

## **Motor Learning Development among Physical Education Students: Instructional Implications**

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### **ABSTRACT**

Motor skill learning is a fundamental aspect of physical education, particularly in preparing Physical Education, Health, and Recreation (PJOK) students to become professional educators. However, its implementation in higher education continues to face challenges, ranging from the dominance of mechanistic instructional approaches to the limited integration of theory and practice in the post-COVID-19 pandemic era. This study aims to examine the development of motor learning among PJOK students and to formulate its implications for instructional practice in higher education. This study employed a systematic literature review with content analysis of 30 published articles from the period 2015–2025, retrieved from Scopus, Web of Science (WoS), Google Scholar, DOAJ, ResearchGate, and Garuda databases. The findings indicate that motor learning is influenced by individual factors, learning environments, instructional strategies, and educational policies. Innovations in digital media (e.g., Lectora and multimedia flipbooks), blended-gamified approaches, and the integration of theory and practice have been shown to effectively enhance students' motivation, conceptual understanding, and motor skills. Comparisons with global studies highlight infrastructure gaps, underscoring the need for a paradigm shift toward adaptive, evidence-based strategies aligned with the digital era. Practically, these findings call for lecturers to integrate innovative media, institutions to provide adequate infrastructural support, and students to develop pedagogical readiness and character as future PJOK teachers.

**Keywords:** Motor Learning; Physical Education; PJOK Students; Digital Media; Instructional Strategies.

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## **INTRODUCTION**

In physical education, motor skills are essential because mastery of fundamental movements determines an individual's ability to develop physical fitness, participate in sports activities, and achieve more complex motor skills. Students in Physical Education, Health, and Recreation (PJOK) programs carry two primary responsibilities in higher education. First, they must acquire motor skills for their own physical competence. Second, and more critically, they must develop the pedagogical abilities required to transfer these skills to students in schools. Therefore, motor learning in higher education is not merely technical but also strategic in shaping the adaptive professional identity of future physical education teachers (Bahridah & Neviyarni, 2021).

Despite the central role of motor skills in the PJOK curriculum, several challenges persist in instructional practice. Many educators continue to rely on traditional, repetition-based

teaching models that inadequately consider meaningful learning contexts and movement variability. As a result, students struggle to internalize adaptive motor concepts (Pratama et al., 2025). Furthermore, discrepancies between field practice and instructional theory often lead to slower skill acquisition (Rosmi & Nurhuda, 2024). The abrupt shift to online learning during the COVID-19 pandemic further exacerbated these issues by significantly reducing the intensity of motor practice, ultimately affecting students' motor skill quality.

Amidst these challenges, advances in educational technology have emerged, offering new opportunities to improve motor learning. Interactive digital media such as Lectora have been shown to increase student participation Afandi & Susanto (2021), while multimedia flipbooks have demonstrated similar outcomes by enhancing motivation and conceptual understanding of movement (Afandi et al., 2023). At the global level, comparable innovations have been reported. For example, Blain et al., (2022) implemented blended-gamified learning approaches, while Müller & Wagner (2025) integrated digital-based formative assessment. These findings suggest that technology plays a significant role in enhancing motor learning.

Furthermore, recent research by Müller et al., (2026) in Germany revealed that although pre-service physical education teachers hold positive attitudes toward formative assessment and adequate technological self-efficacy, their self-efficacy in implementing formative assessment remains low. This finding underscores the importance of systematically integrating assessment competence into teacher education curricula, not only as theoretical knowledge but also through guided practical experiences. This is relevant to the Indonesian context, where PJOK students are also required to master motor skills as well as digital pedagogical readiness (Ramadhan et al., 2023).

However, a critical review of the literature reveals a significant demographic and thematic research gap. Demographically, the majority of motor learning studies focus on children and adolescents (Ali & Hartati, 2018; Humaira et al., 2024), with the specific needs of pre-service PE teachers (PJOK students) receiving far less attention. This is concerning because, as evidenced by Ramadhan et al., (2023), Indonesian PJOK students' motor abilities often fall into the moderate to low categories. Thematically, while recent research has advanced our understanding of digital media in motor learning Afandi et al., (2023) and the importance of formative assessment competence for pre-service teachers Müller et al., (2026), these critical areas of inquiry have largely evolved in parallel, without integration. There is a clear absence of a comprehensive literature synthesis that connects innovative instructional strategies (digital, gamified, blended) with the development of both motor skills and pedagogical readiness specifically for higher education students in the post-pandemic era. This study addresses this lacuna by systematically synthesizing these previously siloed areas of research to develop an integrated understanding of motor learning in higher education.

