

## Digital Modules in Research Team-Based Learning in Higher Education: A Theoretical Review

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### ABSTRACT

The integration of digital modules in higher education has become increasingly vital in enhancing student engagement, collaboration, and critical thinking, especially in post-pandemic learning environments. Research Team-Based Learning (RTBL) is a collaborative pedagogy that emphasizes problem-solving, peer interaction, and research-based inquiry. This theoretical review explores the role of digital modules in supporting RTBL by synthesizing findings from 15 international open-access studies published between 2020 and 2025. Using a narrative review method guided by PRISMA procedures, studies were selected from reputable databases (e.g., DOAJ, PLOS ONE, Frontiers) based on criteria including relevance to RTBL and use of digital instructional materials. Thematic analysis identified four dominant themes: student engagement, digital literacy, instructional design, and post-pandemic implications. Findings indicate that digital modules enhance the effectiveness of RTBL by providing flexible access to learning materials, promoting active participation, and enabling peer-to-peer interaction. However, their impact is highly dependent on students' digital literacy, the quality of instructional design, and institutional infrastructure. Poorly designed modules or limited digital skills can hinder collaborative learning outcomes. This review concludes that digital modules are not merely supplementary tools but essential enablers of RTBL success. Their implementation requires a balanced strategy that integrates pedagogical, technological, and institutional support. Future research should explore longitudinal impacts, AI-driven instructional feedback, and cross-cultural adaptations to optimize the use of digital modules in collaborative higher education settings.

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## 1. INTRODUCTION

Higher education in the 21st century has undergone a major transformation due to the development of digital technology, changes in competency requirements, and the demands of globalisation. Students are no longer required to master only factual knowledge but also to be able to think critically, collaborate, communicate, and integrate technology into the learning process (Kerruish et al., 2024). One relevant learning approach to address these challenges is Research Team Based Learning (RTBL), which is an extension of Team Based Learning (TBL) that emphasizes research-based collaboration.

RTBL encourages students to work in small groups, discuss real-world problems, and conduct simple research to find solutions. In this context, the use of digital modules is very important because they provide flexible, interactive, and easily accessible learning materials (Alizadeh, 2024). Digital modules can take the form of learning management systems (LMS), application-based e-modules, interactive videos, or systematically organized multimedia content.

The literature shows that the integration of digital modules not only improves accessibility but also enriches the learning experience of students. Burton & Jackson (2024) in a systematic review found that team-based learning combined with online platforms increases student engagement and the effectiveness of collaboration. Similarly, Zhou et al. (2025) emphasize that students' digital literacy plays a major role in determining the effectiveness of digital module use, especially in improving higher-order cognitive learning outcomes.

Furthermore, the COVID-19 pandemic has accelerated the adoption of digital technology in higher education. Many universities utilize digital modules to reduce space and time barriers, enabling synchronous and asynchronous learning (Meng et al., 2024). This situation makes digital modules not just an alternative, but an essential requirement in collaborative learning (Ngoc et al., 2025).

However, the effectiveness of digital modules in RTBL is highly dependent on instructional design. Modules designed with consideration of constructivism, interactivity, and formative feedback principles tend to be more successful in improving students' critical thinking skills (Bach, 2024). Conversely, digital modules that are merely collections of text or static presentations have less of a significant impact.

Thus, the urgency of this study is to theoretically review the role of digital modules in supporting RTBL in higher education. This article presents a literature review of 15 recent international open-access studies (2020–2025) to answer the question: to what extent do digital modules contribute to the effectiveness of RTBL? What are the challenges and opportunities arising from the integration of digital modules in RTBL? And what is the direction for further research development?

This review is expected to provide conceptual contributions for educators and researchers in developing learning strategies that integrate digital modules with RTBL, as well as serving as a reference for more adaptive and innovative higher education practices.

## 2. METHODS

This article uses a literature review method with a narrative approach enriched by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines to ensure transparency and traceability of the literature selection process. The literature review procedure was carried out systematically through four main stages: identification, screening, eligibility, and inclusion.

