MaPan : Jurnal Matematika dan Pembelajaran
p-ISSN: 2354-6883 ; e-ISSN: 2581-172X
Volume 13, No 2, Dec 2025 (236-252)
DOI: https://doi.org/10.24252/mapan.2025v13n2a1

Anomalous Scientific Foundations: Research and Development (R&D) Model Synthesis Practices in Indonesian Doctoral Dissertations

Alimuddin Tampa[1*], Wen Haw Chen[2], Rosidah[3], Fauziyyah Alimuddin[4]
[1,3,4]Faculty of Mathematics and Natural Sciences, Makassar State University
[2]Departement of Applied Mathematics, Tunghai University
[1,3,4]Jl. Mallengkeri Raya, Parang Tambung, Makassar, Indonesia
[2]Xitun District, Taichung City, Taiwan
Correspondence Email: alimuddin@unm.ac.id

Received October 27, 2025; Revised December 12, 2025; Accepted December 19, 2025
Available Online December 24, 2025

Abstract:
The synthesis of Research and Development (R&D) models in Indonesian doctoral dissertations has become increasingly common. This study examines how doctoral students formulate and implement such syntheses, identifying the conceptual and technical challenges they face. Using a concurrent mixed methods design, data were collected through an online survey with open and closed ended questions. Responses from 51 participants were analyzed using descriptive statistics and thematic analysis. The results show that all students used synthesized R&D models without adequate scientific justification, as evidenced by the absence of philosophical grounding, lack of expert validation, misalignment with research paradigms, and omission of preliminary testing. Students also faced three major challenges: limited understanding of philosophical assumptions, difficulty integrating model structures, and strong dependence on informal supervisory advice. These issues undermine methodological coherence and threaten the integrity of developmental research in doctoral programs. The study highlights the need to strengthen methodological training, reform supervision practices, and produce clearer, evidence based guidelines. It recommends prioritizing rigorously validated single model R&D approaches to ensure conceptual clarity and academic credibility.

Abstrak:
Sintesis model Research and Development (R&D) dalam disertasi doktor di Indonesia semakin meluas. Penelitian ini mengkaji bagaimana mahasiswa doktoral merumuskan dan menerapkan sintesis tersebut serta mengidentifikasi tantangan konseptual dan teknis yang mereka hadapi. Dengan menggunakan desain concurrent mixed methods, data dikumpulkan melalui survei daring yang terdiri atas pertanyaan terbuka dan tertutup. Sebanyak 51 respons dianalisis menggunakan statistik deskriptif dan analisis tematik. Hasil penelitian menunjukkan bahwa seluruh mahasiswa menggunakan model R&D tersintesis tanpa justifikasi ilmiah yang memadai, ditandai dengan ketiadaan landasan filosofis, tidak adanya validasi ahli, ketidaksesuaian dengan paradigma penelitian, dan tidak dilakukannya preliminary testing. Mahasiswa juga mengalami tiga tantangan utama: keterbatasan pemahaman tentang asumsi filosofis, kesulitan mengintegrasikan struktur model, serta

ketergantungan yang tinggi pada bimbingan informal dari pembimbing. Masalah-masalah ini melemahkan koherensi metodologis dan mengancam integritas tradisi penelitian pengembangan di program doktor. Penelitian ini menekankan perlunya penguatan pelatihan metodologi, reformasi praktik pembimbingan, dan penyusunan panduan berbasis bukti yang lebih jelas. Penelitian ini merekomendasikan penggunaan model R&D tunggal yang telah divalidasi secara ketat untuk memastikan kejelasan konseptual dan kredibilitas akademik.

Keywords:
R&D Model Synthesis, Doctoral Dissertations, Methodological Integrity, Research Methodology, Philosophical Foundations

How to Cite: Tampa, A., Chen, W. H., Rosidah, & Alimuddin, F. (2025). Anomalous Scientific Foundations: Research and Development (R&D) Model Synthesis Practices in Indonesian Doctoral Dissertations. *MaPan: Jurnal Matematika dan Pembelajaran*, 13(2), 236-252. https://doi.org/10.24252/mapan.2025v13n2a1.

