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Trends and Research Directions on Formative Feedback in Physics Learning: A Systematic Review

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Abstract

Previous studies on formative feedback remain limited and fail to provide a comprehensive overview of research trends and directions. This study aims to systematically review the implementation of formative feedback in physics education using the Systematic Literature Review (SLR) method based on PRISMA guidelines. A total of 25 articles indexed in SINTA and Scopus from 2018 to 2025 were analyzed. The findings indicate that most studies employed quantitative and Research and Development (R&D) methods, focusing mainly on high school students. Formative feedback was commonly developed through digital media such as e-books, e-modules, web platforms, and mobile applications, integrated into strategies like software simulations, feedback loops, IDEAL, and POE. This study highlights the crucial role of formative feedback in improving physics learning. Future studies are recommended to expand research through qualitative or mixed-method approaches and conduct comparative and longitudinal studies to assess its long-term effectiveness across various physics topics.

Keywords: *education research, formative feedback, literature review, physics, education.*

Abstrak:

Penelitian terdahulu dengan tema tentang umpan balik formatif dilakukan masih sangat terbatas dan belum memberikan gambaran komprehensif tentang tren dan arah penelitian. Penelitian ini bertujuan untuk meninjau secara sistematis implementasi umpan balik formatif dalam pendidikan fisika menggunakan metode Tinjauan Pustaka Sistematis (SLR) berdasarkan pedoman PRISMA. Sebanyak 25 artikel yang terindeks di SINTA dan Scopus dari tahun 2018 hingga 2025 dianalisis. Temuan menunjukkan bahwa sebagian besar penelitian tersebut masih menggunakan metode kuantitatif dan Penelitian dan Pengembangan (R&D), dengan fokus utama pada siswa sekolah menengah atas. Umpan balik formatif umumnya dikembangkan melalui media digital seperti buku elektronik, modul elektronik, platform web, dan aplikasi seluler, yang terintegrasi ke dalam strategi seperti simulasi perangkat lunak, putaran umpan balik, IDEAL, dan POE. Penelitian ini fokus pada peran penting umpan balik formatif dalam meningkatkan pembelajaran fisika. Kedepan, untuk penelitian selanjutnya disarankan agar memperluas kajian penelitian melalui pendekatan kualitatif atau metode campuran dan melakukan studi komparatif dan longitudinal untuk menilai efektivitas jangka panjang berbagai topik fisika.

Kata Kunci: *penelitian pendidikan, umpan balik formatif, tinjauan pustaka, pendidikan, fisika.*

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1. Introduction

Formative feedback is an essential component of the learning process because it directly improves its quality. It provides quick evaluation and helps students independently assess their understanding [1]. Formative assessment feedback is an important aspect of designing the learning process and can be a key variable for successful learning [2]. Studies show that formative feedback optimizes self-assessment and reflection, creating effective learning [3]. Previous studies have demonstrated that formative feedback improves students' conceptual understanding [4], [5]. Along with technological developments, the delivery of formative feedback has transformed with the use of computers. Explain that using technology for formative feedback can provide convenience and opportunities for delivering various forms of feedback [6]. The study's results show an increase in conceptual understanding, reinforcing the idea that formative feedback improves conceptual understanding [7]. Additionally, timely feedback has been proven to increase intrinsic motivation and active engagement in the learning process [8].

However, implementing formative feedback in physics education still presents various challenges. Contributing factors include feedback that cannot accommodate all students [9], varied learning difficulties requiring different feedback tools [10], and limited learning time affecting feedback quality [11]. Additionally, low student participation makes it difficult for teachers to provide formative feedback. Conversely, students often cannot determine their level of understanding because they do not receive instant, timely feedback [12].

There have been many efforts to resolve issues in the implementation of formative feedback in learning. Several studies have examined the use of computer media to provide comprehensive, instant feedback. Game-based formative feedback was developed [13], while a website medium was used to improve conceptual understanding [14] and problem-solving skills in the concept of Hydrostatic Pressure [15]. Formative feedback is also provided through interactive media [16]. Video models are considered more effective and are popular with students [17], [18], as is text-based feedback. Integrating formative feedback into the learning process has been proven to positively impact students' conceptual understanding [19]. Recent research also reveals the effectiveness of formative feedback in physics learning and shows its important role in improving the quality of the learning process [20]. These findings suggest that technology can set a new standard for providing personalized feedback [21].

