

Implementation, Outcomes, and Effectiveness of Research-Based Learning: A Systematic Literature Review

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ABSTRACT

RBL (Research-Based Learning) is multi-faced learning. RBL can be applied through different instructional strategies and techniques. The outcome of RBL itself also varies according to the skills needed in the 21st century. However, RBL requires specific guidance on how to implement it properly and correctly so that the multi-faced RBL can be directed and maximize its effectiveness. This study aims to identify the implementation, outcome, and effectiveness of RBL. This study conducted a systematic literature review of 449 articles related to RBL. A number of these articles were selected through inclusion and exclusion criteria, which included a timeline, type of document, source, and language. Finally, 40 articles were selected for analysis. This study incorporates multiple research designs, where the review meets the Publishing Standards for Item Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA). Science Direct, Eric, and Google Scholar as databases were used to find articles in this study. The results showed that RBL can be implemented properly in three ways, namely RBL as a method, RBL development which in this case must go through trials first, and integration of RBL in further learning also requires trials. While the outcomes of RBL include cognitive, attitude, and skill aspects. Finally, the effectiveness of RBL still requires further research related to the attitude aspect.

Key words: Research-based Learning, Implementation, Outcome, Effectiveness

INTRODUCTION

Research-based Learning (RBL) is one of the important learning models today. The Organization for Economic Co-operation and Development (OECD) (2005) itself has voiced the integration of research-based learning model into the education of prospective teachers at the undergraduate and master levels. Moreover, nowadays new knowledge is rapidly growing and developing in line with technological developments, so one must actively learn and continuously seek research (Sota & Peltzer, 2017). The demands of educational professionalism are also the basis for the importance of research-based learning; education must always be creative, proactive, and innovative to design new learning solutions based on scientific foundations (Easterday et al., 2018; Marín, 2020).

Several studies have shown the importance of RBL. Wessels et al. (2021) openly reveal that RBL is a panacea in terms of an effective learning format; Srikoon et al. (2014) promoted that RBL is a learning process to build important 21st century skills; RBL can challenge teachers

to rethink their usual pedagogy (Brew & Saunders, 2020); RBL can cover several different learning methods in one learning process (Usmeldi, 2016; Usmeldi et al., 2017); Suntusia et al. (2019) stated that RBL can equip students with complex skills; while Suyatman et al. (2021) stated that RBL is a learning model that refers to real-life problems so that students can practice their problem-solving techniques and skills.

While the application of RBL in learning can take various forms. Wannapiroon (2014) has tried to develop an RBL model in the form of Research-Based Blended Learning (RBBL); Nuchwana (2012) tried an integration model where RBL is integrated into every activity in the classroom; In a pedagogical context, Brew and Saunders (2020) have proposed a Wheel Model in which teachers must interpret student needs before implementing RBL in learning; Espinoza-Figueroa et al. (2021) have mentioned that RBL can use several learning strategies such as role-playing, simulation, gamification, social media, or teamwork; while Rattanaprom (2019) has mentioned active learning and self-directed learning to identify deficiencies in RBL.

RBL can encourage several aspects of skills. Nuchwana (2012) revealed that RBL can improve three

things, (1) cognitive skills which include situational analysis skills, theory application, and problem-solving, (2) interpersonal skills and responsibility which include group work ability, responsibility, ability to plan to learn independently, and (3) numerical analysis, communicative and information technology which includes the ability to communicate, the use of information technology. Singh et al. (2019) stated that RBL can strengthen abilities such as problem-solving, language and communication, communication and information technology, attitudes, ethics, and others. Sota and Peltzer (2017) have also revealed almost the same thing that RBL can support abilities such as cognitive skills, ethics, social, communication, and others. Khwanchai et al. (2017) specifically mentioned creative thinking skills. Dafik et al. (2019) stated RBL had a significant effect on metacognitive skills.

However, RBL is not without challenges in its implementation. Blume et al. (2015) have mentioned that teachers face the challenge of making the actualization of the research process visible to students. Thus, RBL is not a learning model that only displays research results. Brew and Saunders (2020) explained in their research discussion that RBL still academically has different ideas. Teachers have different opinions about the objectives, methods, and outcomes of RBL. Therefore, research by Junpeng and Tungkasamit (2014) has emphasized the quality of instruction in learning (pedagogy) and how to assess RBL. There were at least four main obstacles in this RBL, (1) teacher mindset, (2) teaching methodology, (3) curriculum design, and (4) academic leadership (Rattanaprom, 2019).

Based on several research results on RBL and its challenges, it can be a reference on how the right formula relates to the implementation of RBL, what outcomes can be maximized through RBL, and how effective RBL is. This is in line with the recommendations of several research results regarding a clear review of the steps and processes of RBL (Camacho et al., 2021; Sota and Peltzer, 2017; Yanti et al., 2019); Nuchwana (2012) have suggested that further research can find other strategies to implement RBL in the classroom; and Wessels et al. (2021) have also suggested that research on the effectiveness of RBL deserves follow-up. Likewise, recommendations for using other research methods have also been expressed (Khwanchai et al., 2017; Marin, 2020; Sota & Peltzer, 2017).