INTRODUCTION

Research and Development (R&D) methodology has evolved from its industrial origins into an adaptive framework within educational research (Hevner, March, Park, & Ram, 2004; Johnson & Hill, Lock, Altowairiki, Ostrowski, Santos, & Liu, 2017). Its primary strength lies in adaptability to address educational problems through context specific, problem-driven inquiry (McKenney & Reeves, 2019). In Indonesia, it dominates doctoral dissertations through models such as Plomp, 4D, ADDIE, and Borg and Gall, valued for their systematic design processes ranging from needs analysis, design, development, validation, implementation, and dissemination (Anwar, 2024; Nur, 2023; Reigeluth, Beatty, & Myers, 2017).

However, a concerning trend has emerged: doctoral students frequently synthesize multiple R&D models without philosophical rationale or epistemological coherence. While this synthesis may appear adaptive, it is conducted without sound justification (Anwar, 2024; Nur, 2023).

This practice creates a critical research gap. To the best of the author's knowledge, no prior research has systematically examined the philosophical coherence and methodological consistency of R&D model synthesis in doctoral dissertations. This gap is urgent, if left unexamined, such practices risk diminishing R&D's credibility as a rigorous scientific method and may constrain its capacity to address complex educational challenges.

Empirical evaluation of dissertations reveals that model selection is driven by pragmatic considerations such as procedural efficiency or personal preference rather than paradigmatic analysis. The fundamental issue lies in the absence of robust philosophical and methodological justifications. Consequently, dissertations exhibit systematic inconsistencies: (1) disparity between theoretical frameworks and applied procedures, and (2) misalignment between research design and instruments (Anwar, 2024; Nur, 2023).

By employing an epistemological lens, this study enriches R&D's theoretical foundations while providing practical guidance for doctoral researchers. This study addresses two questions: (1) How do doctoral students justify and implement the scientific foundations of R&D model synthesis? and (2) What challenges do they face in formulating and executing synthesized models?

Plomp, 4D, ADDIE, and Borg and Gall share systematic sequences: needs analysis, design, development, implementation, and evaluation. This structural commonality reflects their origins in systems design methodologies from industrial and instructional training domains (Barab & Squire, 2016; Hodell, 2015; Irawan, Padmadewi, & Artini, 2018; Ismail, Mawardi, Lufri, Usmeldi, & Festiyed, 2024; McKenney & Reeves, 2019; Tampa, Tawil, & Manggi,, 2023).

However, these procedural similarities obscure fundamental philosophical differences. The Plomp model is grounded in constructivist and pragmatic paradigms, emphasizing iterative, reflective processes aligned with design-based research (Akker, Den, Bannan, Kelly, Plomp, & Nieveen, 2013). The 4D model is rooted in behaviorist and instructional systems theories, prioritizing linear progression and procedural efficiency (Reigeluth & An, 2020). ADDIE offers a modular design for large scale instructional planning, emphasizing procedural control and scalability (Kurt, 2017; Kazanidis, & Pange, 2022). The Borg and Gall model is based on structured positivism, emphasizing empirical validation and methodological rigor through large scale quantitative testing (Brundrett & Rhodes, 2011; Gall, Borg, & Gall, 2020).

These philosophical divergences become critical when researchers merge stages from multiple models without reconciling their underlying assumptions. While procedural elements may appear compatible, their theoretical foundations are fundamentally non interchangeable. Uncritical synthesis across paradigms risks inducing methodological incoherence and undermining epistemic integrity.

Methodological integrity constitutes a fundamental criterion for evaluating synthesized research models (Peffers, Tuunanen, Gengler, Rossi, M., Hui, Virtanen, & Bragge, 2020). This concept encompasses philosophical coherence, procedural consistency, instrumentation alignment, and research design transparency.

Models selected for synthesis must demonstrate compatibility with the overarching theoretical framework, not only conceptually but also within the operational logic underpinning planning, implementation, and validation (Haagen-Schutzenhofer & Hopf, 2020). When a constructivist paradigm is merged with a linear approach without conceptual adjustment, the resulting design becomes vulnerable to systematic inconsistencies. Deploying instruments misaligned with the methodological framework undermines research validity, even when procedural stages appear complete.

A commonly overlooked element is reflective documentation articulating the rationale behind each methodological decision. Without such transparency, synthesis efforts risk being perceived as unsystematic, pragmatically driven amalgamations.

METHODS

This study employed a concurrent mixed-methods design, combining quantitative descriptive and qualitative thematic approaches (Creswell & Clark, 2017). Data were collected through an online questionnaire via Google Forms containing closed ended and open ended questions. Participation was voluntary, with informed consent obtained from all respondents.

