Measuring and Evaluating Educational Research Literacy in Higher Education: A Synthesis of Mechanisms and Discoveries

Jingjing Lin, Toyohashi University of Technology, Japan

The Asian Conference on Education 2022
Official Conference Proceedings

Abstract
In the context of higher degree research, one of the greatest obstacles was equipping students with research literacy. It is, however, an underdeveloped research topic and consequently its associated practices are ill advised. Most would agree that to optimize policy decisions and public spending, it is necessary to evaluate costs in relation to the quality of outputs. Before designing any type of educational intervention to improve the educational research literacy, it is essential to have a measurement instrument that can track and evaluate educational research literacy levels along the progress. This systematic literature review seeks to identify current approaches that measure educational research literacy in higher education institutions and to summarize findings from pertinent evaluation studies. A search of two academic databases Scopus and Web of Science yielded 369 publications, which was screened down to 11 relevant journal articles. The framework analysis method was followed to reveal the mechanisms and outcomes of educational research literacy evaluation. In addition, it will reveal patterns, distributions, and trends of these publications based on their metadata. With a focus on the measurement and evaluation of educational research literacy, the results will also inform the development of instruments to assess educational research literacy in higher education settings. University-level research training providers may also benefit from this study for its results will empower their engaging in evidence-based practice.

Keywords: Research Literacy, Literature Review, Higher Education

Introduction

Consuming and producing domain-specific scientific literature are essential and crucial activities in the lives of all researchers, whether they are established scholars or research students in training. These two activities represent the inputs and outputs of a researcher, which not only demonstrate their research literacy (RL) but also determine their career success. Continuous training to improve a researcher's RL is crucial. Yet, it is not uncommon to see a lack of systematic RL training for faculty members and research students. Continuous informality throughout the researcher development process in higher education leaves the researchers' maturation to chance (Raddon, 2011).

Training researchers is a lengthy process that is frequently segmented by scientific fields. For instance, educational research literacy (ERL), which is considered a domain-specific skill (Groß Ophoff et al., 2015; Lea & Street, 2006), can differ significantly from medicine RL. Different domains exhibit varying levels of RL training interest and development. A search for "research literacy" in Scopus on November 5, 2022, yielded only 201 results since 1996, with 104 records in the social sciences subject area and 113 records in medicine, nursing, and health sciences. The health-related subject area is the most active, whereas education science is much less active on this topic.

Across domains, RL studies appear to be closely associated to frontline practitioner roles, such as nurses (Hines et al., 2016), psychiatry residents (Forehand et al., 2022), social workers (Marsh & Fisher, 2008), and chaplains (Fitchett et al., 2012). In education sciences, they are schoolteachers (Evans, 2017) and Pre-Service Teachers or PST (Gutman & Genser, 2017). This list of practitioners does not include any researchers. In other words, RL studies focus more on practitioners than researchers even though researchers are much more engaged with research activities.

Universities are the primary research training institutions. Therefore, the author undertook a systematic literature review (SLR) to search for RL studies that reported university students and faculty members in the understudied domain of education science, with the goal of revealing: How is ERL trained, measured, and evaluated in the population of potential/established educational researchers in higher education?

Methods

Search strategy

The SLR was in accordance with the PRISMA 2020 Statement (Page et al., 2021). Scopus and Web of Science were searched on 20 June 2022 for original research articles in peer-reviewed journals using the keywords "research literacy" or "research literacies". Results were screened by checking the titles and abstracts of the records to determine their relevance. If marked as relevant, the full text files of the records were downloaded for additional relevance evaluation based on the eligibility criteria.