Therefore, this investigation is crucial. This study aims to systematically examine the development of motor learning among PJOK students and to formulate its implications for instructional practice in higher education. This article presents a synthesis of the literature on innovative motor learning strategies, with a particular focus on digital innovation and adaptive approaches relevant to pre-service teacher students. The novelty of this research lies in the development of a conceptual framework that explicitly links motor skill development with the pedagogical readiness of PJOK students an aspect rarely discussed integratively in prior literature. Consequently, this study not only examines the effectiveness of digital learning media but also offers practical recommendations for lecturers, students, and higher education institutions in improving the quality of motor learning in the digital era.

## **METHOD**

This study employed a Systematic Literature Review (SLR) approach using a content analysis methodology. This approach was selected to achieve a comprehensive understanding of motor learning through the synthesis of findings from relevant previous studies and was organized in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

## Data Sources

Article searches were conducted in major databases, namely Scopus and Web of Science (WoS). Google Scholar, Garuda (Garba Rujukan Digital Indonesia), and ResearchGate were also used to identify additional relevant literature.

## Search Strategy

The article search was carried out in January 2025, covering publications from 2015 to 2024. The keywords used were a combination of English and Indonesian terms with the following Boolean operators:

("motor learning" OR "motor skill acquisition" OR "pembelajaran motorik") AND ("physical education" OR "pendidikan jasmani") AND ("higher education" OR "students" OR "university students" OR "pre-service teachers"). The applied filters included:

1. Document type: journal articles or systematic reviews;
2. Language: English and Indonesian;
3. Field: physical education, sport, and educational sciences.
4. Inclusion and Exclusion Criteria
5. The inclusion criteria were as follows:
6. Articles published between 2015 and 2025;

A focus on motor skill learning within the context of physical education/sport;

1. Population: university students or pre-service teachers;
2. Articles available in full-text form.
3. The exclusion criteria included:
4. Studies focusing solely on early childhood or adolescents without relevance to university students;
5. Clinical studies (e.g., patient rehabilitation or physiotherapy);
6. Articles that were not peer-reviewed or were limited to opinion/editorial pieces;
7. Articles not available for full-text access.

## Selection Process

The initial search yielded 156 articles. After removing duplicates, 120 articles remained. During the title and abstract screening stage, 65 articles were excluded due to irrelevance to the research focus. A total of 55 articles underwent full-text review, of which 25 articles were excluded for failing to meet the inclusion criteria. Consequently, 30 articles were included in the final analysis.

The selected articles were then assessed for quality based on three aspects: (a) clarity of research design, (b) contextual relevance to physical education, and (c) traceability of reference sources.

## Data Extraction and Analysis

The extracted data included: author(s), year of publication, country of origin, study design, population, motor learning strategies, and key findings. Data analysis was conducted using a thematic analysis approach following Braun and Clarke (2006). The stages included: (1) repeated reading of the texts to gain contextual understanding, (2) identification of key themes, (3) thematic categorization, and (4) development of a narrative synthesis. To ensure consistency, the coding process was conducted manually by comparing agreement among the authors.

Four major themes were analyzed: (a) fundamental concepts of motor learning, (b) influencing factors, (c) instructional strategies and media, and (d) implications of motor learning in higher education.