However, studies on formative feedback in physics education tend to be limited in scope, focusing on specific contexts, media, and variables. Few studies present a comprehensive overview of trends, approaches, and previous research results. Consequently, there are no available references that provide a complete picture of how formative feedback has been implemented, which media are most widely used, and which aspects remain obstacles. Therefore, this study aims to conduct a literature review on the implementation of formative feedback in physics education. The study will summarize previous findings, identify research gaps, and suggest directions for future research.

2. Research Methodology

This study uses the Systematic Literature Review (SLR) method with reference to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. SLR was chosen because it allows researchers to systematically, structurally, and transparently identify, evaluate, and synthesize relevant research results. Using this approach, the study serves as both a literature summary and a comprehensive overview of conceptual developments, innovations, and the implementation of formative feedback in physics learning in various contexts. SLR is also considered appropriate because it can map research trends, identify research gaps that are still rarely studied, and provide a strong theoretical basis for future research directions.

The SLR process in this study was carried out in three stages: planning, implementation, and summarization. During the planning stage, the researchers formulated objectives, compiled research questions, and determined the selection criteria and article search strategies. The implementation phase included searching the literature, screening articles based on inclusion and exclusion criteria, and determining their eligibility for further analysis. Finally, the summary stage organized and synthesized the obtained data, providing a comprehensive interpretation of the direction and trends of formative feedback research in physics learning.

2.1 Planning Stage

The planning stage began with the development of a research protocol that included the objectives, research questions, search strategy, and article selection criteria. The research questions examined (1) trends in formative feedback research in physics learning, (2) the development of formative feedback, and (3) the implementation of formative feedback in a learning context. The search sources were limited to SINTA (Science and Technology Index) and Scopus. SINTA, a national indexing portal managed by the Ministry of Education, Culture, Research, and Technology of the Republic of Indonesia, maps academic publication performance. Scopus is an international database. The publication range was limited to the period from 2018 to 2025 to capture the latest developments. The keywords used were "formative feedback" and "physics education".

2.2 Implementation Stage

In accordance with the PRISMA flow, the implementation process was carried out in four stages.

2.2.1 Identification

The identification stage began with determining which databases would serve as the main sources for literature searches. Two databases were used in this study: SINTA (Science and Technology Index) and Scopus. Using the Publish or Perish (PoP) tool, articles were searched in both databases, focusing on research articles (see Table 1). This application facilitates more systematic article searches and allows for the use of keywords. The keyword used was "formative feedback," representing the study's main focus. This term was chosen to ensure that the identified articles actually discussed formative feedback in terms of its development and implementation in learning, particularly in physics education.

2.2.2 Screening

The screening stage narrowed down the initial search results to align with the study's focus. At this stage, articles obtained from the SINTA and Scopus databases were filtered by year of publication. The time range was set from 2018 to 2025. This time period was chosen because research from this period reflects the latest developments in the concept of formative feedback in physics learning, in terms of both theory and application.

2.2.3 Eligibility

The eligibility stage ensures that articles passing the annual selection meet publication quality standards. For articles originating from SINTA, only journals with accreditation levels 1 to 4 are retained because these categories are considered to have guaranteed quality through Indonesia's national accreditation process. For articles from Scopus, the selection focuses on journals in quartiles Q1 to Q4. These quartiles indicate the relative position of journals based on their citation rates and research impact. Duplicate articles are also removed at this stage, namely publications identified as duplicates in both databases (e.g., articles accredited by SINTA and indexed by Scopus). Only one version of each article is retained. The selection criteria can be seen in Table 1.

Table 1. Research selection criteria

Category	Inclusion Criteria	Exclusion Criteria
Type of publication	Research articles	Conference proceedings, reports, editorials, book chapters, or non–peer-reviewed publications
Research focus	Studies discussing formative feedback in physics learning	Outside the field of physics learning
Time range	2018–2025	< 2018
Language	Indonesian and English	Other than Indonesian and English
Indexing	Indexed in Scopus (international) or SINTA (Indonesian national index)	Articles not indexed in both of these databases

2.2.4 Inclusion

After screening, 25 articles that met all criteria were obtained and analyzed further.