Objectives and Research Questions

The purpose of this study is to review research publications on RBL with the main question how is the proper implementation of RBL in classroom learning? This study uses a systematic review method to answer this question, where this method has not been widely found related to RBL research. Furthermore, based on the objectives of this study, the following research questions were investigated;

1. From 2012 to 2022, how was RBL implemented?
2. From 2012 to 2022, what learning outcomes did RBL strengthen?
3. From 2012 to 2022, how effective was RBL?

METHODS

This research method uses a systematic literature review method (SLR). The aim is to minimize bias, through identification, source selection and synthesis (Moher et al., 2015). Furthermore, PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) was used as a guide for the SLR method with the following objectives; 1) define a systematic research topic, 2) generate inclusion and exclusion criteria, and 3) analyze a broad database (Idris et al., 2022).

The PRISMA flow chart was used in the selection of articles relevant to the research question. This diagram consists of several steps, including search strategy, selection criteria, selection process, data collection, and analysis (Idris et al., 2022). The PRISMA flow chart below (Figure 1) provides an overview of the process from the initial literature search (449), screening, and critical assessment, of the articles generated in the analysis.

The process of finding articles is carried out through research main keywords, related terms, or synonyms, including research-based learning, implementation, outcome, and effectiveness. The goal is to bring up a specific database with the extra possibility of similar publications appearing. To ensure the level of research quality, only journal articles and conference proceedings were included in this study. Conference proceedings were included to allow for the most up-to-date research related to the research theme. While the data parameters were set to cover research results from 2012 to 2022 (the last 10 years). The search string for this study was research-based learning, and the following three research databases were used sequentially; Science Direct, Eric, and Google Scholar.

Furthermore, the Boolean search was used in this study which focuses on, among others; 1) Research-Based Learning, 2) Implementation, 3) Outcomes, and 4) Effectiveness. the Boolean search uses AND to link the Research-Based Learning search section with other sections. Table 1 presents the selected Boolean search terms to represent the search process according to the theme of this research.

Next is the inclusion and exclusion criteria as a screening method. The article selection criteria were determined by filtering all the articles found as many as 449 articles using the database sorting function. A total of 147 articles were reviewed against a set of inclusion and exclusion criteria (see Table 2). Thus, all articles that will be included in the review must comply with all these inclusion and exclusion criteria until 302 articles were found and then enter the eligibility stage.

Eligibility screening is a screening procedure after inclusion and exclusion criteria. This procedure uses a manual method, including checking the manuscript of the article by reading the title and abstract to ensure the article is relevant and per the research question. Articles not related to the theme of research-based learning, education, learning, pedagogical instruction, implementation, outcome, or effectiveness were excluded from the review list. So that the remaining articles only amount to 40.

This study uses qualitative thematic analysis techniques. Xu and Zammit (2020) stated that this analysis is the same