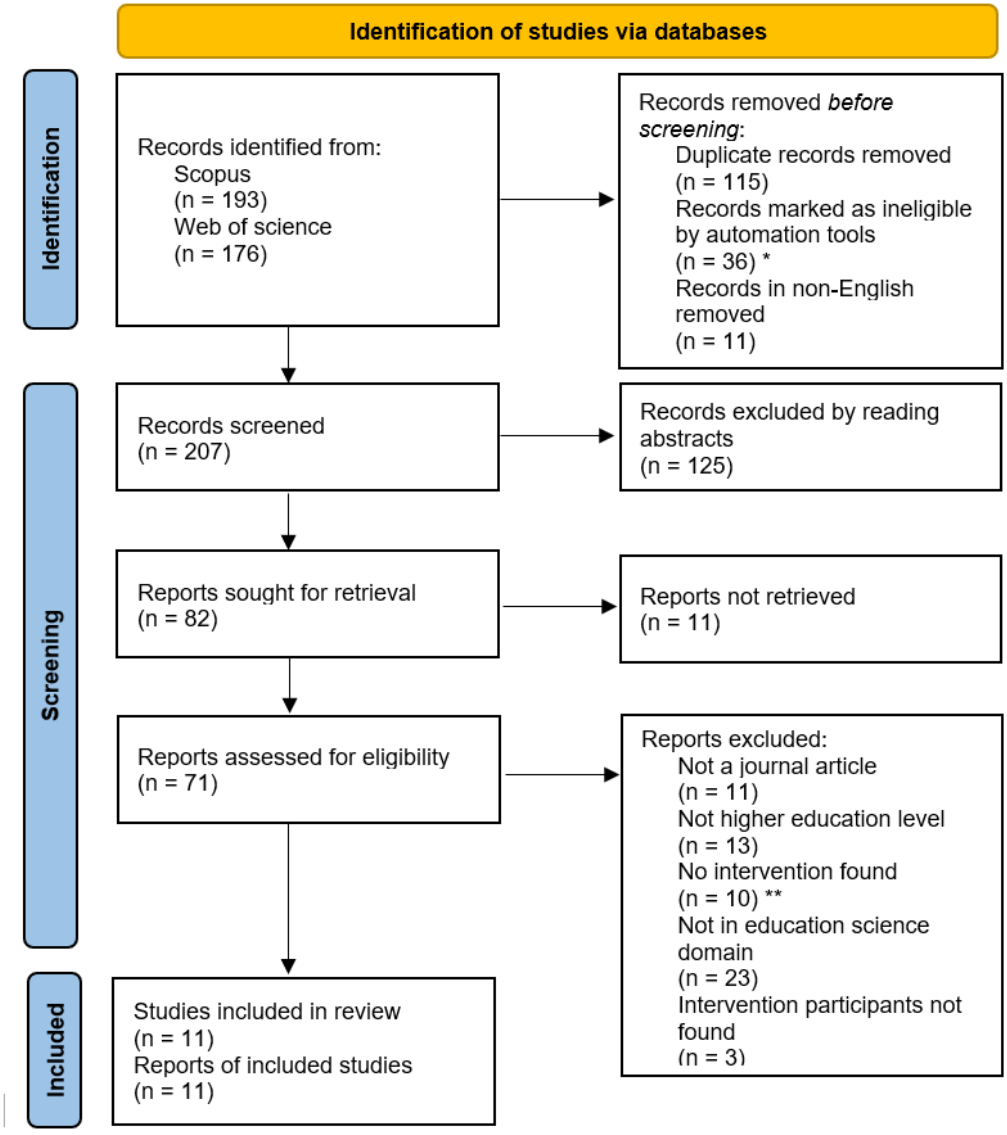
Eligibility criteria

Articles were included if they were published in English, in peer-reviewed journals, reported RL intervention(s) or measurement at the higher education level in the domain of education sciences, collected empirical data from actual participants, and were available in full text.

Articles were excluded if they were: (a) published in a language other than English; (b) not journal articles; (c) outside the higher education settings; (d) without RL intervention(s) or measurement; (e) studying subjects outside education sciences; (f) without full text files; (g) missing actual participants in the described intervention.