2.3 Summarization Stage

The results of the analysis are presented in the form of a PRISMA flowchart, which illustrates the process of selecting articles from the initial stage to the final analysis. The PRISMA flowchart can be seen in Figure 1.

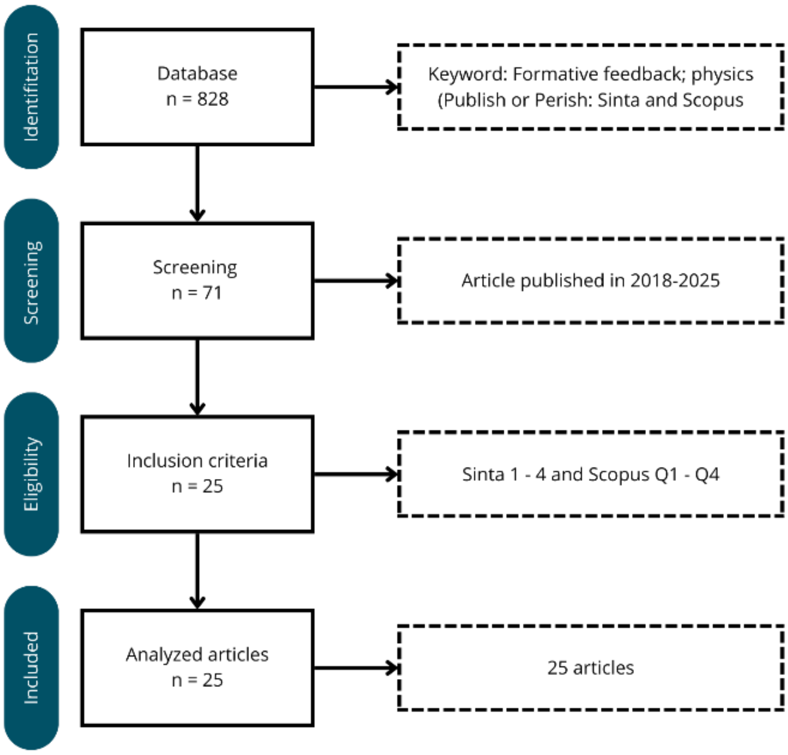

Figure 1. PRISMA flowchart

3. Results and Discussion

3.1 Results

To provide a more detailed picture of the development of research related to formative feedback in physics learning, a review of several relevant articles was conducted. The articles demonstrate variations in the context, approach, and objectives of applying formative feedback, including media development, conceptual understanding, and student thinking skills. The general attributes of the selected articles are as follows.

3.1.1 Distribution of Publications Based on Year of Article Reviewed

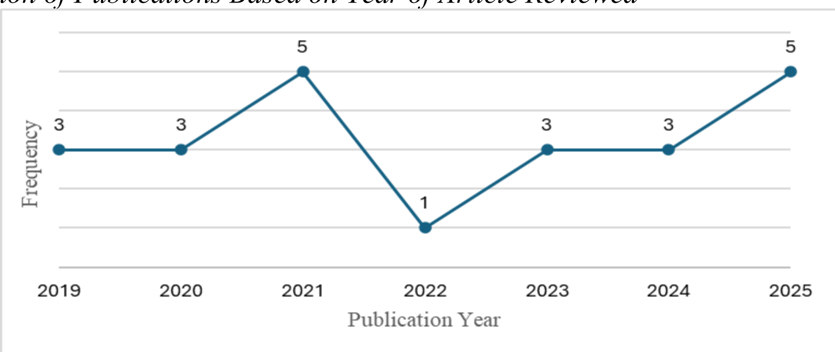

Figure 2. Classification of research based on year of publication

Figure 2 shows that studies on formative feedback in physics education vary from year to year. However, the number of publications increases in 2024 and 2025, indicating growing academic interest in the topic. This surge can be attributed to the growing demand for assessment innovations and educational policies that encourage the use of formative feedback. Nevertheless, instability in the number of publications in previous years shows that research continuity in this field still needs strengthening to produce a more sustainable knowledge base.