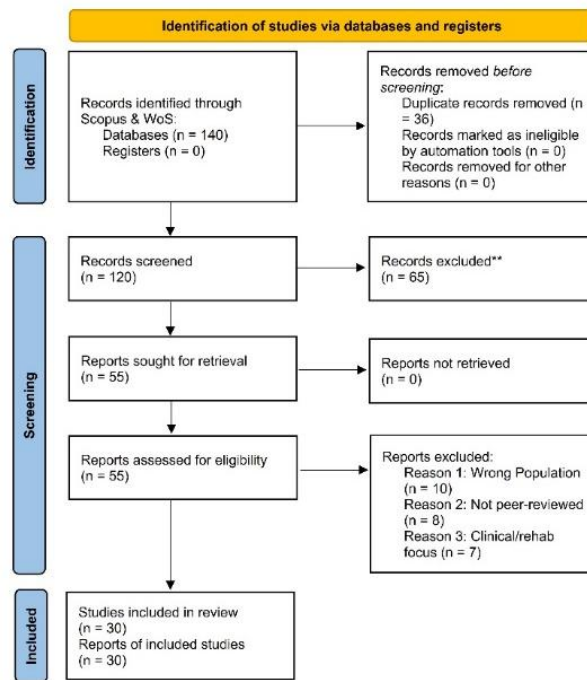


Figure 1. Prisma Flow Diagram

## RESULT AND DISCUSSION

### Results of the Synthesis

The following section presents a summary of 30 articles that describe key components of motor education in higher education: (a) foundational concepts of motor learning; (b) factors influencing learning success; (c) instructional approaches and learning media; and (d) the impact of motor education in higher education. Table 1 presents the results of the synthesis.

Table 1. Synthesis of Results from the Systematic Review of Motor Learning in Higher Education

Theme	No. of Studies	Representative Studies	Key Findings	Methodological Quality
Fundamental concepts of motor learning	5	Hidayat (2018); Ficanysha & Neviyarni (2021)	Motor learning involves cognitive, affective, and psychomotor domains; integration of theory and practice is essential for effective learning.	Mostly descriptive qualitative studies; moderate quality due to reliance on narrative literature.
Influencing factors	7	Ficanysha & Neviyarni (2021); Pratama & Santoso (2020); Kotzsch et al. (2025)	Individual factors (motivation, physical readiness), environmental factors (facilities, lecturer support), and educational policy significantly affect motor learning.	Mixed survey and case-study designs; moderate to high quality.
Instructional strategies and media	12	Afandi & Susanto (2021); Afandi et al. (2023); Blain et	Digital media (Lectora, flipbooks), blended-gamified	Many quasi-experimental studies and meta-analyses;

Theme	No. of Studies	Representative Studies	Key Findings	Methodological Quality
		al. (2022); Han et al. (2022); Kok (2023)	approaches, and visual/verbal feedback improve motivation and motor skills.	high quality in international studies, moderate in local studies.
Implications of motor learning in higher education	6	Rosmi & Nurhuda (2024); Pratama et al. (2025); Müller & Wagner (2025)	A paradigm shift toward adaptive strategies, theory-practice integration, and digital pedagogy is required for pre-service PE teachers.	Mostly review and comprehensive literature studies; moderate quality.

Of the 30 analyzed articles, instructional strategies and learning media were the most frequently discussed topic (12 studies). This indicates that pedagogical innovation and the use of digital technology are central concerns in the development of motor learning in higher education. These findings align with global trends emphasizing blended learning and interactive media to enhance motivation and motor skill acquisition (Blain et al., 2022; Kok, 2023). In the Indonesian context, the use of relatively simple digital media such as digital flipbooks and Lectora applications is more dominant (Afandi & Susanto, 2021; Afandi et al., 2023), reflecting adaptation to limitations in facilities and infrastructure.

The second most prominent theme concerns factors influencing motor learning (seven studies). International research by Kotsch et al., (2025) highlights the role of cognitive capacity, motivation, and learning environment support. In contrast, national studies emphasize limitations in campus facilities, lecturer-student ratios, and educational policy. This difference in focus suggests that local contexts are more influenced by structural factors, while global studies emphasize individual and psychological aspects.

Next, fundamental concepts of motor learning (five studies) remain an important theme, although less frequently discussed. These studies emphasize the integration of cognitive, affective, and psychomotor domains and the alignment of theory and practice (Ficanysa & Neviyarni, 2021; Hidayat, 2018). The predominance of descriptive qualitative methodologies indicates that conceptual studies still require stronger research designs.

Finally, implications of motor learning in higher education (six studies) mainly address curriculum development directions. Global studies Müller & Wagner (2025) recommend digital pedagogy and adaptive strategies, while national research emphasizes alignment with the Merdeka Belajar-Kampus Merdeka policy Merdeka (O. S. Y. Pratama et al., 2025; Rosmi & Nurhuda, 2024). This theme is relatively new and still evolving, with most studies employing review-based methodologies, resulting in moderate methodological quality.