In the identification stage, literature searches were conducted in several reputable international and open access databases such as PubMed Central (PMC), Directory of Open Access Journals (DOAJ), Frontiers, BMC, and PLOS ONE. The keywords used included: “digital module”, “team-based learning”, “research team-based learning”, and “higher education”.

The screening stage was carried out by applying the following inclusion criteria:

- (1) articles published between 2020 and 2025,
- (2) in English,
- (3) available in open access, and
- (4) focusing on collaborative learning or TBL involving digital modules.

The eligibility stage involved reviewing the titles, abstracts, and content relevance of the articles to the research focus. From the initial search results of 65 articles, 15 articles passed the final inclusion stage and were used as the main sources for analysis.

Data analysis was conducted using a thematic approach. Each article was examined to identify patterns and main themes related to the benefits, challenges, and recommendations for implementing digital modules in the context of Research Team-Based Learning (RTBL). The results of the analysis were then grouped into four major themes:

- (a) increased student engagement,
- (b) the role of digital literacy,
- (c) instructional design, and
- (d) post-pandemic implications.

To maintain validity and reliability, triangulation of findings between studies and verification of sources from reputable international journals were carried out. The studies analyzed covered a variety of research approaches quantitative, qualitative, systematic reviews, and conceptual studies as shown in the research by Burton & Jackson (2024); Meng et al. (2024); Alizadeh (2024).

Using this methodology, the article not only presents a summary of previous research results but also compiles a comprehensive theoretical synthesis of the role of digital modules in supporting the effectiveness of RTBL in higher education environments.

### 3. FINDINGS AND DISCUSSION

#### 3.1 Findings

The following is a summary of the main findings from a theoretical review of the role of digital modules in Research Team-Based Learning (RTBL) based on the international studies analyzed:

**Table 1.** Findings on the role of digital modules in Research Team-Based Learning (RTBL) based on international studies

Key Aspects	Research Findings	Notes
Post- Pandemic Context	The COVID-19 pandemic has accelerated the adoption of digital technology, making digital modules a core component of modern education systems, especially for hybrid learning models.	Digital modules have proven effective in maintaining the continuity of the learning process when physical interaction is limited, and their role continues in the post-pandemic era.
Instructional Design Quality	The effectiveness of digital modules depends heavily on the quality of their design. Successful modules not only present information, but also integrate elements of interactivity, scaffolding, and continuous feedback.	Digital modules should be designed as pedagogical tools that encourage critical thinking skills, not just as a collection of static texts.
Enhancing Student Engagement	The majority of studies show that digital modules significantly increase student engagement, motivation, and participation in team-based learning.	Interactive and visually appealing modules that utilize multimedia help students become more independent and actively participate in discussions.
The Role of Digital Literacy	The level of digital literacy among students plays a crucial role in determining the extent	Students with high digital literacy are able to access, evaluate, and

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to which they can make optimal use of digital modules. integrate digital content into team discussions.

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The use of digital modules in the context of research team-based learning (RTBL) is gaining widespread attention in higher education, especially in relation to increasing student engagement, the role of digital literacy, instructional design, and the post-pandemic context. Findings from various studies show that digital modules not only serve as additional learning resources, but also as catalysts for encouraging more active, critical, and collaborative learning among students. Each dimension studied provides important insights into how digital modules can be effectively utilized to improve the quality of the teaching and learning process.

First, the aspect of increasing student engagement is one of the most consistently reported findings in the literature. Most studies, as described by Burton & Jackson (2024) and Silva et al. (2022), show that digital modules have great potential in motivating students. Students who use digital modules tend to participate more in team discussions, both online and offline. This may be because digital modules are usually designed to be more interactive, contain multimedia, and present content in an easily accessible format. These advantages help students feel more connected to the material and motivated to take part in the collaborative learning process. In addition, the integration of digital modules also allows students to be more independent in preparing themselves before group discussions, thereby improving the quality of team interaction. Thus, student engagement increases not only in terms of the number of participants, but also in the quality of their contributions.