Data extraction

Based on the metadata downloaded from the two databases, a data extraction table was created, including the following columns of information: database source, publication year, authors, title, source title, abstract, and citations. All full text pdf files and corresponding citation records were saved in the Zotero software. The author read each article and extracted the following information: country, research purpose, research type, research design, discipline, intervention, education level, participants, measurement instrument, and results.



*If no keywords of "research literacy" or "literacies" were found in title or abstract of a record, the record is excluded.

**If it is a review study, even though it might not involve intervention it is not excluded.

Figure 1: The PRISMA flowchart

Data synthesis

This research followed the integrative method of qualitative evidence synthesis as described in Lin et al. (2022). Using the predefined ten parameters of information as the synthesis framework, the framework analysis (Oliver et al., 2008) was applied. It is a structured and transparent method for the analysis of primary qualitative data as it begins with an a priori framework of the concepts and themes against which the data is extracted and synthesized, and also maps the characteristics of each identified theme or topic area to allow for data further interrogation (Boland et al., 2017).

Results

Search results

Figure 1 depicts the procedure for data search and screening. 11 records (Table 1) out of 369 initial search results from the two databases met the eligibility criteria and were included for further actions.

Characteristics of included articles

According to Table 1, most reviewed articles were published in 2017. The nation with the most publications was Germany, followed by the United States and other nations (United Kingdom, Australia, Israel, and Jerusalem). There were six quantitative studies, three mixed-methods studies, and two qualitative studies. The most prevalent research design was the cross-sectional survey, closely followed by the pre-test–post-test control group design. Almost 73% of the eleven studies that collected data from PST students in teacher education programs. The sample size ranged from 14 to 2,113 participants.

Measure instruments of ERL

Over the past decade, a German academic team (Schladitz et al., 2013) has been developing and validating the LeScEd booklet, which is derived from the Learning the Science of Education (LeScEd, http://bit.ly/3TbNXy) project and serves as the measurement instrument to evaluate ERL. This booklet was the most frequently cited instrument in the sample of four studies (Groß Ophoff et al., 2015, 2017; Groß Ophoff & Egger, 2021; Schladitz et al., 2017) because of their continuous effort in sharing and reporting from their project. All test items were designed as forced-choice tasks, and it was suggested that, if adopted, the test should be divided into two tests to avoid testing effects due to repeated measurements (Groß Ophoff et al., 2015). The test questions fall into three categories: information literacy (IL), statistical literacy (SL), and ethical reasoning (ER) (evidence-based reasoning). The instrument has been tested using dependable scientific methods, such as pretest–posttest control group or cross-sectional/longitudinal surveys, and frequently with large samples of PST students (e.g., 2,113 in one study and 1,655 in another study, as shown in Table 1). The LeScEd booklet is available to other researchers for their own projects upon request.

Australia-based Han and Schuurmans-Stekhoven (2017) developed a two-scale, three-step RL framework. Two scales are source/literature search (SLS) and research integration methods (RIM), and three steps are technological searching and locating, accurate understanding and interpretation, and critical evaluation and synthesis of information. They claimed to have developed a survey questionnaire based on the information literacy self-

efficacy scale by Kurbanoglu et al. (2006). However, their 15-item scale was quite different from Kurbanoglu et al.'s 17-item scale. The additional information in their paper revealed that the authors' claim of basing their scale on Kurbanoglu et al. (2006)'s was likely an error. Instead, Han and Schuurmans-Stekhoven (2017) developed and validated "a 15-item self-report survey that captures two related factors–SLS and RIM–that are inter-temporally stable" to measure RL.