3.1.2 Research Methods in the Articles Reviewed

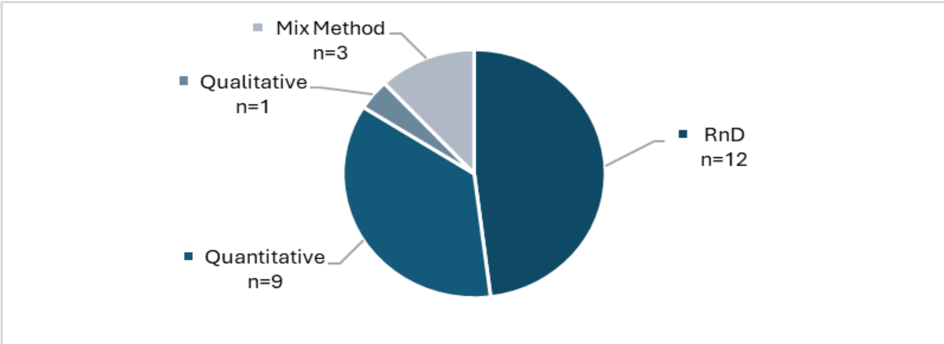

Figure 3. Classification of research based on research methods

Figure 3 shows the classification results of the research methods used in formative feedback studies in physics education. Most studies employed quantitative and developmental approaches, indicating a primary focus on measuring learning outcomes based on numerical data and developing products or media to support the implementation of formative feedback. Conversely, relatively few studies used qualitative or mixed methods, so exploration of the experiences, perceptions, and dynamics of interaction between students and teachers in the practice of formative feedback has not been widely revealed in the existing literature.

3.1.3 Research subjects in the articles reviewed

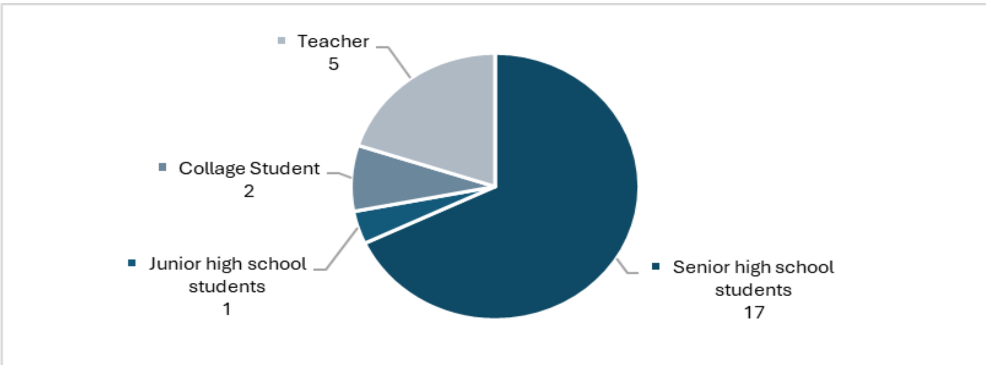

Figure 4. Classification of research based on research subjects

Figure 4 shows the results of classifying the research subjects in studies of formative feedback in physics learning. Most studies involved high school students, followed by teachers and university students. Only a few involved junior high school students. This pattern shows that the study of formative feedback is more focused on secondary education, which is considered an important phase for developing an understanding of physics concepts and thinking skills.

3.1.4 Physics Topics in the Articles Reviewed

Figure 5 shows the variety of physics topics reviewed in studies on formative feedback. These studies covered topics in mechanics, including kinematics, Newton's laws, momentum and impulse, work and energy, linear motion, particle dynamics, and simple harmonic motion. Regarding fluid materials, the research discusses fluid dynamics, fluid statics, pressure, and hydrostatic pressure. Several other studies highlight electricity and magnetism through topics such as electrical circuits and electromagnetic induction. Additionally, there are studies on thermodynamics focusing on heat and temperature, as well as on modern physics discussing quantum physics. Some articles only mention physics in general without specifying particular topics.

