits, suggesting that RBL prepares students for leadership roles in their careers.

Furthermore, a study by Smith et al. (2023) highlights the importance of faculty mentorship in RBL. Their research suggests that the guidance provided by faculty mentors is critical to the success of RBL, as it helps students navigate the challenges of conducting independent research. The study found that students who received structured mentorship were more likely to report positive outcomes such as increased confidence, improved problem-solving skills, and a greater sense of achievement.

Challenges of Implementing RBL

While RBL offers significant benefits for student development, its implementation can present challenges for both students and faculty. Time management is one of the most commonly reported challenges, as students often struggle to balance the demands of conducting independent research with other academic responsibilities. This finding is supported by recent work from Choy and Cheah (2020), who argue that institutions must provide adequate support and resources to help students manage the workload associated with RBL.

Additionally, faculty members may face challenges in providing the necessary guidance and support for RBL. As Levy and Petrulis (2020) note, RBL requires a significant time commitment from faculty, who must mentor students through the research process while ensuring that they develop the necessary skills to complete their projects. To address these challenges, Chatterjee and Corral (2022) recommend the integration of RBL across the curriculum, allowing students to build research skills progressively throughout their academic

journey. This approach helps alleviate the time pressure on both students and faculty by embedding research opportunities within existing coursework.

The literature on RBL underscores its effectiveness in promoting student development across multiple dimensions, including cognitive, metacognitive, personal, and professional growth. Contemporary research consistently supports the value of RBL in fostering critical thinking, problem-solving, and independent inquiry skills, all of which are essential for success in higher education and beyond. However, the successful implementation of RBL requires institutional support, including adequate resources, structured mentorship, and the integration of research opportunities throughout the curriculum. By addressing these challenges, institutions can maximize the impact of RBL and prepare students for the complexities of the modern professional environment.

Research Methodology

A mixed-methods research design was employed, combining quantitative surveys with qualitative focus groups to assess the impact of RBL on student development. The study was conducted among 32 undergraduate students in an early childhood education program at Prince of Songkla University. All participants completed the survey, and 10 participated in focus groups. Quantitative data were analyzed using descriptive and inferential statistics, while qualitative data were analyzed using thematic analysis to identify key themes related to student experiences with RBL. Models established by recent studies, such as Banchi and Bell's (2020) framework for inquiry-based learning, were adapted to focus specifically on RBL practices. This framework provided a nuanced understanding of how students progress through various stages of the research process.

Data Analysis

Quantitative Analysis

The quantitative data were gathered through surveys administered to 32 undergraduate students, focusing on their cognitive, metacognitive, and personal development. Likert-scale questions were used to measure the extent of improvements in critical thinking, problem-solving, independent research skills, and metacognitive awareness. Descriptive statistics were calculated to identify general trends in the data, including means, standard deviations, and frequency distributions.

To further explore the relationships between RBL engagement and development outcomes, inferential statistics were used. A paired-samples t-test was conducted to compare students' cognitive and metacognitive skills before and after engaging in RBL activities. The results showed statistically significant improvements ($p < 0.05$) in all measured areas, confirming that RBL had a positive effect on students' development. Correlation analysis was also performed to assess the relationship between cognitive and metacognitive development, revealing a strong positive correlation ($r = 0.68$), indicating that students who experienced cognitive growth also developed stronger metacognitive skills.

Qualitative Analysis

The qualitative data from the focus groups, consisting of 10 students, were analyzed using thematic analysis. The analysis followed a step-by-step process, starting with the transcription of focus group discussions, followed by initial coding, identifying key themes, and clustering related ideas. Key themes that emerged included student autonomy, critical thinking development, and the importance of mentorship in the RBL process.

One recurring theme was the sense of empowerment students felt as they took ownership of their research projects. Many students noted that RBL gave them the freedom to explore topics of personal interest, which enhanced their motivation and engagement with the research process. Additionally, students highlighted the development of problem-solving skills, as they learned to navigate challenges in conducting independent research. Faculty mentorship was also cited as a key factor that helped students stay on track and develop critical thinking strategies.