Jerusalem-based researchers Gutman and Genser (2017) identified three RL skills, including recognizing and defining a problem, formulating a research question, and designing a research method. They evaluated the impact of problem-based learning on 62 PST students' awareness of the relationship between RL and pedagogical practice using the pre-test–post-test control group design. The intervention consisted of a 12-week, 28-hour RL in education course that spanned one academic semester. As measurements, they utilized the Research Literacy Inventory (RLI, by Shank & Brown, 2013), the scoring scheme for the Research Literacy Task (RLT, by Gutman & Genssner, 2017), and online forum posts. The RLI consists of 18 self-reported statements. Before and after the intervention, students evaluated the statements on a five-point Likert scale. After one month of attending the intervention, students were provided with an empirical article and an open-ended RLT to evaluate the intervention's long-term impact. Students were required to analyze the article and demonstrate RL by defining the problem, identifying a similar problem in their own practice, formulating a research question, and designing a research method. For each aspect of recognizing, defining, formulating, and designing, students' responses were analyzed using the scoring scheme depicted in their study.

The Psychological Research Inventory of Concepts (PRIC) by Veilleux and Chapman (2017b) from the United States is another instrument worthy of mention. Two studies were conducted to develop and validate the instrument (Veilleux & Chapman, 2017a, 2017b). Although it is not an ERL scale, it was in the psychology field, which is highly relevant to education sciences. Their research demonstrates the validity and usefulness of the PRIC scale by conducting three studies with participants of both psychology major and non-psychology majors. PRIC is a "20-item vignette-based multiple choice measure to assess knowledge about research methods and statistics in psychology" (Veilleux & Chapman, 2017b, p. 2). A test with a score range of 0 to 20 takes approximately 30 minutes to complete. The respondents were required to provide either yes/no or mostly open-ended responses to the questions attached to each vignette. The PRIC measure is accessible to other researchers for use in their own projects upon request.

Multiple-choice questions and open-ended questions can be distinguished as two response formats in the aforementioned measures. Regarding measuring ERL, Schladitz et al. (2017) found no distinct advantage between the two response formats in terms of item's objective/subjective difficulty; therefore, both formats can be used in ERL tests.

Table 1. Key characteristics of sampled 11 articles

Article	Country	Type	Design	Participants	RL	Sample size (n)	Instrument
(Tuñón, 2002)	United States	Qual	case studies	doctoral students	IL	15	–
(Groß Ophoff et al., 2015)	Germany	Quan	CG pre-test–post-test	undergraduate students (a majority as PST)	ERL (IL, SL, and ER)	82–EG; 32–CG	LeScEd booklet
(Hosek, 2016)	United States	Qual	cross-sectional survey	university students	ML; IL	14	SDS: 2-item
(Schladitz et al., 2017)	Germany	Quan	cross-sectional survey	university students (58% as PST)	ERL (IL, SL, and ER)	600	LeScEd booklet
(Groß Ophoff et al., 2017)	Germany	Quan	cross-sectional survey	university students (51%–62% as PST)	ERL (IL, SL, and ER)	1,360–study 1; 753–study 2	LeScEd booklet
(Amir et al., 2017)	Israel	Mixed	action research (longitudinal)	PST	RL	74	–
(Han & Schuurmans-Stekhoven, 2017)	Australia	Mixed	CG pre-test–post-test; focus group interview	HDR (with PST as the control group)	RL; IL	38–EG; 10–CG	SDS: 15-item
(Veilleux & Chapman, 2017b)	United States	Quan	cross-sectional and longitudinal surveys	undergraduate psychology students and mTurk participants	RL; SL	521–study 1. 378–study 2 (83–EG; 295–CG). 72–study 3	PRIC vignettes
(Gutman & Genser, 2017)	Jerusalem	Mixed	CG pre-test–post-test	PST	RL	62	RLI; RLT
(Groß Ophoff & Egger, 2021)	Germany, Austria	Quan	cross-sectional survey	mostly PST	ERL (IL, SL, and ER)	1,360–Germany 295–Austria	LeScEd booklet
(Scanlan, 2021)	United Kingdom	Quan	one group pre-test–post-test	undergraduate PST	RL	220	SDS: 3-item

Note: Qual=Qualitative research; Quan=Quantitative research; Mixed=Mixed-methods research; PST=pre-service teachers who are enrolled in teacher education program(s); HDR=higher degree research; mTurk = Amazon Mechanical Turk; ECT=early career teacher; RL=research literacy; ERL=educational research literacy; IL=information literacy; ML=media literacy; ER=evidence-based reasoning; SL=statistical literacy; DL=digital literacy; SDS=self-developed survey; EG=experiment group; CG=control group; LeScEd booklet=Learning the Science of Education (LeScEd) project's test for the assessment of Educational Research Literacy; PRIC=Psychological Research Inventory of Concepts; RLI=Research Literacy Inventory (Shank & Brown, 2007); RLT=Research Literacy Task.