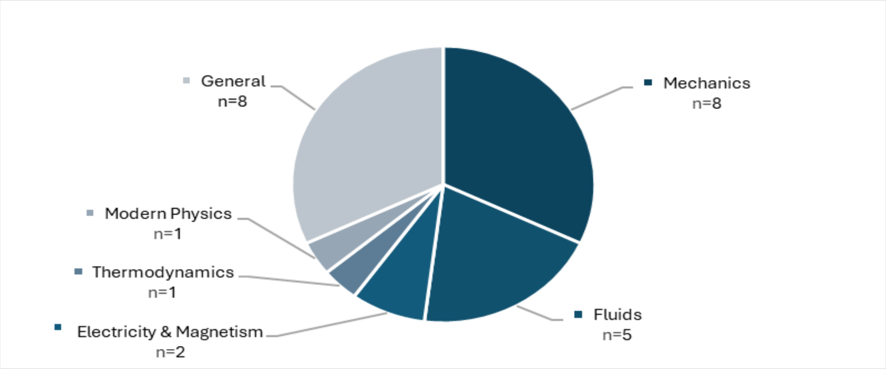

Figure 5. Classification of Research Based on Material Studied

Further analysis was conducted on the keywords used in the reviewed articles. Since keywords reflect the main focus and trends in research, mapping them is important to obtain an overview of the dominant themes in formative feedback studies in physics education. Details of the keyword categorization can be seen in Table 2.

Table 2. Categorization of Keywords from the Articles Reviewed

Category	keywords
Assessment & Feedback	Formative assessment, formative feedback, corrective feedback, peer assessment, diagnostic assessment, summative assessment.
Strategies & Approaches	Feedback loop model, scaffolding, multiple representations, POE, ADDIE, IDEAL strategy, problem-solving.
Media & Technology	Simulation, student response system, software Socrative, web-based assessment system, e-book, mobile-based tutorial, Android, website, interactive video.
Competence & Learning Outcomes	Conceptual understanding, science process skills, learning outcomes, self-regulated learning, student attitudes, conceptual mastery.

The analysis of keywords shows that research on formative feedback in physics learning largely highlights terms related to assessment and feedback, such as formative assessment, formative feedback, and corrective feedback. In addition, keywords related to media and technology are also quite prominent, for example simulations, student response system, Socrative software, and web-based formative system. Several other studies emphasize pedagogical approaches, such as the feedback loop model, scaffolding, POE, multiple representations, and problem-solving. In terms of learning outcomes, frequently appearing keywords include conceptual understanding, self-regulated learning, students' attitude, and scientific processing skill. This pattern indicates that research does not only focus on the implementation of formative assessment but also on learning strategies, the use of digital media, and the development of students' competencies. Further details regarding the 25 selected articles are provided in Table 3.

The analysis shows that formative feedback in physics learning is often integrated with digital media, such as applications, electronic modules, and online learning platforms. This approach provides rapid, specific, and continuous feedback, which supports improving students' conceptual understanding and thinking skills. Additionally, some studies emphasize developing learning models that integrate formative feedback into instructional strategies, such as the POE, IDEAL, and simulation-based learning approaches. These findings demonstrate that formative feedback is positioned not only as an assessment tool, but also as an integral component of the physics learning process.

