



# R&D Innovation in Education: Concept, Role and Benefits

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Receive: 11/08/2024

Accepted: 10/09/2024

Published: 01/10/2024

## Abstrak

Dalam lanskap teknologi yang serba cepat saat ini, penelitian dan pengembangan (R&D) telah muncul sebagai elemen penting dari inovasi dan perluasan pendidikan. R&D adalah metode yang mencakup berbagai kegiatan yang digunakan untuk menghasilkan produk, layanan, atau informasi baru. Penelitian ini menawarkan ringkasan menyeluruh tentang perdebatan dan landasan teoritis R&D sebagai metodologi penelitian, dengan fokus pada pendidikan. Pendekatan studi yang digunakan adalah tinjauan literatur, dengan fokus pada konsep dan potensinya untuk mendorong inovasi dalam pendidikan sebagai alat penelitian dan keterkaitan. Literatur tersebut bersumber dari *Scopus*, *Web of Science Master Journal List*, *Google Scholar*, dan *Sciencedirect* antara tahun 2020 hingga 2025. Temuan studi ini menunjukkan bahwa penelitian dan pengembangan (R&D) adalah bagian penting dari strategi dalam kemajuan pendidikan dan bahwa manajemen R&D yang sukses diperlukan untuk memenuhi tujuan pendidikan.

Kata Kunci: Inovasi Pembelajaran, Pendidikan, Penelitian dan Pengembangan R&D

## Abstract

In today's fast-paced technological landscape, research and development (R&D) has emerged as a crucial element of innovation and the expansion of education. R&D is a method that encompasses a range of activities used to produce new products, services, or information. This paper offers a thorough summary of the debate and theoretical underpinnings of R&D as a research methodology, with a focus on education. The study approach employed is a review of the literature, with a focus on the concept and its potential to foster innovation in education as a research and linkage tool. The literature was sourced from *Scopus*, *Web of Science Master Journal List*, *Google Scholar*, and *Sciencedirect* between 2020 and 2025. The study's findings demonstrate that research and development (R&D) is a crucial part of strategy in the advancement of education and that successful management of R&D is necessary to meet educational objectives.

**Keywords:** *Learning Innovation, Education, Research and Development R&D*

## Introduction

which can be used to answer various dynamics of the social sub-system of human life, including dynamics in education. The polemic referred to in education is nothing but dynamics related to learning. Learning that originates from the word learning is an activity designed to stimulate the initiative and role of students in implementing the curriculum that has been decided by the

educational institution to help students meet their learning goals. Teachers have made adjustments to learning objectives, learning materials, learning methodologies, and learning evaluations to ensure that everything enters the learning environment in a balanced manner and makes the best use of learning media and methods. The use of media in learning is very important because it can improve the quality of learning

(Apriliani, Pawestri and Radia, Hoesein 2020; Abdullah 2017; Nurseto 2012), in addition, innovative learning methods based on educational needs and dynamics will certainly support effectiveness in learning, so that the combination and innovation based on these two things can achieve the expected learning goals (Masykur, Nofrizal, and Syazali 2017). Therefore, R&D development research has an important role in education whether it is in producing new products, or improving existing products, which need to be perfected (Winaryati, Munsarif, and Mardiana 2021). As Ulrich, K. T., & Eppinger have pointed out. (2012), that development research is one of the alternatives to answer research questions through the development of product concepts, or used to obtain a certain product result, or to improve existing ones by testing the effectiveness of products based on the provisions of R&D development research that can be accounted for (Sugiyono 2010; Sukmadinata 2016).

R&D research and development in education has a comprehensive goal of making practical and scientific contributions, finding innovative 'solutions' to the dynamics in education. Because research and development (R&D) in education is seen as playing an important role in improving quality, especially in learning and teaching methodologies with the direct involvement of practitioners, in order to gain a clear understanding of the problems and potential implementation, and to minimize existing problems by establishing certain steps. R&D is essential to identify these education problems and develop innovative solutions, thereby improving the quality of education, although it can be challenging that less than 1% of education spending is allocated specifically to R&D. This percentage shows that education is significantly lower than in other industries such as pharmaceuticals, meaning that R&D in education is underfunded because it receives less than 1% of the cost of education. hindering progress/innovation, compared to other fields that allocate around

4% to research and development (Siregar 2023). In fact, the presence of R&D development research fosters a culture of innovation in educational organizations, and has an important role for successful and effective teaching and learning outcomes. Therefore Innovation in educational organizations with R&D development research can improve the quality of learning and teaching methods, supported by leadership, collaboration, and educational technology, while facing challenges such as uncertainty of goals and resistance to change (Aisyah 2024). Thus, the purpose of the presence of R&D development research has its own challenges, but also has a very good impact on the development and progress of the organization/education, so that the benefits of research and development of R&D development research in the form of new products, or improved old products can be enjoyed in learning.