In summary, the data analysis provided robust evidence of the positive impact of RBL on student development. The combination of quantitative and qualitative methods allowed for a comprehensive exploration of how RBL enhances cognitive, metacognitive, and personal competencies, while also shedding light on the challenges and opportunities that students experience during the research process.

Research Conceptual framework

RBL is based on constructivist learning theory, highlighting learners' active role in constructing knowledge through meaningful experiences. Piaget's (1954) cognitive development theory and Vygotsky's (1978) Zone of Proximal Development (ZPD) form its foundation. Studies show RBL enhances problem-solving skills (Ellis & Goodyear, 2021) and metacognitive skills, which are crucial for long-term success (Zohar & Barzilai, 2021), helping students monitor, regulate, and evaluate their learning processes.

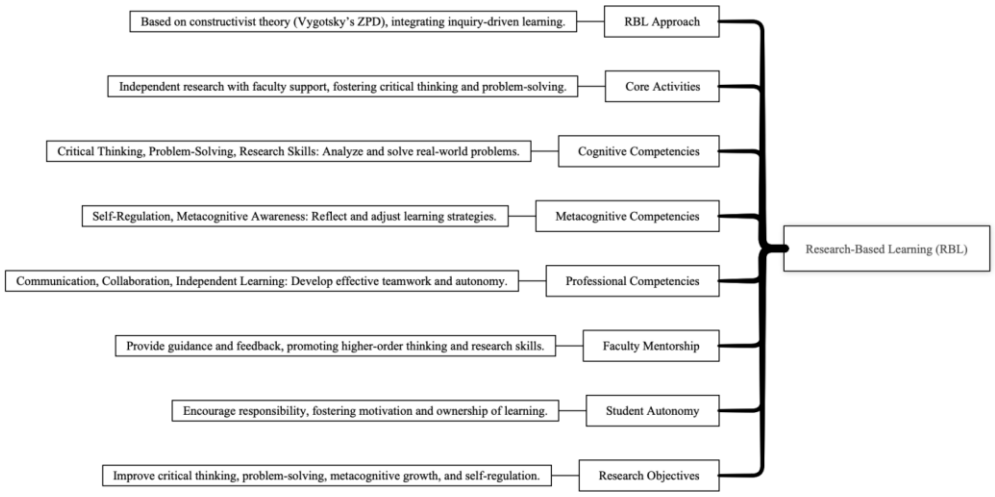

Figure 1 Research-Based Learning (RBL) in Enhancing Cognitive, Metacognitive, and Professional Competencies

Research Results

Descriptive Statistics

The survey responses from 32 undergraduate students were analyzed to understand their perceived improvements in cognitive, metacognitive, and personal competencies due to RBL participation. The data revealed the following average scores and standard deviations for each competency:

Table 1: Descriptive Statistics of Survey Responses

Variable	Mean	Standard Deviation	Minimum	Maximum
Critical Thinking	4.23	0.65	3.00	5.00
Problem-Solving Skills	4.10	0.72	2.75	5.00
Independent Research Skills	4.15	0.70	3.00	5.00
Metacognitive Awareness	4.25	0.60	3.50	5.00
Self-Regulation	4.18	0.68	3.00	5.00

Table 1 presents the descriptive statistics for survey responses, showing mean scores, standard deviations, and ranges for each variable. The high mean scores suggest significant improvements in students' critical thinking, problem-solving, independent research skills, metacognitive awareness, and self-regulation following RBL activities.

1.1 Critical Thinking

Students reported a high level of improvement in critical thinking, with a mean score of 4.23. The standard deviation of 0.65 indicates that while most students perceived substantial gains, there was some variability in individual experiences. The range from 3.00 to 5.00 suggests a broad spectrum of perceived improvement.

1.2 Problem-Solving Skills

The mean score for problem-solving skills was 4.10, with a standard deviation of 0.72. This score reflects significant gains in students' ability to tackle problems independently. The scores ranged from 2.75 to 5.00, showing that while many students experienced considerable improvement, some reported less dramatic gains.