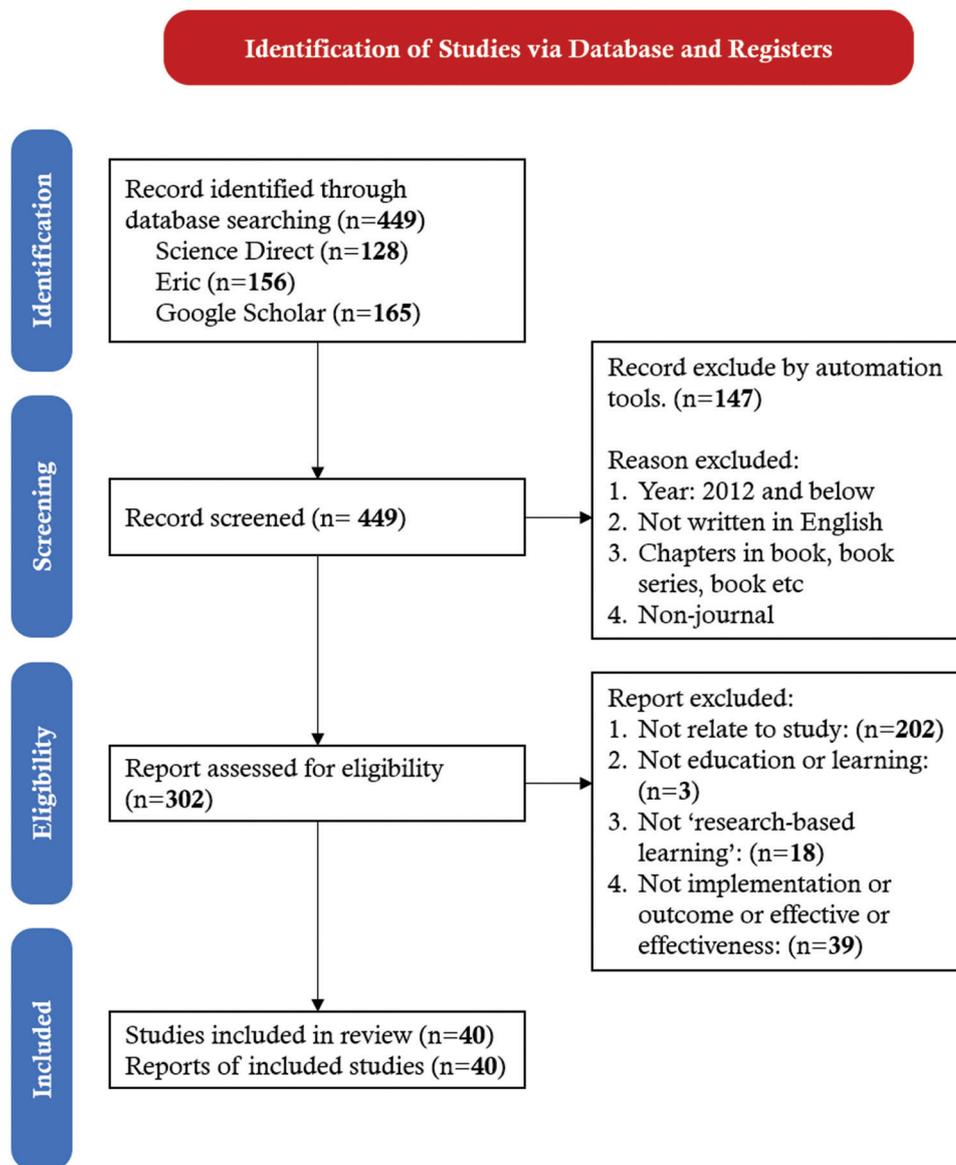


Figure 1. Flow diagram detailing the application of PRISMA to studies published between 2012 and 2022

Table 1. Boolean search terms

Search section	Search terms
Part 1	“Research-based learning” OR “research-based education” OR “research-based instruction”
Part 2	“implementation” OR “outcome” OR “effect” OR “effective” OR “effectiveness”

Table 2. The inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Timeline	2012-2022	Before 2012
Type of document	Article	Books, series of book, chapter in book
Source	Journal	Non-journal
Language	English	Non-English

as the synthesis of interpretation and explanation. Thus, 40 manuscripts were reviewed with great care, especially in the

abstract, findings, and discussion sections. The data that answered the research questions were collected and abstracted for evaluation. After that, thematic analysis was carried out to find themes through recording similarities, counting, grouping, detecting patterns and themes, and building links. Flemming et al. (2019) stated that thematic analysis was the most efficient method for synthesizing data from mixed research designs.

Two methods were used to carry out thematic analysis in this study, namely deductive and inductive thematic. Deductive is done through the identification of several themes related to research questions, while inductive is through the identification of themes based on previous research patterns.

RESULTS AND DISCUSSION

The results of the review managed to collect 40 article manuscripts. Three topics were created based on research questions; 1) implementation of research-based learning,

2) outcomes of research-based learning, and 3) effectiveness of research-based learning. The appendix shows the list of the reviewed articles.

In general, RBL is a learning model to introduce students to how to learn and build their knowledge (Srikoon et al., 2014). Kerdmanee et al. (2015) have even specifically mentioned that RBL is a research-based instruction with the core principle of equipping students with the skills to acquire knowledge independently. Al-Maktoumi et al. (2016) provide a synonym for inquiry-based learning where RBL is an activity connecting research with pedagogical instruction in a learning environment; thus this research activity allows students to recognize the variety and complexity of building knowledge in a cross-disciplinary scope. Furthermore, Rattanaprom (2019) explained that RBL provides space for students to think and build a synthesis freely based on empirical data or information and facilitates students to present their findings to the public. Thus, RBL refers to the main point of equipping students with certain skills that enable them to build their knowledge.

Per the research question of this research, this RBL needs to find the right way how to implement it, what the expected outcome is, and how effective it is.

Implementation of RBL

Camacho et al. (2017a) stated that RBL can be achieved through a wide and open range of techniques. Even Sota and Peltzer (2017) also emphasized that RBL-based learning is multi-faced. This learning can refer to various learning strategies and instructional techniques with the main reference being to link research and teaching.

Initially, this RBL did appear to link research and teaching/learning (Brennan et al., 2019; Nuchwana, 2012). Brennan et al. (2019) further explain that there were many 'links' to bridge this research and teaching/learning. But the problem is, this relationship is complex. Research and teaching/learning are also two different disciplines with different complexities. So that these differences ultimately become a reference for how the relationship between the two can be built. What happens a lot is trying to carry out learning using research methods, as done by Al-Maktoumi et al. (2016), Kerdmanee et al. (2015), Camacho et al. (2017a), Sota and Peltzer (2017), Brennan et al. (2019), Jacobsen (2018), Reyes and Gentry (2019), Yanti et al. (2019), Brew and Saunders (2020), Suyatman et al. (2021), Wessels et al. (2021), Suntuasia et al. (2019) and others.