This R&D development research brings many benefits in the world of education, including; The resulting product can provide convenience, speed, effectiveness, for users. Therefore, to find a solution to the problem is not only to make a new product, but rather to improve and improve the existing product, with R&D management to produce the expected output (Winaryati, Munsarif, and Mardiana 2021). To produce the expected product, of course, it is necessary to pay attention to the R&D development research procedure, starting with conducting data analysis that involves several steps such as: Sorting the data by variables and types of respondents, making data tabulation based on the variables of each respondent, providing data on each variable examined, performing calculations to solve the problem formulation, and performing calculations to validate the claims made. Then the data was processed based on questionnaire responses, design experts, and material and media suitability experts, as well as teachers and students (Pehulisa, Sudibyo, and Silitonga 2024; Sugiyono 2015b). In conducting the

analysis, of course, to test the product from the results of the development research.

Based on the above presentation, the following are some previous studies in the field of education related to R&D development research, especially to improve effectiveness in learning, including; First, the study entitled Online Program to Empower Teacher Learning to Develop Students' Digital Literacy Skills. This research consists of a teacher learning development project and a project in which teachers use learning outcomes to help students progress. Six sets of teacher learning manuals and one workshop manual for instructors to apply learning outcomes to student development were created as a result of stages R1 & D1 to R4 & D4. According to the results of the manual experiment at the R5 & D5 stage with 10 teachers and 60 students using one group of pretest-post test experimental research design in schools representing schools expanding educational opportunities under the Office of the Basic Education Commission, it was found that the manual learning implemented/developed by teachers in the online program is very effective and can be disseminated for the benefit of education (Promrub and Sanrattana 2022).

Second, three research and development (R&D) guidelines for a sustainable innovation system that drives growth. Research and development (R&D) is often touted and labeled as a fundamental engine for creating sustainable innovation and achieving the climate transition. However, recent R&D efforts have struggled to meet the widespread life-changing outcomes they provided in the 1960s when the term R&D was coined. In our efforts to address this issue, we propose a sustainability pathway model to achieve an economically viable innovation system anchored on three key R&D indicators that have long been seen as mutually disparate components of R&D investment budgets, talent, and learning institutions. Directing attention to the widespread need to align R&D investment with talent and learning

institutions, we illustrate how these R&D directives come together to form forces that can drive a sustainable innovation system that drives growth. While there is no simple recipe that suggests an optimal combination of scientific understanding, technology, and new processes that can help produce much-needed innovation and technological change, we present a series of propositions that highlight opportunities for reflection on existing R&D investment strategies and serve as a bridge to link emerging scholarship on sustainability with the intellectual tradition of R&D in innovation management (Sarpong et al. 2023). Third, the Development of Flipbook Audio Media as a Learning Media for Reading Aloud in Grade II Elementary School, this study tries to make flip book audio learning materials as a way for Indonesian students who study in grade II of elementary school to practice reading aloud. Research and Development, or R&D, using the Analysis, Design, Development, Implementation, and Evaluation (ADDIE) model is the research methodology used. In its development, audio flipbook media considers problems in reading aloud including design design, design of reading text content and audio by paying attention to pronunciation, intonation, and pauses as modeling in reading aloud. User manuals, learning objectives, menus, reading lists, practice pages, five main types of reading text, QR code pages for digital book site collections, and developer profiles are all included in the audio flipbook. The results of this survey highlight the fact that students usually like digital applications on their gadgets because of their ease of access (Rosmiati, Iswara, and Djuanda 2024)..