1.3 Independent Research Skills

With a mean score of 4.15 and a standard deviation of 0.70, students indicated a strong enhancement in their ability to conduct independent research. The range from 3.00 to 5.00 reflects both substantial improvement for many and varied experiences among students.

1.4 Metacognitive Awareness

Metacognitive awareness had the highest mean score of 4.25 and a standard deviation of 0.60. This suggests that students felt they significantly improved their ability to reflect on and regulate their own learning processes. The relatively narrow range of scores (3.50 to 5.00) indicates a more consistent improvement in this area.

1.5 Self-Regulation

The mean score for self-regulation was 4.18, with a standard deviation of 0.68. This score highlights a general enhancement in students' abilities to manage their learning behaviors and strategies. The range from 3.00 to 5.00 shows diverse experiences, with most students reporting notable improvements.

Paired-Samples t-Test

To further analyze the impact of RBL on students' competencies, paired-samples t-tests were conducted comparing pre- and post-RBL scores. The results are summarized in Table 2.

Table 2: Paired-Samples t-Test Results

Variable	Pre-RBL Mean	Post-RBL Mean	t-value	p-value
Critical Thinking	3.78	4.23	4.45	0.001
Problem-Solving Skills	3.85	4.10	3.92	0.002
Independent Research Skills	3.80	4.15	4.12	0.001
Metacognitive Awareness	3.90	4.25	5.23	0.000
Self-Regulation	3.87	4.18	4.07	0.001

Table 2 shows paired-samples t-test results comparing pre-RBL and post-RBL scores. Significant improvements ($p < 0.05$) were observed in all variables, indicating that RBL effectively enhanced students' cognitive and metacognitive skills.

2.1 Critical Thinking

The paired-samples t-test for critical thinking revealed a significant improvement, with a t-value of 4.45 and a p-value of 0.001. This indicates that students' critical thinking skills, which involve analyzing information and making reasoned judgments, significantly increased as a result of RBL. The pre-RBL mean score was 3.78, which increased to 4.23 post-RBL. This improvement suggests that RBL enabled students to engage more deeply with the material, enhancing their ability to think critically.

2.2 Problem-Solving Skills

Similarly, problem-solving skills improved significantly, with a t-value of 3.92 and a p-value of 0.002. The mean score increased from 3.85 pre-RBL to 4.10 post-RBL, reflecting a considerable improvement in students' ability to identify, analyze, and resolve complex problems. This suggests that RBL, by engaging students in real-world problem-solving activities, effectively cultivates their ability to tackle challenges independently.

2.3 Independent Research Skills

Independent research skills showed a notable enhancement, with a t-value of 4.12 and a p-value of 0.001. The pre-RBL mean score was 3.80, increasing to 4.15 post-RBL. This result indicates that RBL effectively developed students' capacity to conduct independent research, including designing research methods, collecting data, and analyzing results. This improvement highlights the role of RBL in fostering autonomous learning and research proficiency.

2.4 Metacognitive Awareness

Metacognitive awareness demonstrated the most significant improvement, with a t-value of 5.23 and a p-value of 0.000. The mean score rose from 3.90 to 4.25 post-RBL, signifying that RBL had a strong impact on students' ability to reflect on and regulate their learning processes. Metacognitive awareness is critical for students to become self-directed learners, as it involves understanding one's own learning strategies and making adjustments to improve outcomes.

2.5 Self-Regulation

Self-regulation, which refers to students' ability to manage their time, effort, and strategies in learning, also saw significant gains, with a t-value of 4.07 and a p-value of 0.001. The pre-RBL mean score was 3.87, which increased to 4.18 post-RBL. This result underscores the positive impact of RBL on students' ability to manage their learning activities more effectively, promoting independence and discipline in their academic work.

Correlation analysis was conducted to examine the relationships between these variables, which are key competencies in the learning process. Table 4 will provide detailed correlation coefficients, showing how improvements in one competency (e.g., critical thinking) are associated with gains in others (e.g., problem-solving and metacognitive awareness). These correlations offer further insight into how the development of cognitive and metacognitive skills through RBL is interrelated, reinforcing the holistic benefits of this pedagogical approach.