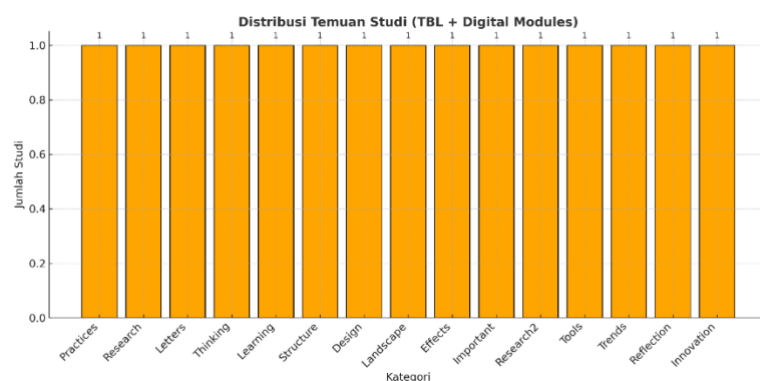
Second, digital literacy plays a crucial role in determining the extent to which students can make optimal use of digital modules. Zhou (2025) emphasises that students with high levels of digital literacy have a significant advantage in accessing, evaluating, and utilising digital content. Digital literacy includes technical skills, such as operating devices and applications, as well as critical skills for assessing the credibility of available information. In the context of RTBL, students with better digital literacy are able to find additional sources, validate data, and integrate this information into team discussions. Conversely, students with low digital literacy often face obstacles in understanding how to use the modules, which can potentially reduce the effectiveness of learning. This shows that the successful implementation of digital modules depends not only on the quality of instructional design but also on students' readiness in terms of digital skills.

Third, instructional design factors are a fundamental aspect that determines the effectiveness of digital modules. Bach (2024) emphasizes the importance of designs that not only present information but also integrate elements of interactivity, scaffolding, and continuous feedback. Digital modules designed with high interactivity, for example through adaptive quizzes, simulations, or integrated discussion forums, encourage students to think more critically. Meanwhile, scaffolding in digital modules helps students gradually understand concepts from simple to complex. Continuous feedback also provides opportunities for students to immediately correct mistakes, understand their weaknesses, and develop more effective learning strategies. In other words, proper instructional design can make digital modules not just a means of delivering material, but a pedagogical tool that supports higher-order thinking processes.

Fourth, another important finding relates to the post-pandemic context. According to Meng et al. (2024), the COVID-19 pandemic accelerated the digitization of learning in various universities. RTBL, which was previously mostly conducted face-to-face, shifted to the online realm by utilizing digital modules as the main tool. This change was not only temporary but continued into the post-pandemic period. Digital modules have proven to be a strategic solution in maintaining the continuity of the learning process when physical interaction is limited. In fact, in the post-pandemic period, digital modules continue to be used because of their flexibility and effectiveness in supporting team-based learning. This shows a paradigm shift in learning in higher education, where digital technology is no longer just a supporting tool but an integral component of the modern education system.

When considered holistically, these four aspects complement each other and form a new framework for understanding the role of digital modules in RTBL. Increased student engagement emphasizes the importance of intrinsic motivation and active participation, while digital literacy highlights students' readiness to manage information. Instructional design ensures that digital modules truly encourage critical thinking, rather than just presenting passive information. On the other hand, the post-pandemic context provides an external impetus that accelerates the implementation of digital modules as an integral part of educational practice. It is this combination of internal (motivation, digital literacy) and external (global context) factors that makes digital modules increasingly relevant in supporting team-based learning.