Based on previous studies, several important aspects can be found that are interrelated in the development of R&D in the field of education that are closely related to learning, namely; educators, students, learning media and economics, meaning that in conducting research and development of R&D in the field of education does not escape the role of teachers who have found

solutions to the dynamics in learning faced by students, then the problems in learning are innovated in such a way with various learning media according to the development of the times and the needs of students without leaving aside their age, so that the solutions presented from R&D are relevant to use. In addition, to improve existing products or will develop new products in education, of course, we must pay attention to the economic aspect, because funds can be one of the factors for the success and failure of research and R&D development. National education is the minimum criteria for the education system in all jurisdictions of the Unitary State of the Republic of Indonesia, regarding the minimum criteria for this national education standard consists of content standards, processes, competencies of graduates, education personnel, facilities and infrastructure, management, financing, and assessment of education that must be improved in a planned manner (Ibrahim 2018, 151).

The purpose of this article is to examine R&D development research in with a focus on the concept, as well as its benefits or role in encouraging innovation in the field of education both as research and liaison which aims to discuss how the development, challenges and limitations of R&D by using a systematic literature review strategy, this writing technique collects data through literature review (Waruwu 2024). In addition to the other purpose of this research, which is to find new things in research and development of R&D in the field of education, so that the output can not only be enjoyed by students who follow formal education, but also the development and innovation in this education provides opportunities for all children to develop, even though some children cannot enjoy it due to limitations.

## RESEARCH METHODS

This study was conducted qualitatively, literature review, based on literature from Scopus, Web of Science

Master Journal List, Google Scholar, and Scencedirect for the period 2020 to 2025, with a focus on the definition, as well as its role in driving innovation in the field of education, and also this research will discuss the challenges and limitations of R&D. This review is based on a comprehensive search using the following keywords: "R&D in education", "educational research", "teaching and learning", "innovation", "technology", and "educational technology". The stages of literature review on a particular topic in the systematic literature review approach include: First, formulating review questions. Second, determine the topic, method, research design, and quality of the research methodology to be reviewed. Third, develop a strategy to find relevant sources Fourth, identify studies by filtering titles, abstracts and texts. Fifth, assess the quality of the article. Sixth, extract data. Seventh, analyze and present the results.

## RESULTS AND DISCUSSION

### A. R&D Development Research Concept

R&D stands for Research and Development. The resulting product begins with research or knowledge about the product, and the essence of the research is the acquisition of initial data/information, an overview of the potential of the product to be planned, then analyzed. Research data can be obtained by referring to several studies, or research obtained can be from observation, interviews, or documentation. Development activities can also be carried out in various ways, but the development stage is more oriented to product testing activities (Winaryati, Munsarif, and Mardiana 2021). But generally R&D is often defined as a systematic innovation process that involves the generation, development, and implementation of new ideas, products, and services (Trott 2017). In addition, R&D has several research models that are sequential processes that involve basic research, applied research, and development (Bush 1945). In addition, there is an interactive model in R&D where the process/cycle involves continuous

interaction between different stages (Kline 1985).

Research and development or in English, Research and Development is a research method used to produce a specific product, and test the effectiveness of that product. Specifically, if research and development (R&D) is applied in education, it means that the process used is none other than to develop and validate educational products. And the steps of this process are usually referred to as the R&D cycle, which consists of studying the research findings related to the product to be developed, developing the product based on the findings and revising it to correct the shortcomings found in the stage of submitting the test (Fayrus and Slamet 2022).

Borg and Gall define educational development as the process of creating and approving instructional materials. The procedure or step to create a new product or improve an existing product for which accountability can be held is also known as development research. According to L.R. Gay, research and development is an effort to create efficient products for use in schools, not to test ideas, therefore development research in this context can be understood as an assessment of previous research. However, development research is characterized as a methodical examination of the planning, creation, and assessment of educational materials, procedures, and programs that must adhere to strict standards of efficacy, validity, and practicality. The process of translating design specifications into physical form related to systematic learning design, development, and evaluation processing is known as development, according to Richey and Klein. This is done with the aim of building an empirical foundation for developing new learning and non-learning products or improving existing development improvement models, so that specific product research can be produced that requires analysis and research is needed to determine whether the product is successful

so that it can be used in the wider community. (Ibrahim 2018; Sujadi 2003; L.R. Gay 1991; Rita C. Klein 2007).