In summary, the paired-samples t-test results highlight the significant positive impact of RBL on multiple competencies essential for academic success. The improvements in critical thinking, problem-solving, independent research skills, metacognitive awareness, and self-regulation illustrate the effectiveness of RBL in fostering deeper, more autonomous learning.

Table 3: Correlation Analysis

Variable	Critical Thinking	Problem-Solving Skills	Independent Research Skills	Metacognitive Awareness
Critical Thinking	1.00	0.62**	0.65**	0.68**
Problem-Solving Skills	0.62**	1.00	0.57*	0.60**
Independent Research Skills	0.65**	0.57*	1.00	0.63**
Metacognitive Awareness	0.68**	0.60**	0.63**	1.00

Table 3 presents correlation analysis results showing relationships between variables. Strong positive correlations ($p < 0.01$) among critical thinking, problem-solving skills, independent research skills, and metacognitive awareness indicate that improvements in one area are associated with improvements in others.

3.1 Critical Thinking and Problem-Solving Skills

Correlation: $r = 0.62$, $p < 0.01$ There is a moderate positive correlation between critical thinking and problem-solving skills ($r = 0.62$), suggesting a strong association between these two competencies. This means that students who improved their critical thinking abilities also tended to improve their problem-solving skills. Since both competencies involve analyzing complex problems and formulating solutions, it is expected that gains in one would support gains in the other. The significant p-value ($p < 0.01$) confirms that this correlation is statistically significant, meaning it is unlikely to have occurred by chance.

3.2 Critical Thinking and Independent Research Skills

Correlation: $r = 0.65$, $p < 0.01$ A strong positive correlation ($r = 0.65$) was found between critical thinking and independent research skills. This indicates that as students' critical thinking improves, their ability to conduct independent research also improves. Independent research requires critical evaluation of sources, constructing arguments, and synthesizing information—skills that are directly linked to critical thinking. The strength of this correlation suggests that enhancing critical thinking is crucial for fostering effective independent research.

3.3 Critical Thinking and Metacognitive Awareness

Correlation: $r = 0.68$, $p < 0.01$ The strongest correlation observed in this analysis is between critical thinking and metacognitive awareness ($r = 0.68$). This suggests that students who become better at reflecting on their learning processes and regulating their learning behaviors also demonstrate significant improvements in their ability to think critically. Metacognitive awareness involves understanding one's own thinking processes, which plays a vital role in developing higher-order thinking skills, such as critical thinking. The significant correlation between these two competencies underscores the interconnectedness of self-awareness and effective cognitive functioning.

3.4 Problem-Solving Skills and Independent Research Skills

Correlation: $r = 0.57$, $p < 0.05$ A moderate positive correlation ($r = 0.57$) was found between problem-solving skills and independent research skills, suggesting that improvements in students' ability to solve problems are related to their capacity for conducting independent research. Independent research often requires students to navigate challenges, gather and analyze data, and develop solutions, which are key aspects of problem-solving. The moderate strength of this correlation indicates a meaningful relationship, though it is slightly weaker than the other correlations. The p-value ($p < 0.05$) confirms the significance of this association.

3.5 Problem-Solving Skills and Metacognitive Awareness

Correlation: $r = 0.60$, $p < 0.01$ There is a strong positive correlation ($r = 0.60$) between problem-solving skills and metacognitive awareness, meaning that as students improve their problem-solving abilities, they also tend to become more metacognitively aware. Metacognitive awareness enables students to better plan, monitor, and evaluate their approaches to solving problems, suggesting that the development of metacognitive skills supports more effective problem-solving. The strength of this relationship, along with its statistical significance ($p < 0.01$), highlights the importance of metacognitive development in enhancing problem-solving capabilities.