Thus, it can be concluded that the success of digital modules in supporting RTBL in higher education is not determined by a single factor, but rather by the interaction between instructional design, student digital literacy, the socio-educational context, and student motivation and engagement. Higher education institutions need to pay attention to these four aspects simultaneously so that the application of digital modules is not just a trend, but truly has a significant impact on improving the quality of learning. In the future, further research can be directed at efforts to develop more adaptive digital-based instructional design models and strategies to improve student digital literacy, so that the benefits of digital modules can be maximized in a sustainable manner.



**Figure 1.** Summary of the 2020–2025 International Study on Digital Modules and RTBL

Figure 1 shows the distribution of findings from studies on the role of digital modules in supporting Research Team-Based Learning (RTBL) in higher education institutions during the period 2020–2025. In general, the majority of studies show that the use of digital modules has a positive impact on increasing student engagement, strengthening learning outcomes, and developing collaborative skills. Digital modules are considered capable of providing flexible access, high interactivity, and connectivity between team members, which are characteristic of the RTBL approach. In the context of collaborative learning, students can access teaching materials asynchronously, discuss their findings online, and actively contribute to group problem-solving. This is in line with the findings of Burton & Jackson (2024), who stated that digital media strengthens student motivation and engagement in team-based tasks.

However, the graph also shows that not all research results show consistent positive impacts. Some studies highlight that the success of digital modules is highly dependent on the quality of instructional design and the readiness of students and lecturers in utilizing technology. For example, research by Lunt & Rogers (2024) shows that although digital modules can increase the effectiveness of RTBL, learning outcomes can vary if instructions are not clearly designed or if students' digital literacy is low. In other words, digital modules are not an instant solution; their effectiveness requires mature pedagogical strategies and institutional support.

The data distribution in Figure 1 also confirms that user experience and the quality of interaction between students play an important role in maximising the benefits of digital modules. Zhou's (2025) study underscores that digital literacy has a direct correlation with students' cognitive achievements, particularly in critical thinking and complex problem-solving skills. Students with better digital skills tend to be able to utilize module features, such as discussion forums, interactive quizzes, and multimedia-based simulations, to explore the material and contribute more meaningful ideas to the team.

In addition, several studies in this distribution of results emphasize the importance of institutional context. In the post-pandemic era, when online learning has become more dominant, digital modules are no longer seen as a supplement but rather a primary necessity. Flores-Cohaila, (2024), for example, found that digital modules allow RTBL to continue to function effectively even when students are not physically present, thereby supporting the hybrid model that is now increasingly common in higher education. This shows that the digitization of modules can expand access to education while maintaining the quality of collaboration.

Overall, Figure 1 shows a generally optimistic pattern: most studies agree that digital modules increase student engagement and enrich team-based learning experiences. However, the variation in results serves as a reminder that educational technology innovation always requires a contextual approach. Going forward, further research is needed to examine the integration of digital modules across various disciplines, particularly how they can be designed to be inclusive for students with diverse technological backgrounds. Thus, the distribution of findings in the 2020–2025 period not only reflects the positive potential of digital modules but also opens up opportunities to continue refining the implementation of RTBL in global higher education institutions (Roossien et al., 2025). In this case, the researcher will attach a summary table of the journals reviewed in this article.

**Table 2.** Summary of Journal Reviews

No	Title	Research Focus	Method	Main Contributions / Findings
1	Team-based learning in health professions education: A systematic review (Alizadeh, 2024).	Effectiveness of TBL in health professions education.	Systematic review of empirical studies.	Confirms that TBL improves critical thinking skills, clinical application, and collaboration among students.
2	Collaborative online learning quality in higher education (Bach, 2024).	The quality of online collaborative learning in higher education.	Mixed-method (survey & content analysis).	Provides indicators of the quality of collaborative online learning, including social interaction, task design, and technology support.
3	Digital Modules and Student Engagement in Higher Education (Burton & Jackson, 2024).	The effect of digital modules on student engagement.	Experimental – pre/post test.	Interactive digital modules increase student motivation and participation in learning activities.
4	Institutional Support for Digital Learning Platforms (Bygstad & Munkvold, 2022).	Institutional support for digital learning platforms.	Qualitative – case study (multi-institutional).	Demonstrates the importance of institutional managerial and technical support for the successful implementation of digital platforms.
5	Hybrid and Online RTBL Models in Post-COVID Universities (Flores-Cohaila, 2024).	Hybrid and online Research Team-Based Learning (RTBL) models post COVID-19 Online-based.	RTBL comparative case.	studies remain effective when supported by collaborative research assignment designs and synchronous-asynchronous platforms.