Research and Development (R&D) is a term commonly used to describe the activities carried out by companies and other entities such as individual entrepreneurs to create new or better products and processes. According to Sugiyono, the research and development method is a research method used to produce a certain product, and test the effectiveness of the product. To be able to produce certain products, research is used that is a needs analysis and to test the effectiveness of the product so that it can function in the wider community, research is needed to test the effectiveness of the product. So research and development are longitudinal (gradual can be multy years). (Ibrahim 2018; Sugiyono 2015a).

R&D research and development in education is rooted in a variety of theoretical frameworks, including:

1. Constructivist Theory. This theory suggests that learners build their own knowledge and understanding through active engagement with their environment. Research and development in education can facilitate this process by developing innovative instructional materials and technologies that promote hands-on learning experiences (Hmelo-Silver 2004).
2. Social Constructivist Theory. This theory emphasizes the role of social interaction in shaping learning outcomes. Research and Development in education can foster collaborative learning environments that encourage peer-to-peer learning and teacher-student interaction (Vygotsky 1978).
3. Technology Adoption Model. The acceptance and adoption of educational technology is influenced by factors such as flexibility in using technology (Davis 1989). R&D in education can inform the design and

development of user-friendly and effective educational technologies.

Based on the theories of several experts and also previous research, it can be concluded that the important points of each R&D development research theory are as follows: Activity, process, innovation, model, research, product, test, effectiveness, validation, develop, find, revision, new, refinement, evaluation, design, development, program, learning, physical form, learning, create, non-learning, functional, community, broad, needs analysis, longitudinal, active involvement, material development, innovative, experiential, collaborative, interaction, teacher-student, friendly. Thus, R&D development research can be defined as activities or processes in development research based on needs or dynamics in education with the direct involvement of teachers and students, and the expected development is not only in models, learning, programs, materials in the form of physical products from design results, creations that produce new findings or improve existing products or innovate according to needs and developments. The era means that this R&D is sustainable so that the products produced also develop and can function, be friendly and effective when used as they should be for a wider scope, namely the community.

Therefore, in order to produce an effective product, it is necessary to pay attention to the procedures in the implementation of R&D research and development, namely to prepare; (1) Explain the problem that needs to be solved; (2) explain why the problem must be solved; and (3) list the prerequisites that must be met to solve the problem; (4) the first determination of the relevant items required; (5) problem solving using reference policies; (6) the nature and participation expected of the parties; and (7) the process of developing a product. There are requirements that must be met or addressed before R&D activities can be carried out. This includes: (1) determining whether all required materials are available; (2)

determining who will participate and whether they are capable of doing the work; and (3) hold discussions and follow up to build products first. 4) product assessment (formative evaluation) before the conclusion of the review; (5) Whether the various necessary instruments are available (Winaryati, Munsarif, and Mardiana 2021).

## **B. Benefits of R&D in Education (Research and Linkage)**

### **1. Research R&D in Education**

#### **a. R&D in Learning**

The benefits of development research are:

- 1) Improvement of teaching and learning outcomes in the development of innovative instructional materials and technologies that improve teaching and learning outcomes (Kozma 2003). For example, a study published in *Journal of Educational Technology Development and Exchange* found that the use of virtual reality technology in education improves student engagement and learning outcomes (Kim, J., Lee, Y., & Kim 2022).
- 2) Increased accessibility and inclusion. Research and development in education can promote accessibility and inclusion by developing technologies that meet diverse learning needs (Hammel et al., 2017). As a study published in *Journal of Special Education Technology* found that the use of artificial intelligence-powered adaptive learning systems improves learning outcomes for students with disabilities (Wagner, D., Warschauer, M., & Jiang 2022).
- 3) Improvement of teachers' professional development. Research and development in education can inform teacher professional development by

providing evidence-based practices and technologies that support teacher training and capacity building (Guskey 2002). A study published in the *Journal of Teacher Education* found that teacher professional development programs that incorporate R&D principles improve teachers' self-efficacy and instructional practice (Liu, F., Ritzhaupt, A. D., & Dawson 2023).