In addition, studies on the development of RBL to find a suitable formula related to implementation in learning have also been carried out, such as research from Worapun (2021) to produce management learning based on RBL principles; Usmeldi (2017) produced a Research-Based Physics Learning Model with a scientific approach; Khwanchai et al. (2017) produced an RBL lesson plan strategy; Wannapiroon (2014) produced Research-Based Blended Learning (RBBL); Junpeng and Tungkasamit (2014) produced an assessment through RBL; Blume et al. (2015) named their product Die Lernfabrik; and Tungkasamit and Junpeng (2012) developed a curriculum for RBL-based training.

The integration of RBL in learning has also been carried out by several researchers. Like Nuchwana (2012), McGill et al. (2012), Brennan et al. (2019), Rattanaprom (2019), Behrmann (2019), Westwell and Ingle (2020), Helgøy et al. (2022), Marín (2021), Marín (2020), Kırıcı and Bakırcı (2021), Espinoza-Figueroa et al. (2021). The integration of RBL almost resembles the results of RBL research as a method. However, the difference is that integration is more likely to adopt RBL incompletely where RBL must be adjusted with certain considerations; while RBL as a direct method was adopted in its entirety without any considerations. In simple terms, RBL as a method directly implements RBL without any modification, while integration still requires modification and adjustment.

RBL as a method in Sota and Pelzer's (2017) research applies a research framework in learning such as identifying research topics, objectives and research questions, research tools both data collection tools and intervention tools, theory application, and so on. While the integration still allows some adjustments so that the RBL does not become a complete RBL, it can turn into another framework even though in character it does not lose its authenticity. Research from Rattanaprom (2019) can be an example where RBL then consists of three main domains after the integration process, namely contemplative, systems thinking, and professional; then Marín (2021) succeeded in generalizing RBL in the form of concrete steps of learning through this integration, which include orientation, conceptualization, investigation, conclusion, and discussion; likewise, in other research, Marín (2020) revealed several guidelines which include focus, understand, define and conceive, build and test, and present.

RBL development studies also fall into this category of integration because the things that cause the development itself were considerations for adjusting RBL to fit the context and content of learning. Research from Worapun (2021), for example, underlies the development of RBL on the importance of developing a learning curriculum to lead students to the right career development. So that in the next stage, Worapun (2021) produced 5 stages of the teaching plan; (1) ideas and information analysis, which emphasizes teaching students to design each learning purpose, (2) planning and creative design, which instructs students' processes of developing lesson plans, choosing teaching strategies, and selecting assessment tools, (3) action taking, is to analyze purposes of classes, design learning management, develop learning skills, synthesize the knowledge in classes, and evaluate classes, (4) presentation and reflection are to formulate systematic presentation and reflection skills for students, and (5) evaluation and improvement, is to let students practice evaluation of classes before and after instruction.

Usmeldi (2017) also did the same thing. He based his research on assumptions about the need for developing learning that supports the achievement of comprehensive competencies. It is necessary to develop learning in which there are work steps such as thinking processes, work procedures, creativity, and independence. Thus Usmeldi (2017)

then offers a Research-Based Physics Learning Model with a Scientific Approach with six stages, (1) exposure stage, (2) lecturing of core knowledge, (3) experience stage, (4) internal report for feedback, (5) presentation, and (6) final report. Meanwhile, Tungkasamit and Junpeng (2012) based their development studies on the consideration that nowadays student-centered learning needs to change to RBL. Therefore, this RBL requires an assessment system to ensure that RBL is implemented effectively and efficiently. Wannapiroon (2014) has considered technological developments, and orientation to improve several student abilities such as critical thinking, problem solving, self-regulation, and flexible student learning styles. So Wannapiroon (2014) offers RBBL model with steps; (1) Framing and Analyzing Problems, (2) Designing and planning research, (3) Interpreting and evaluating, and (4) Presenting research findings.

Based on the review of research results from 2012-2022, implementing RBL in learning can be done through three things in general, (1) Adoption of RBL as a method in which learning instructions use research steps as a whole, (2) Through development studies followed by trial, or (3) Integration (Table 3). This research does not try to detect how the most effective and efficient way of implementing RBL is, this research is more focused on how to implement RBL in general. This is due to the character of RBL itself which is indeed multi-faced, it is open to various learning strategies and instructional techniques (Sota & Peltzer, 2017).