Overall, the synthesis reveals a balance between global emphases on advanced technology and national focuses on adaptive strategies under constrained conditions. This balance opens opportunities for enhanced collaboration and knowledge transfer to optimize motor learning in the Indonesian context.

### Fundamental Concepts of Motor Learning

Motor learning is an internal transformation process involving repetition, feedback, and adaptation of movement strategies. In physical education, this process focuses on how students acquire, retain, and transfer movement skills. According to Hidayat (2018), motor learning is not merely mechanical repetition but a complex interaction of cognitive, affective, and psychomotor components.

A more comprehensive approach to motor learning is required for students in Physical Education, Sport, and Health (PJOK) programs. Such an approach should consider conceptual understanding, movement problem-solving, and application in school-based physical education. As demonstrated by Rosmi & Nurhuda (2024), learning processes that integrate theory with field practice enhance students' motor skills. Rohisfi & Neviyarni (2021), further argue that balance across the cognitive, associative, and autonomous phases influences motor learning success. Thus, motor learning should not be viewed solely as mechanical skill acquisition but as a broader framework encompassing affective and social dimensions that support character development among PJOK students as future teachers or coaches.

### **Factors Influencing Motor Learning**

The literature review identifies several factors influencing the effectiveness of motor learning. First, individual factors, such as motivation, physical readiness, and prior movement experience, play a crucial role (Ficanysha & Neviyarni, 2021). Second, environmental factors, including sports facilities, lecturer support, and availability of instructional media, significantly affect learning outcomes. Afandi & Ratno Susanto (2021) emphasize that a conducive learning environment enhances student engagement in motor learning.

Instructional methods and strategies also play an essential role. H. G. Pratama & Santoso (2020) found that limited instructional strategies during the pandemic negatively affected students' motor skill development. Meanwhile, Kotzsch et al., (2025) highlight the influence of social conditions and educational policies on motor skill development. These findings align with Van Hecke et al., (2016), who demonstrated that global policies and institutional support play a critical role in promoting physical activity, with implications for physical education policy development in higher education.

Contextual factors in Indonesia are also significant. Penelitian Akbar et al., (2019) found that institutional traditions, such as those in Islamic boarding schools (pesantren), shape specific physical activity patterns influencing motor skills among adolescents and university students. Additionally Pinton & Sugiharto (2020) emphasize the importance of integrating motor learning with lifelong learning concepts to foster sustained motivation for physical fitness and health.

### **Effective Instructional Strategies**

The literature highlights various innovative strategies and media that effectively support motor learning. Afandi & Susanto (2019) demonstrated that the use of Lectora media enhances student motivation and understanding of motor skills. Afandi et al., (2023) further found that multimedia-based digital flipbooks enrich learning experiences through interactive visualization. Beyond digital media, constructivist-based instructional modules effectively connect theory and practice. This aligns with Hidasari et al., (2018), who showed that contextual instructional modules improve motor skills while deepening conceptual understanding.

Internationally, Blain et al., (2022) emphasize the importance of blended-gamified approaches in post-pandemic physical education, which significantly increase student engagement. Similarly, Kok (2023) discusses digital pedagogy in Dutch physical education, highlighting applications, digital feedback, and personalized learning methods. Han et al., (2022) through a meta-analysis, demonstrated that various feedback types visual, combined visual-verbal, self-modeling, and corrective feedback significantly enhance learners' motor skills.

Comparatively, local studies emphasize simple educational technologies (e.g., Lectora, flipbooks, constructivist modules) to strengthen conceptual understanding and motivation, while international studies focus on advanced digital integration (real-time feedback, gamification, learning applications) and adaptive pedagogical approaches. These findings align with Martín-Rodríguez & Madrigal-Cerezo (2025), who highlight the role of gamification, wearable devices, and digital technologies in enriching motor learning experiences.

### **Implications of Motor Learning in Higher Education**

The primary implication of these findings is the need for a paradigm shift in motor learning within higher education. First, PJOK lecturers must adopt adaptive instructional strategies that integrate digital media with hands-on practice to prepare students for an increasingly digitized physical education landscape. Second, curricula should emphasize pedagogical competencies in teaching motor skills, enabling students to function not only as performers but also as facilitators of movement learning.