Participants were 51 doctoral students in education from seven public universities across Indonesia. All had adopted synthesized R&D models in their dissertations and reached at least the data collection phase. Of 97 responses, 51 met the eligibility criteria through purposive sampling.

The questionnaire comprised 19 items examining synthesis practices and challenges across two domains: (1) scientific foundations (model description, philosophical justification, validation items P.1.1.1–P.1.3.3), and (2) challenges (technical and conceptual difficulties items P.2.1.1–P.2.2.3). Items elicited categorical (yes/no) and open-ended responses.

Content validity was confirmed by three experts (CVI $\geq$ 0.81). Pilot testing with 15 students yielded Cronbach's Alpha of 0.845. The questionnaire is available at https://doi.org/10.17605/OSF.IO/N68S2.

Data were collected online between February 23 and May 11, 2025. Quantitative data were analyzed using descriptive statistics via SPSS version 26. Qualitative data were analyzed thematically following Braun and Clarke (2025) framework using NVivo 12, with the constant comparative method employed (Charmaz, 2014).

Trustworthiness was established through: member checking and expert peer review (Lincoln & Guba, 1985); test-retest procedures and debriefing sessions for dependability; reflexivity journals for confirmability (Patton, 2025); independent coding by two analysts for researcher triangulation; and data saturation assessment (Guest, Namey, & Chen, 2020) with contextual descriptions (Tisdell, Merriam, & Peyrot, 2025) for transferability.

RESULTS AND DISCUSSION

1. Results

A total of 97 respondents completed the questionnaire. After screening, 51 responses met the eligibility criteria.

a. Scientific Foundations of Synthesized R&D Model Practices

Table 1. Data Summary: Scientific Foundations of Synthesized R&D Model Practices

Question Code	Data Description
P.1.1.1	▪ 17 students (33.3%) synthesized three R&D models ▪ 34 students (66.7%) synthesized two R&D models
P.1.1.2	▪ The types of R&D models synthesized varied considerably (non-uniform) ▪ For three models: Plomp & ADDIE; Plomp & 4D; ADDIE & Borg/Gall ▪ For two models: Plomp & ADDIE, ADDIE & 4D; Borg/Gall & ADDIE, ADDIE & 4D
P.1.1.3	▪ Reasons for synthesizing R&D models: ▪ No single model is considered perfect; combining models makes the framework more complete (35.3%) ▪ To facilitate easier implementation (21.6%) ▪ Based on recommendations from supervisors or graduate program coordinators (17.6%) ▪ To enhance the rationality and scientific rigor of the

Question Code	Data Description
	development process (25.5%)
P.1.2.1	▪ 92.2% did not provide any philosophical justification for the model synthesis. The reasons cited include: "unnecessary, as it has already been established by experts," or a lack of philosophical knowledge ▪ Only 7.8% articulated a philosophical foundation, typically stating: "to complement each other."
P.1.2.2	▪ 52.9% answered "do not know." ▪ 33.3% provided no response ▪ 13.7% offered explanations such as: "the philosophical basis of Plomp lies in its four development stages; ADDIE is based on five stages; Borg & Gall follows a nine-stage development process."
P.1.2.3	▪ 100% of the students did not conduct any analysis of philosophical compatibility to examine epistemological coherence
P.1.2.4	▪ 72.5% did not explain their rationale for synthesizing R&D models. Their reasoning: "It is unnecessary because the synthesized sequence is already self-explanatory." ▪ 27.5% provided justifications, explaining that model components were synthesized to complement deficiencies in individual model stages
P.1.3.1	▪ 100% of students stated that their synthesized R&D model was not validated by R&D experts ▪ Instead, validation or feedback was sought from: Promoter and co-promoter (72.5%) ▪ Promoter, co-promoter, and peer colleagues (27.5%)
P.1.3.2	▪ 100% of students did not conduct pilot testing of the synthesized R&D model before application
P.1.3.3	▪ 100% of students did not present their synthesized R&D model in academic forums (national or international) before its implementation ▪ However, most students reported having presented their research findings in scientific forums at national or international levels

Most students (66.7%) synthesized two models, while 33.3% synthesized three. Combinations varied widely with no standardized pattern. Motivations were predominantly pragmatic: perceived incompleteness of single models (35.3%), ease of implementation (21.6%), supervisor suggestions (17.6%), and desire for scientific rigor (25.5%).