3.6 Independent Research Skills and Metacognitive Awareness

Correlation: $r = 0.63$, $p < 0.01$ A strong positive correlation ($r = 0.63$) was observed between independent research skills and metacognitive awareness, indicating that students who enhanced their research skills also demonstrated improvements in their ability to reflect

on and regulate their learning processes. Conducting independent research often requires students to think about how they are learning, adjust their strategies, and reflect on their progress, which are all elements of metacognition. This strong correlation suggests that developing independent research skills helps students become more self-aware and better equipped to manage their learning.

Discussion

The findings of this study demonstrate the significant benefits of Research-Based Learning (RBL) in enhancing students' cognitive, metacognitive, and personal competencies. The quantitative results reveal substantial improvements in critical thinking, problem-solving, and independent research skills, while the qualitative data emphasize the importance of student autonomy and faculty mentorship in supporting these developments. These findings align with existing literature, reinforcing the role of RBL as a powerful educational approach for fostering essential skills.

One of the key findings from this study is the improvement in *critical thinking* skills, with students reporting a significant increase following RBL activities. This is consistent with the work of Boekaerts (2016), who highlights the critical role of research activities in promoting higher-order thinking skills. Boekaerts argues that engaging students in inquiry-driven learning environments allows them to develop deeper cognitive processing abilities, which was evident in this study as students applied theoretical knowledge to solve real-world problems. The findings also resonate with Kuh (2008), who found that research-oriented learning experiences are linked to higher academic performance and intellectual engagement, further validating the positive impact of RBL on cognitive abilities.

Similarly, the improvement in *problem-solving skills* observed in this study is supported by previous research. For example, Hattie (2009) emphasized the importance of active learning methods like RBL in promoting problem-solving skills, particularly by encouraging students to work through complex challenges independently. This study's findings align with Hattie's work, as students reported enhanced confidence in approaching and solving problems. The positive correlation between critical thinking and problem-solving in this study further suggests that these competencies are interconnected, which has been documented in prior literature (Kuhn & Dean, 2004).

The significant enhancement in *metacognitive awareness* and *self-regulation* in this study reflects the growing body of research that underscores the importance of these competencies in academic success. Greene and Azevedo (2021) highlight the critical role of self-regulated learning in both academic and personal development, asserting that students who are able to monitor and control their learning processes tend to perform better in academic settings. This study corroborates those findings, showing that RBL helps students develop stronger self-regulation skills by promoting autonomy and goal-setting. The positive correlation between metacognitive awareness and critical thinking in this study also reflects findings from research by Schraw and Moshman (1995), who argued that metacognitive awareness is essential for effective critical thinking.

While the results of this study are largely in agreement with existing literature, it also highlights certain challenges associated with RBL. One such challenge is the *need for effective faculty mentorship*, which plays a pivotal role in guiding students through their research processes. This finding mirrors the conclusions drawn by Moust, van Berkel, and Schmidt

(2007), who emphasized that successful RBL implementation depends heavily on the quality of faculty support. Without proper mentorship, students may struggle to navigate the complexities of independent research, leading to frustration and disengagement.

Additionally, this study reveals that some students faced difficulties in managing the *independence* required by RBL. While autonomy is a critical component of RBL, it can also be daunting for students who are not accustomed to managing their learning processes independently. Previous research by Zimmerman (2002) highlights that while self-regulated learning is beneficial, students often require scaffolding and gradual release of responsibility to fully develop these skills. Therefore, this study suggests that future RBL implementations should consider providing additional support structures for students, particularly at the beginning of the research process.

The findings from this study contribute to the growing evidence that RBL is a highly effective pedagogical approach for enhancing critical thinking, problem-solving, metacognitive awareness, and self-regulation. However, the challenges related to faculty mentorship and student autonomy indicate areas where further refinement is needed. Future research should explore strategies for overcoming these challenges and continue to investigate the long-term impact of RBL on students' academic and professional development, ensuring that it remains a sustainable and beneficial teaching approach.