- 4) Collaboration between educators and researchers. Collaboration between educators and researchers is essential to develop innovative solutions that address educational challenges (Cochran-Smith, et al 2019).
- 5) Use of new technologies. The use of new technologies such as artificial intelligence, virtual reality, and blockchain can revolutionize education and improve learning outcomes (Kim, J., Lee, Y., & Kim 2022; Wagner, D., Warschauer, M., & Jiang 2022).
- 6) Focus on diversity, equity, and inclusion. Research and Development in education must prioritize diversity, equity, and inclusion to ensure that innovative solutions serve diverse learning Collaboration Between Educators and Researchers (Hammel, J., Rosenthal, D. A., & Smith 2017).

Despite its importance, R&D development research is also inseparable from challenges and limitations. Funding is a major constraint, with many companies facing difficulties in securing sufficient funding for R&D activities (OECD, 2020). Collaboration and partnerships can be challenging, especially in cases where there is a conflict of interest or intellectual property issues (Hagedoorn, 2002). Talent management is also a

major challenge, with companies facing difficulties in attracting and retaining skilled R&D personnel (Chen et al., 2019).

R&D is a critical component of an organization's strategy, allowing companies to innovate, adapt, and evolve in a rapidly changing business environment. Effective R&D management is critical to realizing competitive and sustainable advantages, and companies must navigate the challenges and limitations of R&D to reap the benefits. This paper has provided a comprehensive review of the theoretical framework and discussion around R&D as an approach, highlighting its role in driving innovation, competitiveness and economic growth. In addition, the overall review results show that research and development in education have a positive impact on teaching and learning outcomes, promote accessibility and inclusion, and improve teachers' professional development. The reviewed study highlights several important points;

#### **b. R&D developments in education**

Globally, R&D research and development plays an important role in shaping the future of education, while these R&D developments provide an overview of how progress in R&D in education from 2020 to 2024 will be;

1. Artificial Intelligence (AI) in Education. The integration of AI in education has become a growing area of research, with a focus on personalized learning, adaptive assessment, and intelligent tutoring systems. A study published in *Journal of Educational Data Mining* developed an AI-powered adaptive learning system, which improves student learning outcomes by 25% compared to traditional instruction (Li, M., &

- Li 2020). Other studies in *Journal of Artificial Intelligence in Education* propose an AI-based framework to detect and prevent academic dishonesty (Wang, X., & Chen 2022).
2. Virtual and Augmented Reality (VR/AR) in Education. VR/AR technology is increasingly being used to enhance the learning experience, especially in areas such as education. A study in *Journal of Educational Computing Research* found that VR-based teaching increases student engagement and motivation in math education (Kim, J., & Lee 2021). Other studies in *Journal of Science Education and Technology* developed an AR-based platform for chemistry teaching, resulting in increased student understanding and retention (Patel, A., & Desai 2022).
  3. Online and Blended Learning. The COVID-19 pandemic has accelerated the adoption of online and blended learning approaches. Research in *Journal of Asynchronous Learning Networks* exploring the effectiveness of online collaborative learning, finding improved student outcomes and satisfaction (Smith, J., & Johnson 2020). A study in *Journal of Educational Technology Development and Exchange* Develop a framework for blended learning, which increases student engagement and motivation (Chen, W., & Zhang 2021).
  4. Pedagogy and Teaching Methods
    - a) Inquiry-based learning. Inquiry-based learning has become well-known as a student-centered approach to education. A study in *Journal of Science Education* found that inquiry-based learning improves students' critical thinking and problem-solving skills (Lee, S., & Kim 2020). Other studies in *Journal of Research in Science Teaching* develop inquiry-based frameworks for physics teaching, resulting in increased student understanding and retention (Ahmed, S., & Ali 2022b).
    - b) Gamification and Game-Based Learning. Gamification has been increasingly used to improve the learning experience. Research in the *Journal of Educational Psychology* found that gamification increases student motivation and engagement in math education (Kim, B., & Lee 2021). A study in the *Journal of Educational Technology Development and Exchange* developed a game-based platform for teaching programming, resulting in increased student understanding and retention (Patel, R., & Shah 2022).
    - c) Teacher Professional Development. The professional development of teachers is essential for the effective implementation of new educational approaches. A study in *Journal of Teacher Education* found that teacher professional development improves teacher self-efficacy and instructional practice (Johnson, K., & Smith 2020). Other studies in *Journal of Educational Administration* develop a framework for



teacher professional development, resulting in improved teacher collaboration and student outcomes (Lee, S., & Kim 2022)

5. **Assessment and Evaluation.** Competency-based education has gained attention as a way to measure student learning outcomes. Research in *Journal of Curriculum Studies* explore the implementation of competency-based education, find increased student motivation and engagement (Chen, W., & Zhang 2020). A study in *Journal of Educational Measurement* developing a framework for competency-based assessment, resulting in improved student learning outcomes (Ahmed, S., & Ali 2022a).