6	Applying Vygotsky's Social Constructivism in Digital Learning Environments (Kerruish & Patel, 2024).	Application of social constructivism theory in digital.	Conceptual analysis + teaching observation.	environment Offers a pedagogical framework based on collaboration and scaffolding to enhance interaction in e-learning.
7	Challenges in Instructional Design for Digital Team-Based Learning (Lunt & Rogers, 2024).	Instructional design challenges for digital TBL.	Qualitative thematic analysis of instructors' interviews.	- Identifying barriers such as limited design time, digital competency, and difficulties facilitating online teamwork.
8	Effectiveness of online learning: A systematic review (Meng et al., 2024).	Effectiveness of online learning in higher education.	Systematic review (meta-analysis).	Concludes that online effectiveness depends on interactivity, clarity of instructions, and platform support.
9	A pre-post quasi-experimental study of team-based learning effectiveness for Vietnamese nursing students (Ngoc et al., 2025)	Effectiveness of TBL on learning outcomes of Vietnamese nursing students.	Quasi-experimental (pre-post test).	TBL improves students' academic outcomes and self-confidence compared to conventional methods.
10	Team-based 4learning s5ystematic review (R6oossien et al., 20275)	Synthesis of TBL research findings across disciplines Groups	Systematic review	evidence on the impact of TBL on cognitive and affective learning outcomes and provides an agenda for further research.
11	Comparing TBL in-class vs online (Silva et al., 2022)	Comparison of the effectiveness of face-to-face and online TBL.	Experimental comparative study.	No significant differences; effectiveness depends on group interaction and instructor support.
12	Digital Literacy and Student Readiness in Team-Based Learning (Zhou, 2025)	The relationship between digital literacy and learning readiness in the context of TBL.	Quantitative correlational survey.	- High digital literacy is positively correlated with active participation and learning outcomes in digital-based TBL.
13	A pre-post quasi-experimental study of team-based learning effectiveness for Vietnamese nursing students (Ngoc et al., 2025)	Assessing the effectiveness of Team-Based Learning (TBL) on improving learning outcomes and critical thinking skills of nursing students in Vietnam.	Pre-post quasi-experimental design: students were divided into groups that participated in TBL for one semester; data were collected through pretest-posttest, questionnaires, and classroom observations.	Demonstrating that TBL significantly improves critical thinking skills, team collaboration, and learning motivation, this study strengthens the empirical evidence for the effectiveness of TBL in health education contexts in Southeast Asia.

14	Team-based learning pedagogy enhances the education quality: A systematic review and meta-analysis (Xie <i>et al.</i> , 2025)	To synthesize empirical evidence regarding the impact of Team-Based Learning (TBL) on the quality of learning in health professions education.	A systematic review and meta-analysis method of 45 experimental and quasi-experimental studies from various countries; statistical analysis using effect size pooling.	A meta-analysis showed that TBL significantly improves academic performance, clinical skills, and learning satisfaction compared to traditional lectures. This study strengthens the theoretical and empirical basis for TBL as an effective collaborative pedagogy in higher education.
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### 3.2 Discussion

The results of the review show that digital modules play a fundamental and transformational role in the successful implementation of Research Team-Based Learning (RTBL) in higher education. Digital modules now serve not only as a medium for delivering content, but have evolved into a dynamic learning ecosystem that facilitates collaboration, social interaction, and collective reflection among students. This finding is in line with Vygotsky's social constructivist view, which emphasises that knowledge is constructed through social and dialogical processes; in this context, digital modules act as virtual mediation spaces that strengthen interactions between research team members (Kerruish & Patel, 2024).