A critical finding was the absence of philosophical grounding. Most students (92.2%) provided no philosophical justification. When asked about individual model foundations, 52.9% stated they did not know, 33.3% did not respond, and only 13.7% mentioned structural aspects. None conducted a compatibility analysis.

Validation practices were weak. No students validated their models with R&D experts, relying instead on supervisors (72.5%) or peers (27.5%). None conducted pilot testing or presented models in scholarly forums before implementation.

b. Challenges in Synthesizing R&D Models

Table 2. Summary of Reported Challenges in Synthesizing R&D Models

Question Code	Data Description
P.2.1.1	▪ 84.3% of students experienced difficulties in selecting which R&D models to synthesize, citing that the models had similar stages—some detailed, others not. ▪ Only 15.7% of students reported no difficulty in selecting models, stating they simply chose those that suited their needs, or combined models as they saw fit.
P.2.1.2	▪ 92.2% of students encountered challenges in distinguishing between stages of different models, choosing which stages to integrate, and determining how many stages to synthesize. ▪ Only 7.8% of students reported no difficulty, explaining that they synthesized based on the sequence of each R&D model.
P.2.2.1	▪ 94.1% believed that synthesized models are superior to single models, citing reasons such as more comprehensive stages and the combination of multiple theories leading to a more complete model. • 5.9% were unsure, stating that it depends on whether the research process is conducted scientifically or not.
P.2.2.2	▪ 72.5% could not decide whether to use a synthesized or single R&D model. Their decision would depend on whether there are authoritative references (books or reputable journal articles) stating that R&D should not be synthesized, as well as on the supervisor's preference. ▪ 21.6% preferred using a synthesized model, arguing it has more comprehensive stages and leads to better outcomes.

Question Code	Data Description
	▪ 5.9% stated they would not use synthesis because it complicates implementation and makes it difficult to distinguish between synthesized stages.
P.2.2.3	▪ All postgraduate lecturers, including program leaders, shared a unified perception regarding the synthesis of R&D models. ▪ It was suggested that one of the lecturers should write a book or publish an article in a reputable journal to serve as a reference.

Most students (84.3%) experienced difficulties selecting models due to structural similarities. Similarly, 92.2% faced challenges distinguishing stages and determining synthesis scope.

Despite difficulties, 94.1% believed synthesized models were superior, citing comprehensive stages. However, 72.5% were undecided about future use, depending on the availability of credible references and supervisor preferences. Only 21.6% committed to continuing synthesis, while 5.9% preferred abandoning it.

Students emphasized the need for institutional support, noting that while faculty accepted synthesis, the absence of formal references was problematic. They recommended that faculty produce scholarly publications to establish authoritative guidance.

2. Discussion

a. Absence of Scientific Foundation in R&D Model Synthesis

The findings reveal that students focus on technical execution while overlooking theoretical underpinnings. They ignore differences between models, insufficiently analyze underlying assumptions, neglect systematic considerations, and bypass validation procedures. Instead, synthesis is guided by pragmatic preferences and informal supervisory input, resulting in mechanical assembly prone to logical inconsistencies.

This represents a fundamental weakness in scientific legitimacy. R&D research requires logically coherent, internally consistent, and empirically validated design structures. Literature emphasizes that research design integrity is rooted in alignment of assumptions and systematic reasoning across all components (Gamage, 2025; Levitt, Morrill, Collins, & Rizo, 2021). A synthesized model lacking proper validation cannot be deemed scientifically legitimate (Campbell, McKenzie, Sowden, Katikireddi, Brennan, Ellis, Hartmann-Boyce, Ryan, Shepperd, Thomas, Welch, & Thomson, 2020; National Academies of Sciences Engineering and Medicine, 2019). The assumption that the validity of individual source models automatically ensures synthesis validity reflects a fundamental misconception (Tang, Boker, & Tong, 2025; Vowels, 2023).

Recent scholarship underscores the complexity of integrating different approaches. Coates (2021) argues that effective synthesis requires careful assessment of compatibility, while Liu (2022) stresses addressing underlying assumptions explicitly. Synthesis is not merely technical aggregation but scientific reconstruction requiring rigorous validation.

While synthesizing R&D models is theoretically permissible, achieving scientific legitimacy depends on strict adherence to standardized procedures. Effective synthesis must begin with a comprehensive analysis assessing the compatibility of models being integrated. The resulting framework should be documented systematically (Al-Ababneh, 2020; Braun & Clarke, 2025).