Interventions of ERL

Table 2 compares eight interventions found in eleven studies, excluding three studies that did not report any interventions (Groß Ophoff et al., 2017; Schladitz et al., 2017; Groß Ophoff & Egger, 2021). On the basis of a subjective evaluation of the replicability of these eight interventions, four were rated as high and four as low.

High-level replicability intervention 1. Tuón (2002) reported that the ERD8226 course trained doctoral students in education in information literacy and had both online and face-to-face formats. The online course consists of an introduction page and nine modules which spread over eight weeks. Students learned how to select databases, refine a search, and locate and retrieve full text documents during weeks 1–4. The fifth week covered research types, publication types, publication cycle stages, etc. The weeks 6–7 focused on print resources and websites/search engines. Week 8 focused on the university library's document delivery service. Before and after taking the course, students were not evaluated on their information literacy skills. The course included two assignments (20% and 50% of the course grade), an online group project (30% of the course grade), and weekly forum participation. However, based on student feedback regarding the first iteration, the second iteration changed one assignment into a series of mini assignments, gave students the option between forum discussions and short essays, and eliminated the team project. Consequently, the course has become more of an independent learning experience than a team-based one. The online course was later redesigned to fit into a one-day summer institute course. Comparing the two formats with regard to the output quality of students revealed no significant difference.

High-level replicability intervention 2. The purpose of the Research Ripped from the Headlines (RRH) assignment was to train students through a six-component intervention to become critical research consumers (Hosek, 2016). Component 1: Students locate research-related news from various sources; once selected and approved by the teacher, students post the news articles to the class Twitter feed using the #RRH hashtag. Component 2: Students locate, read, and summarize the research mentioned in the news articles. Component 3: During reading, students annotate the article, which later becomes part of their presentation in class. Component 4: Students identify and describe the connections between the research and the course content. Component 5: Students speak with at least one person outside of class about the news or/and related research to elicit feedback on the topic. Component 6: Each student gives a 10-minute presentation to their classmates. The research process, paradigms, everyday ways of knowing, forming arguments and making claims, and the ethics of communication research were used to stimulate class discussions. Utilizing a post-assessment survey with two questions (see p. 51), fourteen students' learning and affective motivations for the assignment were examined. Students responded positively to the assignment, as revealed by four themes in the survey results: "content mastery, learn from peer observation, research consumption habits, and information literacy development" (p. 51).

High-level replicability intervention 3. The intervention designed by Gutman and Genser (2017) centered on the transmission of three RL skills: "identifying and defining a problem, formulating a research question, and designing a research method" (p. 63). Participants were divided into two learning communities (LC): online (OLC; 31 students) and blended (BLC, 34 students). Both LC utilized the same course materials, exercises, and tasks and were instructed by the same instructor. OLC students studied solely independently, whereas BLC students also participated in lectures and in-person discussions. All participants engaged in four-week online forum discussions. Week 1: students received the RLI-based pre-test. Week

2: students discussed to cooperatively define the term–research problem (first forum). Week 5: they identified a particular research problem faced by them in the field (second forum). Week 8: they formulated an appropriate research question through discussions (third forum). Week 11: students together designed a procedure that was considered suitable for investigating the formulated research question (fourth forum). Week 12: students received the RLI-based post-test. Week 16: the RLT was given to participants to evaluate the long-term effect of the intervention. Immediate after the intervention, the three RL skills improved significantly, but there was no significant difference between OLC and BLC regarding the immediate effect of PBL on RL. Regarding the long-term impact of PBL on the three RL skills, the OLC group outperformed the BLC group. Long-term evidence suggests that self-regulated asynchronous learning benefits students' retention of RL skills more than synchronous learning.