Outcome of RBL

An interesting review came from the research results of Corwin et al. (2015) which divided the outcome of RBL into three, namely probable, possible, and proposed. The probabilities, in which case the level of possible outcome is smaller than possible, consist of increasing content knowledge, analytical skills, self-efficacy, persistence in science, technical skills, and career clarification. Possible applications of RBL include increasing project ownership, communication skills, motivation in science, collaboration skills, tolerance for obstacles, a sense of belonging to a larger community, strengthening science identity, and increasing positive interaction with peers. RBL is also proposed to encourage access and development of self-authorship.

Corwin et al.'s (2015) review of probable is corroborated by several other research results. Nuchwana's (2012) research stated that one of the RBL outcomes is cognitive skills with details including situational analysis, theoretical application, and problem-solving; Srikoon et al. (2014) said that RBL can improve the knowledge discovery aspect, even this aspect is associated with working skills, which means that knowledge in the form of content is very likely to be passed on to practical skills through RBL; likewise, Usmeldi (2016) emphasized that RBL can encourage mastery of knowledge which also continues on practical skills; Sota and Peltzer (2017) and Behrmann (2019) both stated cognitive skill outcomes. That is, probable status related to increased knowledge can be possible with this RBL.

Table 3. Implementation of RBL

Implementation	Example of RBL Stages	Source
Method	<ol style="list-style-type: none"> 1. Formulate problems 2. Review the theoretical basis 3. Define the problem statement 4. Planning investigation activities 5. Carry out investigations and data analysis 6. Explain the research results 7. Create reports and presentations of results 	Suyatman et al. (2021)
Development	<ol style="list-style-type: none"> 1. Framing and Analyzing Problems 2. Designing and planning research 3. Interpreting and evaluating 4. Presenting research findings 	Wannapiroon (2014)
Integration	<ol style="list-style-type: none"> 1. Focus 2. Understand 3. Define and conceive 4. Build and test 5. Present 	Marin (2020)

Critical thinking skills following the increase in knowledge as an outcome of RBL. Wannapiroon (2014) conducted a study on the development of RBL which was specifically designed to improve critical thinking skills; Usmeldi's (2017) background for his research was the weak condition of students' critical thinking skills which then increased through RBL. RBL which simply refers to student activities to formulate problems, review theories, build hypotheses, collect data, analyze data, and arrive at conclusions, of course, fits very well with the core of critical thinking skills such as analyzing various data, evaluating information, inferring required information, use correct reasoning, and draw conclusions (Ennis, 1996).

Critical thinking skill is a complex ability. Styron (2014) has claimed that critical thinking skills comprise the last three domains of Bloom's Taxonomy, namely analysis, synthesis, and evaluation. Taimur and Sattar (2019) adapting UNIDO stated that critical thinking competencies include (1) knowledge to think critically (information), (2) attitude/disposition to think critically (truth-seeking, open-mindedness, analyticity, systematicity, self-confidence, inquisitiveness and maturity of judgment), and (3) skills to think critically (ability to analyze, synthesize and evaluate information).

The important point of this critical thinking skill is analysis. That is, critical thinking skills contain analytical skills. This makes the research of Suyatman et al. (2021) possible, that one of the outcomes of RBL is analytical thinking skills. In their research, RBL is directed to improve three skills as

indicators of analytical thinking, (1) differentiating which is the ability to distinguish relevant and irrelevant material, (2) organizing which is the ability to determine which elements are suitable from the material that has been determined previously, and (3) attributing which is the ability to determine the point of view, bias, value, or intent that underlies the material presented.

Furthermore, one of the other RBL outcomes that often appears in research results is attitude (Dvorak et al., 2020; Singh et al., 2019; Srikoon et al., 2014; Usmeldi, 2016). Dvorak et al. (2020) display attitudes and beliefs as one of the most common RBL outcomes after 'research knowledge and skills' and 'content knowledge and skills'; Singh et al. (2019) mention attitude in the sense that RBL encourages positive perceptions that working with a professor is important and RBL can foster an attitude of respect for fellow colleagues (students) and teachers; Usmeldi (2016) categorized attitude in the affective domain and stated that RBL can foster scientific attitudes and behavior to later become student characters. However, the research of Srikoon et al. (2014) stated that RBL does not affect mood itself. This is certainly not surprising, because the attitude formation process takes a long time (Usmeldi, 2016).

The emergence of attitude as an outcome of RBL is also reinforced by Nuchwana (2012) by mentioning interpersonal skills and responsibility. RBL that familiarizes students with group work activities ultimately requires student participation to become good group members, have group working abilities, be responsible as group members, and prepare work plans.

Another important thing about RBL is its role in improving the skills needed in the 21st century (Srikoon et al., 2014; Suyatman et al., 2021). The OECD (2019) distinguishes three types of skills; (1) cognitive and metacognitive skills such as critical thinking, creative thinking, learning to learn, and self-regulation; (2) social and emotional skills such as empathy, self-efficacy, responsibility, and collaboration; (3) practical skills such as skills in using new information and communication technology. The things mentioned by the OECD have been clearly shown by the results of these studies on RBL; such as critical thinking (Usmeldi et al., 2017; Wannapiroon, 2014), creative thinking (Khwanchai et al., 2017), responsibility, practical skills in using technology (Nuchwana, 2012), or communication (Singh et al., 2019).