Table 3. List of formative feedback articles

No	Author	Articles Title	Sinta	Scopus
1	[31]	The Use of Different Simulations and Different Types of Feedback and Students' Academic Performance in Physics		✓
2	[32]	Using Socrative software for instant formative feedback in physics courses		✓
3	[5]	Impact of formative assessment based on feedback loop model on high school students' conceptual understanding and engagement with physics		✓
4	[14]	A web-based formative feedback system development by utilizing isomorphic multiple choice items to support physics teaching and learning		✓
5	[33]	Flipping the Feedback: Formative Assessment in a Flipped Freshman Circuits Class		✓
6	[16]	Developing Computer-Assisted Formative Feedback In The Light Of Resource Theory: A Case On Heat Concept		✓
7	[34]	The effect of feedback as soft scaffolding on ongoing assessment toward the quantum physics concept mastery of the prospective physics teachers	✓	✓
8	[35]	Writing Reflective Journal and Corrective Feedback: The Endeavors to Increase Students' Physics Achievement of Dynamic Fluids	✓	
9	[6]	Analysis of Website-Based Formative Feedback Needs in Physics Learning	✓	
10	[20]	Effect of isomorphic problems with feedback to reduce student misconceptions on simple harmonic motion	✓	
11	[4]	The Effect of Ideal Strategy with Formative Feedback on Conceptual Understanding and Physics Processing Skill of XI Graders Senior High School	✓	
12	[36]	The Effectiveness of Integrating Formative Assessment Feedback in Improving Students' Cognitive Abilities in Business and Energy Materials	✓	
13	[37]	Design of POE (Predict-Observe-Explain) Based Physics E-Module Assisted by Computer-Assisted Feedback on Particle Dynamics Material	✓	
14	[38]	Student Concept Mastery in the Interactive Demonstration Learning Model accompanied by Formative Feedback	✓	
15	[39]	Multi-representation-based Recitation Program with Feedback and Reinforcement Questions to Improve Mastery of Momentum and Impulse Concepts	✓	
16	[9]	Development of Physics Learning Media with POE Model-Based Corrective Feedback for Senior High School	✓	
17	[40]	Development of Multi-Representation-Based Physics E-Books with Corrective Feedback on Straight Motion Material for Grade 10 Senior High School	✓	
18	[41]	Development of Mobile Learning accompanied by Constructive Feedback on Electromagnetic Induction Material for High School Students	✓	
19	[42]	Android-Based Tutorial Mobile Development Equipped with Corrective and Constructive Feedback Materials for Data Transmission and Storage	✓	
20	[15]	The Impact of Formative Feedback-Based Educational Websites on Students' Problem-Solving Abilities in Hydrostatic Pressure	✓	
21	[43]	Harnessing large language models to develop research-based learning assistants for formative feedback		✓
22	[44]	Development of a Computer-Based Interactive Video Formative Feedback to Improve Students' Conceptual Understanding of Static Fluid	✓	
23	[45]	Case Study on the Implementation of Peer Assessment in Physics Teaching		✓
24	[46]	The Role of Formative Assessment in Higher Education: Strategies to Improve Learning and Knowledge Retention		✓
25	[47]	Development of Diagnostic, Formative and Summative Assessment Instruments in the PjBL Model to Strengthenthe Profile of Pancasila Physics Students	✓	

The classification shows that the analyzed articles were published in journals with varying national and international accreditation. National publications are spread across various levels of Sinta accreditation, while others have been indexed by Scopus at the international quartile level (see Table 3). This information provides an overview of the extent to which research on formative feedback has been disseminated through reputable journals, ranging from basic national accreditation to internationally recognized journals. Thus, the quality of existing publications and the potential for achieving higher accreditation levels can be understood.

In addition to indicating publisher quality, accreditation classification reflects recognition of the quality of methodology, scientific contribution, and research visibility. Publications in national journals demonstrate relevance to the Indonesian educational context, while publications in international journals indicate researchers' efforts to expand their findings' reach and influence to the global scientific community. It is important to note this distinction because each accreditation level carries different levels of recognition, both academically and practically.

3.2 Discussion

A literature review shows that research on formative feedback in physics education varies in approach, subject, and material studied. In general, the research focuses more on the high school level, particularly on topics requiring deep conceptual understanding, such as mechanics and fluids. In terms of methodology, studies tend to emphasize quantitative approaches and developmental research, while qualitative studies remain relatively limited. Additionally, formative feedback is largely developed and implemented through integration with digital media and innovative learning strategies, indicating a shift in assessment practices toward technology and an emphasis on improving the quality of the student learning experience.

3.2.1 Methodology in Formative Feedback Research

The Research and Development (R&D) method appears to dominate formative feedback research in physics learning. This pattern indicates that most researchers focus primarily on creating classroom-ready products. With the R&D approach, research continues beyond the conceptual stage to produce learning media or tools ready for use by teachers and students. Examples of this application are: e-book with corrective feedback to support conceptual understanding [40], and computer-assisted, feedback-based e-module [37]. These studies confirm that research in Indonesia is oriented towards developing simple yet applicable digital media, aligning with school infrastructure conditions and teachers' practical needs. In addition to e-books and e-modules, several studies focus on developing more interactive, mobile-based media. A researcher integrated constructive feedback into mobile learning for electromagnetic induction [41], and another researcher designed an Android tutorial with corrective and constructive feedback to support learning [42]. Mobile-based media demonstrates researchers' efforts to overcome the limitations of school physics laboratories by providing students with more accessible digital alternatives. Thus, the dominance of the R&D method reflects an academic orientation toward product development and the contextual needs of physics education in Indonesia, where conventional learning facilities are still limited.