Policy implications are also evident. Higher education institutions should provide adequate facilities, lecturer training, and access to learning technologies to support evidence-based motor learning strategies. For students, effective motor learning enhances not only academic and professional competence but also mental and physical readiness as future physical education educators.

Moreover, motor learning in higher education plays a vital role in character development. Idrus and Afni (2025) report that the integration of values such as sportsmanship, discipline, responsibility, and cooperation in PJOK motor learning remains suboptimal. This is reinforced by Afandi et al. (2019, 2023), who emphasize that instructional media innovations can support not only cognitive and psychomotor development but also character formation through collaborative learning experiences. Thus, motor learning serves as a platform for character education alongside physical skill development.

### **Limitations and Directions for Future Research**

This study has several limitations. First, as a qualitative literature review, it relies entirely on the quality and availability of published studies. Potential bias may arise from limited access to paid articles, language constraints (non-English literature not fully included), and methodological variability across studies. Second, although literature selection was conducted systematically, this review did not fully implement a rigorous PRISMA-based systematic review protocol, limiting transparency.

Additionally, most analyzed studies focus on primary and secondary education, while literature specifically addressing motor learning in higher education remains limited. This constrains the generalizability of findings to PJOK university students. Another limitation is the lack of longitudinal studies examining long-term effects of digital or blended motor learning strategies.

Future research is recommended to:

1. Conduct systematic reviews using comprehensive PRISMA protocols, including detailed flow diagrams and quality assessments.
2. Develop experimental or quasi-experimental studies in higher education to directly test the effectiveness of specific motor learning strategies.
3. Integrate longitudinal approaches to examine long-term impacts of digital media, gamification, and blended learning on students' motor skills.
4. Expand research to international contexts to enable cross-country comparisons of motor learning practices in physical education.

Through such future studies, motor learning strategy development is expected to become more contextualized, evidence-based, and capable of making a meaningful contribution to the quality of physical education in the post-pandemic era.

## **DISCUSSION**

Through a systematic synthesis of 30 articles, this study reveals that motor learning among Physical Education students is a multidimensional process influenced by individual factors, environment, instructional strategies, and educational policies. This finding aligns with empirical reports from Fajar (2017) and Putri (2017), emphasizing that intelligence and motivation play crucial roles in motor skill acquisition; students with higher intelligence tend to grasp movement concepts more quickly than their peers. Specifically, Benesova et al., (2026) demonstrated neurophysiologically that emotional stimuli can modulate postural responses through neural pathways linking the limbic and motor systems, reinforcing the argument that

motor learning is not merely mechanical but also affective. However, this contrasts with findings in general schools that lack the dual burden between national curriculum and religious demands, making the challenges in Islamic boarding schools unique: the integration between spiritual needs and physical requirements.

Instructional strategies and digital media emerged as the most dominant theme (12 studies), indicating that pedagogical innovation is a central concern. The effectiveness of media such as Lectora and flipbooks Afandi et al., (2023) is confirmed by recent studies: Hasibuan et al. (2024) and Susanto et al. (2022) proved that flipbook media in sports physiology learning significantly improved student understanding (from 76% to 89% after validation). Rumawatine (2025) also reported that digital media use in PE resulted in motor skill improvement with a large effect size ( $\eta^2 = 0.275$ ). These findings differ from practices in developed countries as reported by Jiang et al., (2025) through network meta-analysis, where exergaming and advanced technologies ranked highest for improving object control skills (SUCRA = 91.9%) and working memory (SMD = 1.41). This divergence reflects infrastructure and resource gaps between developing and developed countries, as also identified in the comparative study by Sulistiyono et al., (2025) between Indonesia and Pakistan, where Indonesian students demonstrated healthier lifestyles and higher fitness levels ( $t = 3.431$ ;  $p = 0.000$ ), yet access to advanced technology remains limited.