Regarding the explanation of skills, several studies mention the outcome of problem-solving (Nuchwana, 2012; Singh et al., 2019; Srikoon et al., 2014). Almost all of the texts on RBL found in the study mention this problem-solving outcome. This becomes clear because in the RBL stage itself there are framing and analyzing problems (Wannapiroon, 2014); Kerdmanee (2015) stated study to find solutions to problems; or formulating problems (Suyatman et al., 2021; Usmeldi, 2016).

The most obvious thing, RBL certainly equips students to be skilled in conducting research. Usmeldi (2015) mentioned generic abilities where students in RBL are familiar with activities such as analyzing the problem, constructing a solution through lab work, examining the solution, presenting

the finding, and presenting the lab work. Kerdmanee (2015) also stated that the outcome of RBL is to equip students to be skilled in conducting research properly and correctly. This is certainly not in doubt, because RBL itself is a learning in which it directs students to do research.

RBL aims to equip students to be skilled in conducting research, then this RBL is suitable for learning for higher education, such as higher education in teacher training. Higher teacher education, as expressed by Susiani et al. (2018), has a target to provide quality teachers per the demands of the 21st century, namely having competence in work ethic, collaboration, communication, responsibility, critical thinking, and problem-solving. RBL in this case is suitable for cultivating critical thinking and problem-solving competencies. Because, RBL itself contains activities such as analyzing, synthesizing, and evaluating.

The demand for a prospective teacher is to be able to construct his knowledge to then instill in his students later. On the one hand, RBL also refers to constructivism with an authentic learning approach, so in practice learning activities must occur such as problem solving, collaboration, direct practice, discovery, and so on. Thus, the output is those prospective teachers can understand the basic concepts and methodologies, solve problems creatively, logically, and systematically, and have a scientific attitude that respects evidence, honesty, and open-mindedness.

RBL is not only suitable for learning in higher education, but this learning will also be very suitable for any learning that aims to cultivate critical thinking skills, creative thinking, and analytical thinking. Furthermore, this RBL in its learning practice can also include skills in the use and utilization of technology to carry out research practices, because nowadays research data can be conditioned through the use of technology itself.

Table 4 describes several outcomes of RBL which, among others, broadly cover the cognitive, affective, and skill domains. RBL equips a person to have cognitive constructs that are clear and valid. That is, someone with RBL practice will get used to analyzing and critiquing data (whether the data is valid or not) and trying to construct conclusions based on the valid data. RBL equips a person to have a good attitude or interpersonal skills. Because in this RBL a person is required to be able to cooperate with other people well, respond to differences of opinion wisely, and solve problems properly and correctly. Likewise, certain skills such as the use of technology or communication are skills that RBL automatically produces, because research activities will certainly use or utilize technology to explore data or access data sources. In addition, research activities also require someone to be able to communicate his findings to others properly and correctly.

Thus, RBL is a very interesting lesson to be applied. RBL can touch all aspects of competence, whether cognitive, behavioral, or skill aspects (Table 4). Therefore, RBL can be regarded as holistic learning.

The Effectiveness of RBL

Tungkasamit and Junpeng (2012) through their development study stated that the effectiveness of RBL reached

Table 4. Outcomes of RBL

Domain	Outcomes	Source
Cognitive	Content knowledge	Nuchwana (2012), Srikoon et al. (2014), Usmeldi (2016), Sota & Peltzer (2017), Behrmann (2019).
	Critical thinking	Wannapiroon (2014), Usmeldi (2017).
	Analytical thinking	Suyatman et al. (2021).
	Creative thinking	Khuana dkk (2017), Kırıcı & Bakırcı (2021).
Affective	Attitude	Dvorak et al. (2020), Singh et al. (2019), Usmeldi (2016), Srikoon et al. (2014).
	Interpersonal skill	Nuchwana (2012).
Skill	Problem solving	Wannapiroon (2014), Kerdmanee (2015), Suyatman et al. (2021).
	Use of information technology	Nuchwana (2012).
	Communication	Singh et al. (2019).
	Generic ability of research	Usmeldi (2015), Kerdmanee (2015).

the “Highest” level. RBL can effectively promote content knowledge outcomes as well as the use of research techniques, methods and tools. In addition, the interesting thing from the development of Tungkasamit and Junpeng (2012) is that students do not focus on theory, but on practice where students learn to build good relationships with other students, learn how to work in groups and play their respective roles. Usmeldi’s (2015) research also supports the statement that RBL is very effective in increasing students’ understanding of knowledge content. Even in another study, Usmeldi (2016) also stated that RBL can improve students’ knowledge very well, improve skills (science processing skills, thinking and reasoning skills) well, and students’ attitudes very well. But even so, Marin (2021) actually displays contrasting results; he stated that students did agree on the benefits and transfer of knowledge through RBL but it achieved the lowest score (neutral) in terms of improving literature understanding. Thus, concerning increasing knowledge through RBL, further studies are needed to ensure its effectiveness and detect what are the obstacles if RBL is not effective at this point.