In contrast, several international studies have shown a tendency to use experimental or quasi-experimental methods to evaluate the effectiveness of formative feedback in enhancing learning outcomes. For example, a researcher examined the use of Socrative software to provide automated feedback integrated into the learning process [32]. Meanwhile, another researcher examined the application of digital simulations as a formative assessment tool in science education [31]. These studies emphasized measuring the impact of formative feedback on improving students' conceptual understanding and thinking skills, thereby producing empirical evidence that reinforces the effectiveness of such interventions.

The difference in orientation between local and international research shows that formative feedback research in Indonesia mainly contributes to the innovation of learning products, while international research focuses more on long-term effectiveness and the integration of advanced technology. In other words, local research emphasizes the availability and accessibility of media, while global research focuses on optimizing feedback function by utilizing artificial intelligence and learning analytics. Both approaches are important for expanding our understanding of formative feedback. From a research methodology perspective, however, the trend in Indonesia still shows the dominance of R&D as a practical effort to address real learning needs in physics education.

3.2.2 Development of Formative Feedback

A web-based formative feedback system was developed through the stages of needs analysis, design, development, and limited testing [14]. Called Tryout and Web-voting, the system helps teachers identify students' mastery of concepts and plan follow-up classroom activities. It can be accessed via computer or smartphone. A similar model was also developed in the form of web-based formative feedback [9]. A computer-based formative feedback system was developed that aligns with students' cognitive abilities [16]. Its development included prototype and method design, expert validation, testing on high school students, and dissemination in educational forums. Before developing the formative feedback system, studies analyzing the need for web-based formative feedback were conducted. The necessity of both verbal and non-verbal formative feedback [6]. This development is based on the limited time and facilities available for implementing formative feedback.

In addition to developing formative feedback directly within a system, the researchers also integrated feedback into teaching media. An e-module based on the Plomp model was developed and integrated it with computer-based formative feedback [37]. The e-module provides corrective feedback and feedback displays for learning evaluation. Wati et al. developed a multi-representation-based physics e-book with corrective feedback [40]. Using the 4D model, this study produced a valid e-book for learning purposes.

Mobile learning can also be used to develop formative feedback. In the study by Handayani et al. feedback in mobile learning was developed using the 4D model [41]. The study produced mobile learning media with feedback suitable for independent learning to support understanding of concepts and motivation to learn. Additionally, Ramadani et al. used the same development model to create a mobile tutorial application [42]. Their research produced an Android-based mobile tutorial with feedback to support independent learning.

3.2.3 Implementing Formative Feedback in Learning

Formative feedback is generally used to support learning outcomes and implementation in the classroom. Đorić et al. used three software simulations with feedback to determine their impact on learning about Ohm's law and resistors [31]. Their results showed that devices with electrical circuit design simulations and tests accompanied by feedback had the most significant impact on student learning outcomes. Ole & Gallos also examined the impact of using the Feedback Model Loop in 12th grade physics learning [5]. Their results showed that implementing formative assessment with the Feedback Model Loop significantly increased student engagement in four dimensions: agentic, behavioral, emotional, and cognitive. Additionally, students' understanding of kinematics concepts increased significantly.

Ziegenfuss & Furse also implemented formative feedback in long-term classes [33]. This study used feedback with different time frames: First, there was online feedback every three weeks. Second, there was feedback on the most difficult material every week. Third, there was feedback based on midterm exam results. Apart from long-term classes, feedback acts as soft scaffolding. A study by Abdurrahman et al. examined this impact and found that using feedback as soft scaffolding encourages better results than traditional feedback based on answer corrections [34].

Djudin conducted research to explain the effectiveness of feedback in dynamic, fluid learning [35]. The study employed an experimental method with a nonequivalent control group design, using experimental and control classes. The results showed that the experimental group had a higher average score than the control group, indicating a high level of effectiveness. Formative feedback can also be integrated using isomorphic questions [20]. This study aimed to determine the effectiveness of using formative feedback with these questions to address students' misconceptions about simple harmonic motion. The results showed a significant decrease in misconceptions after students used formative feedback, demonstrating high effectiveness. Similar results found that students' conceptual understanding improved after implementing website-based formative assessment [6].