To establish legitimacy, synthesized models must undergo validation in open academic forums such as methodological consortia or disciplinary associations to facilitate peer critique. Only after undergoing peer review, empirical testing, and publication in reputable outlets can a synthesized model be recognized as scientifically valid (He, Tian, & Xu, 2023; Recio-Saucedo, Crane, Meadmore, Fackrell, Church, Fraser, & Blatch-Jones, 2022).

Without such rigor, synthesis attempts risk resulting in superficial hybridizations lacking both conceptual robustness and structural validity. Contemporary literature consistently affirms that methodological innovation requires systematic validation (Heinze, Boulesteix, Kammer, Morris, & White, 2024; Jewitt, Xambo, & Price, 2017). Thus, synthesizing R&D models should be regarded not merely as a procedural task but as a complex scholarly endeavor demanding coherence, transparency, and institutional recognition through rigorous validation.

b. Challenges in Synthesis Practices

The core challenge lies not only in a limited understanding of scientific philosophy but also in the difficulty of constructing logically consistent structures. Technical barriers distinguishing stages, sequencing steps, and forming integrated frameworks reflect synthesis efforts undertaken without clear grounding.

When frameworks are merged without a proper understanding of their foundations, the resulting structure tends to be artificial and fragmented. Although integrated stages may appear comprehensive, they often lack internal coherence, yielding fragile design visually complex yet lacking scientific integrity (Rossenberg, Van, Sanderson, Achnak, Brookes, Doci, Ghoreysh, Hack-Polay, Hartgerink, Hopkins, Hornung, Khuda, Lub, McKew, Mendy, & Nijs, 2024).

In developmental research, such incoherence risks undermining internal validity and traceability. Timonen, Foley, and Conlon (2024) emphasize that structurally inconsistent designs generate findings that are difficult to defend. Kroop (2025) notes that misalignments compromise the credibility of the entire study.

Beyond technical factors, students exhibit strong dependence on informal authority figures particularly supervisors and on undocumented institutional norms. When synthesis decisions are driven by convenience or verbal guidance rather than explicit reasoning, research integrity is compromised. Student autonomy is reduced to procedural compliance rather than reflective scholarly agency.

This dependency is aggravated by the scarcity of authoritative scholarly references explicitly discussing the legitimacy of R&D model synthesis its boundaries, validation protocols, and theoretical consequences (Sun & Zuo, 2024). In this vacuum, ambiguity proliferates, resulting in varied and inconsistent practices. Decisions often rest on undocumented opinions, shaped more by local consensus than by rigorous academic standards. Research design accountability weakens, and uncertainty impedes the formation of a coherent methodological tradition (Piran & Tran, 2024).

c. Consequences of Invalid Synthesis

Synthesis practices lacking a solid scientific foundation blur the boundary between academic procedure and technical construction. When synthesis is undertaken without clear orientation, it results not only in methodological disorientation but also in the construction of knowledge that is fragile. In developmental research, this represents a shift in model design from serving as a means of scientific inquiry to functioning merely as a procedural response to formal academic demands (Devezer & Buzbas, 2023; Glick, Miller, & Cardinal, 2008).

Such a condition reflects what scholars call degradation, where scientific practices drift away from their truth seeking purpose and devolve into instrumental routines (Saltelli & Giampietro, 2015). Rather than expanding horizons of knowledge, these practices narrow them into pragmatic routines lacking critical reflection.

The implications extend beyond structural weaknesses they challenge the very legitimacy of research synthesis as an academic endeavor. Without robust theoretical foundations, synthesis efforts fail both in form and justification, undermining not only methodological rigor but also academic credibility (Piran & Tran, 2024).

These findings echo growing concerns about the dangers of unchecked methodological eclecticism. Synthesis practices are facing a dual crisis of coherence and validity. The absence of grounding, weak conceptual architecture, and scarcity of authoritative references have left such practices in an unregulated zone of uncertainty (Sun & Zuo, 2024).

This issue reveals a broader institutional gap in providing validated and systematic guidance. The stakes extend to the integrity of the research tradition itself. This aligns with repeated warnings that design practices unsupported by solid principles risk eroding the foundations of entire academic disciplines (Resnik & Elliott, 2023).

The quality of developmental research should not be judged by the number or complexity of combined stages, but by the strength of its scientific underpinnings logical coherence, methodological clarity, and rigorous validation (Cash, Daalhuizen, & Hekkert, 2023). It is the quality of the research process not the appearance of structural complexity that should define the credibility of any methodological construction.