Conclusion

This study provides valuable insights into the impact of Research-Based Learning on undergraduate students' cognitive, metacognitive, and personal competencies. The significant improvements observed in critical thinking, problem-solving, and research skills underscore the effectiveness of RBL in enhancing student learning outcomes. The findings also highlight the importance of faculty mentorship and student autonomy in the RBL process. As educational institutions continue to adapt to the demands of the 21st century, RBL represents a promising approach to fostering essential skills and preparing students for future challenges.

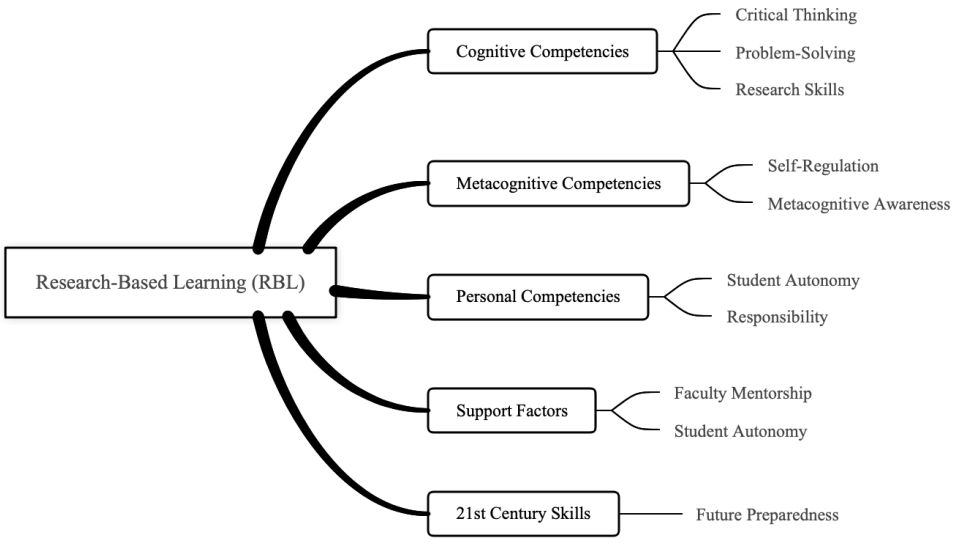

Figure 2 The Impact of Research-Based Learning (RBL)

Recommendations

1. Academic Recommendations

Enhancing Faculty Training and Mentorship: Higher education institutions should focus on developing robust training programs for faculty members to enhance their capabilities in mentoring students during Research-Based Learning (RBL) activities. This training should include strategies for guiding students in critical thinking, problem-solving, and self-regulation, ensuring that faculty are well-equipped to provide effective support throughout the research process.

Promoting Interdisciplinary RBL: Encourage the integration of RBL across different academic disciplines to allow students to explore diverse areas of knowledge and develop transferable research skills. Interdisciplinary RBL programs can foster broader cognitive development and open opportunities for cross-disciplinary collaboration among students and faculty.

2. Policy Recommendations

Institutional Support for RBL: Policymakers in educational institutions should ensure that sufficient resources, including funding and time allocation, are available for the implementation of RBL programs. This includes providing access to research materials, technology, and facilities necessary to support independent research projects.

Embedding RBL into Curriculum Design: Educational institutions should consider embedding RBL as a core component of curriculum design. This approach will not only enhance the academic experience of students but also align the learning process with the demands of the 21st-century workforce, emphasizing skills such as critical thinking, problem-solving, and self-regulation.

3. Operational Recommendations

Structured Research Processes: Implement structured guidelines for RBL projects, outlining the research process in phases to help students manage their workload and stay on track. Providing scaffolding at various stages of the research journey, particularly for novice researchers, will promote more effective learning outcomes.

Enhancing Research Collaboration: Encourage collaborative research opportunities where students can work in teams or with faculty to foster a supportive research environment. Collaborative RBL can enhance peer learning and help students develop teamwork skills alongside their independent research abilities.

Continuous Evaluation of RBL Implementation: Establish systems for the ongoing monitoring and evaluation of RBL activities. This should include student feedback and performance analysis to identify areas of improvement and adjust the RBL framework to better meet student needs and institutional goals.

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