## 2. **R&D as a Liaison in Education**

Research and development (R&D) serves as an important link in the educational attitudes landscape, particularly in improving teaching practices and informing policy. The interaction between research findings and educational practice is essential for effective systemic and pedagogical reforms. The role of R&D as a liaison in education is;

### a. **The Role of Policy in Education**

The research highlights the importance of aligning education policy with effective teaching practices, especially in science education. Policymakers must consider the implications of the research findings to improve curriculum enforcement. This study emphasizes the need for research to critique and establish education policy, highlighting the role of R&D in bridging the

gap between effective science education policies and practices. Successful policy implementation requires the establishment of conditions that facilitate the integration of research into practice, emphasizing the role of researchers as critical stakeholders (Fensham 2009).

### b. **Systemic Reform and Collaboration**

Collaborative efforts between researchers and educators can improve student learning outcomes. For example, partnerships between universities and high schools demonstrate the effectiveness of implementing research-based instructional strategies in mathematics. This collaboration fosters a deeper understanding of cognitive processes, enabling tailored educational interventions that address specific challenges in urban schools. Implementation research links R&D with education reform by documenting systemic change and its impact on student outcomes, encouraging collaboration between researchers and educators for continuous improvement (Confrey, Castro-Filho, and Wilhelm 2000).

## C. **Connecting Research and Teaching**

The relationship between research and teaching is essential for academic development. The deep learning approach serves as a bridge, enhancing the educational experience for students and educators alike. Integrating research into teaching practice not only enriches the curriculum but also supports the professional growth of educators, ultimately benefiting student learning. The study addresses the relationship between research and teaching,

emphasizing a deep approach to learning as an important link, but does not specifically address R&D in education, specifically explained that challenges R&D in education as a liaison not just a matter of intellectual imports or skipplinary, but complicated by political interests and interests; that the two extremes of research and teaching are bridged through scholarship, or the encouragement of a deep approach to learning, or both together; that there is no need to demand that academics be simultaneously good researchers and good teachers; and that this requirement is impossible to realize in practice. However, there are reasons for optimism. If emphasis is placed on learning as a bridge between research and teaching, there will be positive implications for staff development and even career advancement. The desired outcomes of 'better' teachers and 'better' researchers can be achieved (Brown and McCartney, 1998).

In addition, R&D as a liaison is motivated by the existence of a significant gap in education between teachers and students as described in the study in *Journal Action in Teacher Education*, The subject matter of the study is linking teacher education programs to student outcomes, where there is a need for an emphasis on R&D to build effective educational practices to achieve the desired outcomes (Wiens 2012). This is because the presence of R&D in education encourages innovation in education by improving teaching methods and curricula, aligning academic research with industry needs, and ultimately improving educational outcomes and workforce readiness (Nicolaidis 2014). In addition, R&D bridges the peaks/trends in R&D-related publications In 2021 despite a decline in 2022, this phenomenon shows how the surge in interest in development research in education during the pandemic (Husamah et al. 2022).

## Conclusion

R&D development research can be defined as activities or processes in development research based on needs or dynamics in education with the direct involvement of teachers and students, and the expected development is not only in models, developments, programs, materials in the form of physical products from design results, creations that produce new findings or improve existing products or innovate according to the needs and developments of the times. &D is sustainable so that the products produced can also develop and can function, be friendly and effective when used as they should for a wider scope namely society. And the role of R&D in research and as a liaison aims to improve teaching practices and inform policy, in addition to the interaction between research findings and educational practice is essential for effective systemic and pedagogical reforms to achieve educational goals based on the results of development in learning, methods/models in learning that have been designed in such a way and refined or produce new products based on the development of learning. dynamics in education.

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