However, the effectiveness of digital modules in RTBL is not automatic but depends on a number of key determinants. First, student digital literacy is a key prerequisite. Low technological proficiency can hinder access to learning resources, utilization of collaborative features, and active participation in online discussions. Therefore, universities need to develop structured and sustainable digital literacy enhancement programs, both through basic training and the integration of digital skills into the curriculum (Zhou, 2025).

Second, the quality of instructional design determines the extent to which digital modules can foster critical and collaborative thinking skills. Interactive, contextual, and problem-based modules with scaffolding and formative assessment elements have proven to be more effective than passive, informative modules (Bach, 2024). The practical implication is that lecturers and content developers need to collaborate in applying adaptive design principles based on constructivist learning theory and learner-centered design.

Third, institutional support is the foundation for the success of digital RTBL. Technological infrastructure such as Learning Management Systems (LMS), stable internet networks, and academic policies that encourage digital innovation must be prepared systematically. Research by Bygstad & Munkvold (2022) confirms that the sustainability of digital learning innovation is only possible if there is integration between managerial strategies and institutional policies. Therefore, a digital learning governance model that connects lecturers, students, and technology support institutions is needed.

Fourth, the post-pandemic context has marked a paradigm shift from emergency learning to the normalization of digital-hybrid learning (Meng *et al.*, 2024). This shift presents an opportunity for universities to design a more flexible, cross-disciplinary, and learning analytics-based integration of RTBL. In this context, digital modules have the potential to act as enablers that facilitate remote research collaboration and systematic documentation of the learning process.

Conceptually, these findings confirm that the role of digital modules in RTBL needs to be understood in three main dimensions: (1) as a space for socio-epistemic interaction, (2) as an adaptive design-based pedagogical instrument, and (3) as a component of institutional systems that support the digital transformation of higher education. These three dimensions form an integrative framework that can be used as the basis for developing a new theory on Digital-Enabled Research Team Learning (DERTL).

For further research, several strategic agendas need to be prioritized:

1. Longitudinal experiments to assess the impact of digital modules on the development of students' critical thinking, collaborative, and research skills.
2. Development of an evaluation model for the effectiveness of digital RTBL based on learning analytics and an AI-driven feedback system.
3. Cross-cultural studies to understand variations in the adaptation of digital modules in higher education contexts in developing countries.
4. Design-based research to test the integration of social constructivism principles in the design of interactive RTBL modules.

By strengthening the integration between theory, practice, and policy, digital modules can become a key foundation for the transformation of collaborative research pedagogy in the post-digital era.

#### 4. CONCLUSION

This review demonstrates that digital modules play a strategic and multidimensional role in enhancing the effectiveness of Research Team-Based Learning (RTBL) in higher education by functioning not merely as instructional tools but as socio-epistemic ecosystems that facilitate collaboration, social interaction, and scientific reflection within the research process. The findings conceptually extend RTBL theory by positioning digital modules as adaptive pedagogical instruments and integral components of institutional digital transformation, while empirically highlighting that their effectiveness depends on the interplay among students' digital literacy, the quality of instructional design, and sustained institutional support. However, this review is limited by its reliance on existing literature, which constrains the ability to establish causal relationships and to capture long-term and cross-contextual impacts of digital module implementation. Future research should therefore employ longitudinal experimental designs to examine the sustained effects of digital modules on students' critical thinking, collaborative competence, and research skills; develop robust evaluation frameworks integrating learning analytics and AI-driven feedback to enable real-time assessment; and conduct cross-cultural and multi-institutional studies to explore contextual variations in implementation. Collectively, these directions will strengthen the empirical foundation of digital RTBL and advance the development of inclusive, sustainable, and collaborative models of research-based learning in the post-digital era.

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