Suyatman et al. (2021) stated that RBL could effectively improve analytical thinking skills with an indicator of effectiveness, one of which is that students have mastered the concept of knowledge presented in learning. This is contrary to what Marin (2021) previously stated. Suyatman et al. (2021) launched RBL activities to train students to be able to do differentiating, classifying, and attributing which was then packaged into a single unit of ability called analytical thinking. This ability then leads students to master concepts well, improve academic achievement, train on how to learn, and build their knowledge. Thus, RBL

can effectively equip students with certain skills such as analytical thinking and students can use it to master knowledge content well.

Wannapiroon (2014) stated that there was an effective increase in research and critical thinking abilities and students stated that they were very satisfied with the learning of the RBBL model. Kerdmanee et al. (2015) confirmed students’ perceptions of RBL that in general students expressed positive opinions on RBL-based instruction with a “good” level. Meanwhile, Usmeldi (2017) also stated that the implementation of RBL can effectively improve critical thinking skills which include analysis, evaluation, inference, and reasoning.

In addition to critical thinking, Kırıcı and Bakırcı (2021) stated that creative thinking can be effectively improved through RBL even if it has to go through the right steps. Khuana et al. (2017) revealed the same thing even though the results of creative thinking were less effective because students had their perceptions about their classroom environment. This shows that RBL also requires other elements to improve outcomes, it cannot stand alone methodically, and it still requires other reinforcing elements such as a good learning environment.

However, based on the description above, this research on the effectiveness of RBL touches more on aspects of improving cognitive aspects. On the other hand, Wessels et al.’s (2021) study sought to reveal the effectiveness of RBL on several aspects related to attitudes such as joy in working with scientific literature, joy in working with empirical data, uncertainty tolerance, or frustration tolerance. Apart from this research, there has not been much research on the effectiveness of RBL on aspects of attitude.

CONCLUSION

RBL is multi-faced learning. It can refer to various learning strategies and instructional techniques with the main reference being to link research and teaching. The results showed that RBL can be implemented properly in three ways, namely RBL as a method, RBL development which in this case must go through trials first, and integration of RBL in further learning also requires trials. Based on the research discussion, RBL is suitable for learning in higher education, especially higher education in teacher training. RBL will be able to familiarize prospective teachers with clear cognitive constructions, tested attitudes, and qualified skills. Finally, the effectiveness of RBL still requires further research related to the attitude aspect (Bowyer et al., 2022).

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APPENDIX

Summary of the reviewed articles				
No.	Title of Articles	Type of Studies	Research Questions	References
1	How to Link Teaching and Research to Enhance Students' Learning Outcomes: Thai University Experience	Case Study	RQ 1, RQ 2	Nuchwana (2012)
2	The Development of Authentic Assessment Training Curriculum for Research-Based Learning Class in Higher Education of Thailand	R & D	RQ 1, RQ 3	Tungkasamit & Junpeng (2012)
3	The Teaching--Research--Industry--Learning Nexus in Information and Communications Technology	Descriptive	RQ 1	McGill et al. (2012)
4	Development of Research-based Blended Learning Model to Enhance Graduate Students' Research Competency and Critical Thinking Skills	R & D	RQ 1, RQ 2, RQ 3	Wannapiroon (2014)
5	Research Synthesis of Research-based Learning for Education in Thailand	Review	RQ 1, RQ 2	Srikoon et al. (2014)
6	The Continuing Professional Development of the Assessment through Research-based Learning in Higher Education of Thailand	R & D	RQ 1	Junpeng & Tungkasamit (2014)
7	Die Lernfabrik – Research-based Learning for Sustainable Production Engineering	R & D	RQ 1	Blume et al. (2015)
8	Effects of Research-based Instruction in Maritime Medicine Nursing Practicum of Nursing Students, the Royal Thai Navy College of Nursing	Experiment	RQ 1, RQ 2, RQ 3	Kerdmanee et al. (2015)
9	Modeling Course-Based Undergraduate Research Experiences: An Agenda for Future Research and Evaluation	Review	RQ 1, RQ 2	Corwin et al. (2015)
10	The Effectiveness Of Physics Based Research In Learning Engineering Physics	Experiment	RQ 1, RQ 2, RQ 3	Usmeldi (2015)
11	Research-based learning for undergraduate students in soil and water sciences: a case study of hydrogeology in an arid-zone environment	Project	RQ 1, RQ 2	Al-Maktoumi et al. (2016)
12	The Development Of Research-Based Physics Learning Model With Scientific Approach To Develop Students' Scientific Processing Skill	R & D	RQ 1, RQ 2, RQ 3	Usmeldi (2016)
13	An instructional design model with the cultivating research-based learning strategies for fostering teacher students creative thinking abilities	R & D	RQ 1, RQ 2, RQ 3	Khuana et al. (2017)
14	Research Based Learning in Higher Education: A Review of Literature	Systematic Review	RQ 1, RQ 2	Camacho et al. (2017a)
15	The Development of Research-Based Learning Model with Science, Environment, Technology, and Society Approaches to Improve Critical Thinking of Students	R & D	RQ 1, RQ 2, RQ 3	Usmeldi et al. (2017)
16	The Effect of “Research Based Learning Activities” on Students' Intention to Do Research in Graduate Courses	Experiment	RQ 1, RQ 3	Camacho et al. (2017b)
17	The Effectiveness of Research Based Learning among Master degree Student for Health Promotion and Preventable Disease, Faculty of Public Health, Khon Kaen University, Thailand	Survey	RQ 1, RQ 2, RQ 3	Sota & Peltzer (2017)
18	Graduate students' research-based learning experiences in an online Master of Education program	Case Study	RQ 1	Jacobsen et al. (2018)
19	Academics' conceptualisations of the research- teaching nexus in a research-intensive Irish university: A dynamic framework for growth & development	Survey	RQ 1	Brennan et al. (2019)