Formative feedback is integrated into the implementation of the learning model. A study comparing learning with and without formative feedback using the IDEAL strategy has been conducted [4]. Students who used the IDEAL strategy with formative feedback demonstrated significant improvements in conceptual understanding and scientific process skills compared to those who used the IDEAL strategy without formative feedback. Integrating formative assessment feedback improves students' cognitive abilities [36]. Formative feedback can help students build their understanding of a subject. Integrating formative sfeedback into interactive demonstration learning significantly impacts students' conceptual understanding [38]. Data collected before and after the intervention revealed an increase in conceptual understanding within the moderate category. An increase in conceptual understanding after applying formative feedback has also been observed in physics education students [39].

3.2.4 The Role of Media in the Implementation of Formative Feedback

The study's results show that formative feedback development in physics learning is primarily driven by simple digital media, including e-books, e-modules, and web- and mobile-based platforms. This approach demonstrates an inclination to adapt implementation to available resources and the context of the school, ensuring that feedback is practically accessible to teachers and students. The integration of formative feedback through digital media is a dominant theme in many studies. For instance, a web-based system to support physics learning was developed [14], while Suryadi & Kusairi emphasized developing computer-assisted feedback on the concept of heat [16]. Similar efforts include Wati et al. development of a multi-representation-based e-book with corrective feedback and Ayani et al. development of computer-assisted, feedback-based e-modules [40]. Additionally, Handayani et al. presented a mobile learning application with constructive feedback on electromagnetic induction, and Ramadani et al. designed an Android-based mobile tutorial with corrective and constructive feedback [41], [42]. This variety of media shows that formative feedback implementation not only functions as an assessment instrument, but also becomes part of the innovation of learning media that encourages interactive student engagement.

3.2.5 Implications

The results of this study have important implications for the development of physics research and teaching practices. The findings regarding the dominance of simple digital media in formative feedback suggest that learning strategy development in Indonesia focuses primarily on the accessibility and availability of resources. This suggests that teachers and researchers must consider contextual school factors when designing learning innovations. Furthermore, the variation in formative feedback implementation in different learning models confirms its role as both an evaluation tool and an instructional mechanism that encourages student engagement, conceptual understanding, and scientific thinking skills. In terms of research, these results show that there is room for further exploration of integrating formative feedback with advanced technologies, such as artificial intelligence and learning analytics, which are being developed internationally. Meanwhile, for educational practice, these findings confirm that formative feedback can serve as a bridge between assessment and learning, as it simultaneously supports the evaluation process and concept formation.

3.2.6 Limitations

This study has several limitations that should be noted. First, the analysis does not describe the findings of each article in detail. As a result, differences in context, methodological characteristics, and the scope of each study's contribution are not fully described. Consequently, the study highlights general patterns in the development and implementation of formative feedback, rather than providing an in-depth mapping of its specific impact on particular concepts or skills. Second, the literature search was limited to the SINTA and Scopus databases. This implies that relevant studies may have been overlooked, particularly articles published in databases such as Web of Science, ERIC, and other international databases that frequently publish studies on science learning. The limited scope of the search may affect the diversity of perspectives and provide an incomplete picture of global research trends.

4. Conclusion and Suggestions

This study shows that research on formative feedback in physics learning in Indonesia is widely published in national journals, predominantly using quantitative and research and development (R&D) approaches with a primary focus on high school students. Formative feedback development is generally carried out through simple digital media, such as e-books, e-modules, websites, and computers, adapting to school conditions. This contrasts with the global trend of utilizing advanced technology. Implementing formative feedback has proven effective in increasing student engagement, conceptual understanding, and learning outcomes through strategies such as software simulations, the feedback model loop, soft scaffolding, and website-based assessments. Integrating feedback into learning models such as the IDEAL strategy, POE, and interactive demonstrations shows that feedback functions as both an evaluation and an instructional strategy that strengthens students' cognitive skills. Thus, formative feedback occupies an important position in optimizing physics learning in high school. Future studies are recommended to expand research on the implementation of formative feedback through qualitative or mixed-method approaches to gain a deeper understanding of its processes and impacts on physics learning. Comparative and longitudinal studies are also needed to evaluate the long-term effectiveness of formative feedback across various physics topics. Furthermore, integrating advanced technologies such as artificial intelligence and learning analytics is suggested to enhance theoretical development and digital assessment practices.

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