High-level replicability intervention 4. The two-scale three-step RL framework by Han and Schuurmans-Stekhoven (2017) was used to design RL training workshops for higher degree research students at a university in Sydney. Using a parallel group design, they assigned 38 higher degree research students to the control group and 10 to an intensive 12-week, 2-hour-per-week workshop on teacher research education. The proposed framework makes it easier for other practitioners to replicate their design. The focus of their study, however, was to validate a self-designed survey; hence, it did not introduce the implementation of this design, leaving many questions regarding the intervention unanswered. The intervention groups were interviewed following the workshops and provided positive feedback regarding their learning experience. However, the interview results also concluded that "short-term intensive training may have provided theoretical knowledge of what information to process and how to process it, but it is insufficient for students to fully comprehend its application in their own practice" (p. 38).

Low-level replicability intervention 1. The intervention by Groß Ophoff et al. (2015) was a two-part course titled "Introduction to research literacy" for undergraduates. The first section consisted of a two-day orientation module to the university/program that covered seven units. The course covered ESL topics including "comprehensive reading strategies, literature research, and both qualitative and quantitative research designs" (p. 563). The second section consisted of seven units that were delivered every two weeks throughout the semester and focused on scientific writing. The design, development, and implementation of the intervention were not specified. The participants completed the pre-test and post-test using two distinct LeScEd booklets.

Low-level replicability intervention 2. A teacher education college offered four groups of PST students a weekly RL course for one year (Amir et al., 2017). The intervention was used to investigate discomfort rather than RL; yet it instructed students on how to formulate a research question for conducting action research. It engaged students in a one-month Moodle forum discussion followed by two one-day workshops. On the Moodle platform, the formulated and approved research questions were uploaded. The study only reported three-month activities and provided no additional information regarding the course's design or delivery. Students were not evaluated on their RL levels. Instead, their artifacts, forum posts, and researcher logs were analyzed. Students' formulation of research questions to integrate action research into teacher education was revealed to be a crucial and highly complex step, as indicated by the findings. To shed light on the reality of their work in an educational setting, it is crucial that PST students "experience action research in several cycles as they

learn and experience the discourse…in order to shed light on the reality of their work in an educational setting" (p. 13).

Low-level replicability intervention 3. Veilleux and Chapman conducted a similar study that, rather than introducing RL training interventions, aimed to validate their survey measure instrument (2017b). Their investigation revealed three studies, with the third study mentioning mandatory research methods courses for psychology majors at the University of Arkansas. 72 psychology students participated in the study by taking the PRIC test during the first and final weeks of the semester. The results demonstrated that students' PRIC scores increased as the course progressed, demonstrating the test's ability to assess research methods and statistical knowledge.

Low-level replicability intervention 4. University of Winchester placed a two-year intervention for its 220 ITE undergraduate students in their second and third year of the degree program (Scanlan, 2021). This was the longest intervention of the sampled studies. Students received "some taught input on research methodology and methods with a focus on action research and ethical research practice" (p. 4) and "were supported by a university tutor with relevant subject and research expertise" (p. 5). The assistance encompassed approving research proposals, supervising data collection, and directing the final written research reports. The description of such an intervention, however, was limited.