CONCLUSION

This study shows two central issues in doctoral students' use of synthesized R&D models. First, the synthesis is often conducted without clear philosophical or methodological grounding. Second, students struggle to understand and implement the combined models, indicating gaps in their research training. These problems reveal structural weaknesses in how R&D methodology is taught and supervised.

For mathematics education, these findings highlight the importance of coherent and well validated methodological frameworks. Weak synthesis practices can lead to inconsistencies in developing learning models, instructional tools, or assessment instruments, which ultimately affect the quality of research based innovations in mathematics classrooms.

Strengthening methodological integrity is therefore essential for producing reliable educational designs.

Three recommendations follow from this study. Doctoral programs should encourage the use of empirically validated single R&D models to ensure conceptual clarity. Methodology training must include explicit guidance on philosophical assumptions and model selection to prevent incoherent synthesis. Institutions should also strengthen supervision systems so that students receive consistent support in constructing rigorous research designs.

Future studies should examine how specific R&D models perform within mathematics education contexts, classify common implementation errors, and explore institutional factors that shape methodological choices. Such efforts will help build a more robust and sustainable research culture grounded in methodological coherence and academic rigor.

ACKNOWLEDGMENT

The authors extend their sincere appreciation to all students who participated in this study and to the academic colleagues who supported the dissemination of the questionnaire. Special thanks are due to the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia for funding this research under contract number: 035/E5/PG.02.00.PT/2023. The authors also gratefully acknowledge the Rector and the Head of the Institute for Research and Community Service (LP2M), Universitas Negeri Makassar, for their approval and continuous support throughout the implementation of this research.

DECLARATIONS

Author Contribution	:	AT: Conceptualization, Methodology, Instrument development, Data analysis, Writing–Original Draft, Writing–Review & Editing, and Supervision. WHC: Methodology refinement, Formal analysis, and Writing–Review & Editing. R: Data collection, Data curation, and Writing–Review & Editing. FA: Instrument validation, Data analysis support, and Writing–Review & Editing.
Funding Statement	:	This research was funded by the Ministry of

Education, Culture, Research, and Technology of the Republic of Indonesia through a research grant under contract number: 035/E5/PG.02.00.PT/2023.

Conflict of Interest : The authors declare no conflict of interest.

Additional Information : Additional information is available from the corresponding author upon reasonable request.

REFERENCES

Akker, Den, J. V., Bannan, B., Kelly, A., Plomp, T., & Nieveen, N. (2013). Educational design research: an introduction. *Educational Design Research*, *1*, 11–50. https://doi.org/10.1007/978-1-4614-3185-5_11.

Al-Ababneh, M. M. (2020). Linking ontology, epistemology, and research methodology. *Science & Philosophy*, *8*(1), 75–91. https://doi.org/10.23756/sp.v8i1.500.

Anwar, V. N. (2024). *Pengembangan model pedagogi digital dalam pembelajaran matematika terintegrasi computational thinking untuk meningkatkan kemampuan problem solving siswa sekolah menengah pertama*. [Doctoral Dissertation]. Universitas Pendidikan Indonesia.

Barab, S. A., & Squire, K. (2016). *Design-based research: clarifying the terms*. New York: Psychology Press.

Braun, V., & Clarke, V. (2025). Reporting guidelines for qualitative research: a values-based approach. *Qualitative Research in Psychology*, *2*(22), 399–438. https://doi.org/10.1080/14780887.2024.2382244.

Brundrett, M., & Rhodes, C. (2011). *Theories of educational research*. New York: Sage Publications Inc.

Campbell, M., McKenzie, J. E., Sowden, A., Katikireddi, S. V., Brennan, S. E., Ellis, S., Hartmann-Boyce, J., Ryan, R., Shepperd, S., Thomas, J., Welch, V., & Thomson, H. (2020). Synthesis without meta-analysis (swim) in systematic reviews: reporting guideline. *BMJ*, *268*, 1–6. https://doi.org/10.1136/bmj.l6890.

Cash, P., Daalhuizen, J., & Hekkert, P. (2023). Evaluating the efficacy and effectiveness of design methods: a systematic review and assessment framework. *Design Studies*, *88*(101204), 1–31. https://doi.org/10.1016/j.destud.2023.101204.

Charmaz, K. (2014). *Constructing grounded theory*. New York: SAGE Publications.