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Summary of the reviewed articles				
No.	Title of Articles	Type of Studies	Research Questions	References
20	Failure of Research-Based Learning Implementation in Basic Education	Focus Group Discussion	RQ 1	Rattanaprom (2019)
21	Pre-Service Administrators' Experiences with Effective Research-Based Learning Strategies for English Language Learners	Experiment	RQ 1	Reyes & Gentry (2019)
22	Pre-Service Physics Teachers' Research Activities by Research- Based Learning	Case Study	RQ 1	Yanti et al. (2019)
23	Research-based Learning for Skill Development of Engineering Graduates: An empirical study	Empirical analysis	RQ 2	Singh et al. (2019)
24	The Analysis of Student Metacognition Skill in Solving Rainbow Connection Problem under the Implementation of Research-Based Learning Model	Mix Study	RQ 2, RQ 3	Dafik et al. (2019)
25	The Effectiveness of Research Based Learning in Improving Students' Achievement in Solving Two-Dimensional Arithmetic Sequence Problems	Mix Study	RQ 2, RQ 3	Suntusia et al. (2019)
26	The Effects of Research-Inquiry Based Learning on the Scientific Reasoning Skills of Prospective Science Teachers	Experiment	RQ 2, RQ 3	Yuksel (2019)
27	The Halo Effect as a Teaching Tool for Fostering Research-Based Learning	Survey	RQ 1, RQ 2, RQ 3	Behrmann (2019)
28	Making sense of research-based learning in teacher education	Interview	RQ 1, RQ 2	Brew & Saunders (2020)
29	Mapping Contemporary Cinema: blending critical pedagogy and research-based learning in undergraduate curriculum design	Descriptive	RQ 1	Westwell & Ingle (2020)
30	Research-based learning in education studies: Design inquiry using group e-Portfolios based on blogs	Mix Study	RQ 1	Marín (2020)
31	Systematic Review of Course-based Undergraduate Research Experiences: Implications for Music Therapy Education	Systematic Review	RQ 2	Dvorak et al. (2020)
32	Is research-based learning effective? Evidence from a pre-post analysis in the social sciences	Experiment	RQ 1, RQ 3	Wessels (2021)
33	Research-based learning (RBL): Added-value in tourism education	Focus Group Discussion	RQ 1	Espinoza-Figueroa et al. (2021)
34	Research-based learning in a transversal Entrepreneurship and Innovation undergraduate course	Experiment	RQ 1, RQ 2	Camacho (2021)
35	Role of Research-based Learning on Graduates' Career Prospects	Interview	RQ 2	Timiyo & Sriram (2021)
36	The Development of Research-Based Learning Management in the Curriculum Design and Development Course for Teacher Students	R & D	RQ 1, RQ 3	Worapun (2021)
37	The effect of STEM supported research-inquiry- based learning approach on the scientific creativity of 7 th grade students	Experimental	RQ 1, RQ 3	Bakırcı & Kırıcı (2021)
38	The Implementation of Research-Based Learning Model in the Basic Science Concepts Course in Improving Analytical Thinking Skills	Mix Study	RQ 1, RQ 2, RQ 3	Suyatman et al. (2021)
39	Using concept maps to structure a small-scale literature review: an approach to research-based learning in pre-service teacher education	Mix Study	RQ 1, RQ 3	Marín (2021)
40	Research-based education in undergraduate occupational therapy and physiotherapy education programmes: a scoping review	Systematic Review	RQ 1	Helgøy et al. (2022)