Table 2. Interventions found in eight articles

Article	Intervention	Format	Purpose	University
(Tuñón, 2002)	Information Literacy Skills for Doctoral Students in Education (RD8226)	Course	Introduce students to use library resources for literature reviews.	Nova Southeastern University
(Groß Ophoff et al., 2015)	Introduction to research literacy	Course	Introduce students to ERL and necessary skills.	Pädagogische Hochschule Freiburg
(Hosek, 2016)	Research Ripped from the Headlines (RRH)	Assignment	Increase information literacy related to research gathering, critique, analysis, and implementation.	Ohio University
(Amir et al., 2017)	Research literacy	Course	Guide students to formulate a research question for action research; provide academic tools for students to deal with discomfort in teaching.	Achva Academic College of Education
(Han & Schuurmans-Stekhoven, 2017)	HDR teacher research education program	SAU + Workshops	Improve students' RL by running a program designed with the two-scale, three-step RL framework.	Western Sydney University
(Veilleux & Chapman, 2017b)	Research methods courses Ω(in study 3)	Course	Introduce students to research methods.	University of Arkansas
(Gutman & Genser, 2017)	Research literacy in education	Course	Train students in RL using a PBL approach.	Efrata College of Education
(Scanlan, 2021)	Practitioner-focused classroom research	Research practice	Guide students in actual action research related to one aspect of teaching practice.	University of Winchester

Table 2. Interventions found in eight articles (continued)

Article	Provider	Delivery	Media	Duration	Replicability
(Tuñón, 2002)	Library	Online; F2F	WebCT	8 weeks (online); 1-day for 8 hours (F2F)	High
(Groß Ophoff et al., 2015)	University	F2F	Unclear	Part 1–seven units (90 minutes each) in two days; Part 2–seven units every two weeks in the semester	Low
(Hosek, 2016)	Hosek	Blended	Twitter, Blackboard	One semester	High
(Amir et al., 2017)	Four lecturers	Blended	Moodle	One year: 2 hours per week	Low
(Han & Schuurmans-Stekhoven, 2017)	Unclear	Unclear	Unclear	12 weeks: 2 hours per week	High
(Veilleux & Chapman, 2017b)	Chapman	Unclear	Unclear	Five sections of research methods taught in summer, fall semester, and spring semester	Low
(Gutman & Genser, 2017)	Unclear	Online; Blended	Online forums	One semester (12 weeks): 28 hours	High
(Scanlan, 2021)	University	Unclear	Unclear	Two years	Low

Note: F2F=Face to Face; BA=Bachelor of Arts; HDR=higher degree research; SAU=supervision-as-usual; PBL=problem based learning; PST=pre-service teachers; ITE=initial teacher education.

Conclusion

This systematic literature review selected and synthesized eleven peer-reviewed journal articles that reported either RL training interventions or RL measurement instruments in the context of higher education with a focus on education sciences. Two validated measurement instruments were discovered: the LeScEd booklet and the PRIC vignettes. In comparison to other less reliable scales, these two instruments adopted a test format rather than a survey format, were tested on large sample sizes, and are available upon request to other researchers. This review also identified eight RL training interventions, which were compared in terms of their format, purpose, university, participants, provider, delivery, media, duration, and replicability. On the basis of their replicability, they were categorized as either low-level or high-level, indicating the difficulty of replicating them elsewhere.

The next step is to investigate the synonyms (e.g., research competency, research skills, research abilities) and offspring concepts of RL (e.g., statistics literacy, information literacy) through a thorough literature review to better comprehend the current state of the research landscape on this topic. In the meantime, it is also worthwhile to review measurement scales and training interventions from other domains to borrow common knowledge and estimate the differences between domains' RL measurement. Other publication types, including books, were excluded from this evaluation. When reviewing, two highly relevant books were discovered (Badenhorst & Guerin, 2016; Shank & Brown, 2007). Furthermore, these materials are highly pertinent.

Acknowledgments

This work was supported by JSPS KAKENHI Grant Number 22K13755, and MAJ R&D Grant 2022. Special thanks to Ms. Xinyi Liang (Cindy) from The University of Hong Kong, and Mr. Diego Rosal from Toyohashi University of Technology, who work with me to advance the ResearchIC.com project, which is dedicated to enabling researchers and research students to host and attend online journal club events for improved research literacy.

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Contact email: lin.jingjing.qc@tut.jp