Coates, A. (2021). The prevalence of philosophical assumptions described in mixed methods research in education. *Journal of Mixed Methods Research*, *15*(2), 171–189. https://doi.org/10.1177/1558689820958210.

Creswell, J. W., & Clark, V. L. P. (2017). *Designing and conducting mixed methods research* (3rd ed.). New York: Sage Publications Inc.

Devezer, B., & Buzbas, E. O. (2023). Rigorous exploration in a model-centric science via epistemic iteration. *Journal of Applied Research in Memory and Cognition*, *12*(2), 189–194. https://doi.org/10.1037/mac0000121.

Gall, M. D., Borg, W. R., & Gall, J. P. (2020). *Applying educational research: How to read, do, and use research to solve problems of practice* (7th ed.). London, United Kingdom: Pearson Education.

Gamage, A. N. (2025). Research design, philosophy, and quantitative approaches in scientific research methodology. *Scholars Journal of Engineering and Technology*, *13*(2), 91–103. https://doi.org/10.36347/sjet.2025.v13i02.004.

Glick, W. H., Miller, C. C., & Cardinal, L. B. (2008). Reality check on career success and weak paradigms: chance still favors the hearty soul. *Journal of Organizational Behavior*, *29*(6), 715–723. https://doi.org/10.1002/job.538.

Guest, G., Namey, E., & Chen, M. (2020). A simple method to assess and report thematic saturation in qualitative research. *PloS One*, *15*(5), 1–17. https://doi.org/10.1371/journal.pone.0232076.

Haagen-Schutzenhofer, C., & Hopf, M. (2020). Design-based research as a model for systematic curriculum development: The example of a curriculum for introductory optics. *Physical Review Physics Education Research*, *16*(2), 1–24. https://doi.org/10.1103/PhysRevPhysEducRes.16.020152.

He, Y., Tian, K., & Xu, X. (2023). A validation study on the factors affecting the practice modes of open peer review. *Scientometrics*, *128*(1), 587–607. https://doi.org/10.1007/s11192-022-04552-x.

Heinze, G., Boulesteix, A. L., Kammer, M., Morris, T. P., & White, I. R. (2024). Phases of methodological research in biostatistics building the evidence base for new methods. *Biometrical Journal*, *66*(1), 1–8.

https://doi.org/10.1002/bimj.202200222.

Hevner, A. R., March, S. T., Park, J., & Ram, S. (2004). Design science in information systems research. *MIS Quarterly*, *28*(1), 75–105. https://doi.org/10.2307/25148625.

Hodell, C. (2015). *The ADDIE model for instructional design is explained*. Association for Talent Development.

Irawan, A. G., Padmadewi, N. N., & Artini, L. P. (2018). Instructional materials development through the 4d model. *SHS Web of Conferences*, *42*(00086), 1–4. https://doi.org/10.1051/shsconf/20184200086.

Ismail, I. A., Mawardi, Lufri, Usmeldi, & Festiyed. (2024). A comparative analysis of Plomp and 4D development models: a systematic review for dissertation research model selection. *International Journal of Academic and Applied Research*, *8*(11), 158–170. https://doi.org/10.5281/zenodo.14332682.

Jewitt, C., Xambo, A., & Price, S. (2017). Exploring methodological innovation in the social sciences: the body in digital environments and the arts. *International Journal of Social Research Methodology*, *20*(1), 105–120. https://doi.org/10.1080/13645579.2015.1129143.

Johnson, C., Hill, L., Lock, J., Altowairiki, N., Ostrowski, C., Santos, L. R., & Liu, Y. (2017). Using design-based research to develop meaningful online discussions in undergraduate field experience courses. *The International Review of Research in Open and Distributed Learning*, *18*(6), 1–18. https://doi.org/10.19173/irrodl.v18i6.2901.

Kroop, S. (2025). Artifact validity in design science research (DSR): A comparative analysis of three influential frameworks. In *International Conference on Design Science Research in Information Systems and Technology* (pp. 199-215). Cham: Springer Nature Switzerland.

Kurt, S. (2017). *ADDIE model: instructional design*. United State: HRD Press.

Levitt, H. M., Morrill, Z., Collins, K. M., & Rizo, J. L. (2021). The methodological integrity of critical qualitative research: principles to support design and research review. *Journal of Counseling Psychology*, *68*(3), 357–370. https://doi.org/10.1037/cou0000523.