In the context of pre-service teacher pedagogical readiness, this study's findings align with Müller et al., (2026) in Germany, revealing that although pre-service teachers hold positive attitudes toward formative assessment, their self-efficacy in implementation remains low. Similarly, Grimminger-Seidensticker & Seyda (2022) reported that combining theory and practice proved more effective in improving pre-service teachers' attitudes toward inclusive teaching compared to purely theoretical approaches. The self-efficacy instrument developed by Block et al., (2013) and the attitude scale validated by Braksiek (2022) reinforce the argument that measuring these psychological constructs is essential in teacher education program evaluation. However, unlike the structured European context, Indonesian pre-service teachers face unique challenges including facility limitations and disparities in PE implementation quality across schools, as reported by Indahwati et al., (2025): elementary school and madrasah ibtidaiyah students' perceptions of motor learning programs differed significantly ( $t = 4.515$ ;  $p = 0.000$ ), attributable to varying quality of PE implementation.

The practical implications of these findings underscore the need for a paradigm shift in motor learning from mechanistic models toward adaptive, evidence-based strategies. PE lecturers are required not only to teach movement skills but also to equip students with digital pedagogical readiness, as recommended by Müller et al., (2026) that formative assessment literacy needs systematic integration into curricula. From a policy perspective, the comparative study by Hashemi et al., (2021) analyzing PE curricula in Iran, the USA, Germany, Australia, and Japan demonstrates that successful implementation heavily depends on facility standardization and curriculum management decentralization. In Indonesia, the Merdeka Belajar-Kampus Merdeka policy opens opportunities for such integration, yet infrastructure challenges and teacher readiness remain significant homework, as acknowledged in Tegero (2022) study on skill acquisition challenges in flexible learning environments.

This study has several limitations that must be acknowledged. First, as a literature review, these findings depend on the quality and availability of primary studies. Second, most analyzed studies focused on primary and secondary education contexts, while literature specifically addressing motor learning in higher education remains limited, thus generalization requires caution. Third, the absence of longitudinal studies in this synthesis precludes causal inferences about long-term impacts of specific instructional strategies, as also acknowledged as a limitation in Susanto et al., (2022) and Rumawatine (2025) cross-sectional studies.

The findings of this study not only provide insights into motor learning dynamics in higher education but also identify at least four urgent agendas for future research. First, long-term experimental studies (>16 weeks) are needed to test causal effects of digital strategies on physical fitness and motor skills objectively, considering Jiang et al., (2025) proved that interventions under 3 months are more effective for FMS, yet sustainability remains

untested. Second, developing integrated PE curricula combining local values and digital era demands is urgent, referring to the signature pedagogies framework proposed by Hordvik & Beni (2024). Third, comparative studies across school typologies (general, madrasah, Islamic boarding schools) and across countries (Indonesia-Malaysia-Thailand) are needed to test finding generalizability, as recommended by (Sulistiyono et al., 2025). Fourth, exploration of psychological and sociocultural factors such as religiosity, group norms, and social support requires Structural Equation Modeling (SEM) approaches to map their influence on student physical activity participation, considering Cruz et al., (2025) found that sleep duration and physical activity significantly predicted student well-being ( $R^2 = 18\%$ ).

## CONCLUSION

This study affirms that motor learning in higher education is a crucial foundation in preparing Physical Education, Sport, and Health (PJOK) students to become adaptive professional teachers in the digital era. Through a systematic synthesis of 30 articles, it is confirmed that the effectiveness of motor learning is determined by the complex interaction between individual factors (motivation, intelligence), environmental conditions (facilities, lecturer support), instructional strategies (digital media, blended-gamified approaches), and educational policy support. Innovations such as Lectora media, multimedia flipbooks, and the integration of theory and practice have been proven to significantly enhance students' motivation, conceptual understanding, and motor skills. Comparative analysis reveals infrastructure and technology gaps between practices in Indonesia and developed countries. This underscores the importance of context-sensitive approaches in adopting global innovations and reinforces the urgency of developing digital pedagogical readiness for pre-service teachers. The main contribution of this study is the development of a conceptual framework that explicitly links motor skill mastery with the pedagogical readiness of PJOK students – an aspect previously treated separately in the literature. The practical implications of these findings encourage lecturers to transform from mechanistic models toward adaptive, evidence-based strategies. Higher education institutions are required to provide adequate facilities and continuous training, while students need to actively develop both motor competence and professional readiness and character. This synergistic collaboration between lecturers, institutions, and students is key to realizing quality motor learning that aligns with the demands of the digital era and the future needs of physical education.

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