Lincoln, Y., & Guba, E. (1985). *Naturalistic inquiry*. New York: Sage Publications Inc.

Liu, Y. (2022). Paradigmatic compatibility matters: a critical review of qualitative-quantitative debate in mixed methods research. *SAGE Open*, *12*(1). https://doi.org/10.1177/2158244022107992.

McKenney, S., & Reeves, T. C. (2019). *Conducting educational design research* (2nd ed.). UK: Routledge.

National Academies of Sciences Engineering and Medicine. (2019). *Reproducibility and replicability in science*. Washington, D.C.: National Academies Press.

Nur, F. (2023). *Pengembangan model pembelajaran kolaboratif OS2L berbasis blended learning*. [Doctoral Dissertation]. Universitas Negeri Makassar.

Patton, M. (2025). *Qualitative research and evaluation methods* (4th ed.). New York: Sage Publications Inc.

Peffers, K., Tuunanen, T., Gengler, C. E., Rossi, M., Hui, W., Virtanen, V., & Bragge, J. (2020). *A design science research methodology for information systems research. Journal of management information systems, 24*(3), 45-77. https://doi.org/10.2753/MIS0742-1222240302.

Piran, M. J., & Tran, N. H. (2024). Enhancing research methodology and academic publishing: a structured framework for quality and integrity. *ArXiv:2412.05683*, *1*, 1–36. https://doi.org/10.48550/arXiv.2412.05683.

Recio-Saucedo, A., Crane, K., Meadmore, K., Fackrell, K., Church, H., Fraser, S., & Blatch-Jones, A. (2022). What works for peer review and decision-making in research funding: a realist synthesis. *Research Integrity and Peer Review*, *7*(2). https://doi.org/10.1186/s41073-022-00120-2.

Reigeluth, C. M., & An, Y. (2020). *Merging the instructional design process with learner-centered theory: the holistic 4D model*. UK: Routledge.

Reigeluth, C. M., Beatty, B. J., & Myers, R. D. (2017). *Instructional design theories and models: the learner-centered paradigm of education*. UK: Routledge.

Resnik, D. B., & Elliott, K. C. (2023). Science, values, and the new demarcation problem. *Journal of General Philosophy of Science*, *54*(2), 259–286. https://doi.org/10.1007/s10838-022-09633-2.

Rossenberg, Y. G. T. Van, Sanderson, Z., Achnak, S., Brookes, A., Doci, E., Ghoreysh, M., Hack-Polay, D., Hartgerink, C., Hopkins, B., Hornung, S., Khuda, K., Lub, X., McKew, C., Mendy, J., & Nijs, S. (2024). Ontology, epistemology, and methodology. *Elgar Encyclopedia of Organizational Psychology*, 409–416. https://doi.org/10.4337/9781803921761.00082.

Saltelli, A., & Giampietro, M. (2015). The fallacy of evidence-based policy. *ArXiv:1607.07398*. https://doi.org/10.1016/j.futures.2016.11.012.

Spatioti, A. G., Kazanidis, I., & Pange, J. (2022). A comparative study of the ADDIE instructional design model in distance education. *Information*, *13*(9), 402. https://doi.org/10.3390/info13090402.

Sun, P., & Zuo, X. (2024). Philosophical foundations of management research: a comprehensive review. *Journal of Scientific Reports*, *6*(1), 1–22. https://doi.org/10.58970/JSR.1031.

Tampa, A., Tawil, M., & Manggi, I. (2023). *Development research*. Makassar: Badan Penerbit Universitas Negeri Makassar.

Tang, D., Boker, S. M., & Tong, X. (2025). Are the signs of factor loadings arbitrary in confirmatory factor analysis? problems and solutions. *Structural Equation Modeling: A Multidisciplinary Journal*, *32*(1), 142–154. https://doi.org/10.1080/10705511.2024.2351102.

Timonen, V., Foley, G., & Conlon, C. (2024). Quality in qualitative research: a relational process. *Qualitative Research Journal*, *7*. https://doi.org/10.1108/QRJ-07-2024-0153.

Tisdell, E. J., Merriam, S. B., & Peyrot, H. L. S. (2025). *Qualitative research: a guide to design and implementation*. United State: John Wiley & Sons.

Vowels, M. J. (2023). Misspecification and unreliable interpretations in psychology and social science. *Psychological Methods*, *28*(3), 507–526. https://doi.org/10.1037/met0000429.