ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

Active Learning Methodologies in Natural Sciences and Mathematics in Mozambican Higher Education: Implementation Levels, Challenges, and Emerging Trends

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Publication Date: 2026/04/21

Abstract: This study critically examines the body of scientific literature production on active learning methodologies in Mozambican higher education, focusing on Natural Sciences and Mathematics. It addresses how the literature characterizes the implementation of these methodologies, with the aim of systematizing evidence on implementation levels, associated challenges, and emerging trends. Methodologically, the study adopts a qualitative structured narrative review, based on explicit criteria for search, selection, and analysis of scientific publications from the last decade. The analytical corpus comprises empirical studies conducted in the Mozambican higher education context, interpreted through theoretically grounded analytical categories. The findings indicate that the adoption of active learning methodologies remains limited, fragmented, and predominantly localized, often restricted to isolated participatory practices coexisting with traditional lecture-based models. The analysis also reveals multidimensional constraints, including infrastructural limitations, insufficient pedagogical training, curricular rigidity, and weak institutional support. Furthermore, significant gaps are identified in national scientific production, particularly the scarcity of longitudinal studies and the absence of systematic impact evaluations. The study contributes a critical and structured synthesis of the state of the art, clarifying the conditions, limitations, and trends shaping active learning implementation in this context.

Keywords: *Active Learning; Higher Education; STEM Education; Mathematics Education; Mozambique.*

How to Cite: Rivelinho Manuel Mohamade; Agnes Clotilde Novela (2026) Active Learning Methodologies in Natural Sciences and Mathematics in Mozambican Higher Education: Implementation Levels, Challenges, and Emerging Trends. *International Journal of Innovative Science and Research Technology*, 11(3), 3990-4000. https://doi.org/10.38124/ijisrt/26mar2099

I. INTRODUCTION

The contemporary discussion on the quality of higher education has increasingly foregrounded the role of pedagogical practices that foster active student engagement and generate measurable learning gains, particularly in the fields of Natural Sciences and Mathematics. Large-scale empirical evidence (Freeman et al., 2014) demonstrates that active learning approaches are consistently associated with significant improvements in academic performance across science, engineering, and mathematics disciplines. Complementing these findings, Theobald et al. (2020) show that such approaches contribute to narrowing achievement gaps among diverse student populations, underscoring their inclusive potential.

Despite this growing body of evidence, the adoption of active learning methodologies remains uneven and contested. Prince (2004) highlights that their effectiveness is contingent upon pedagogical design, institutional conditions, and alignment with curricular objectives. Similarly, Hattie (2012) argues that pedagogical interventions yield substantial effects

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

only when supported by clear instructional intent, systematic feedback mechanisms, and explicit learning criteria, cautioning against reductive assumptions that equate methodological innovation with guaranteed effectiveness.

Within the specific domains of Natural Sciences and Mathematics, the implementation of active learning approaches presents additional challenges. Hoyles and Lagrange (2010) contend that these challenges are closely linked to the epistemological traditions of the disciplines, rigid curricular structures, and dominant assessment practices in higher education. In many contexts, participatory approaches are introduced in a gradual and peripheral manner, coexisting with entrenched lecture-based models, thereby limiting their transformative potential in reshaping teaching and learning processes.

The Mozambican higher education context introduces further institutional and historical specificities that intensify these challenges. Simango (2023) identifies the persistence of content-centered instructional practices, associated with curricular constraints, organizational limitations, and insufficient pedagogical training. These conditions contribute to the localized and discontinuous nature of pedagogical innovation, which often depends on individual lecturer initiative rather than institutionalized frameworks.

In the field of Natural Sciences and Mathematics education, Mohamade and Guiraguira (2025) point to structural constraints affecting the quality of higher education in Mozambique, including weaknesses in teacher pedagogical preparation, institutional limitations, and the absence of integrated strategies for systemic improvement. Although not exclusively focused on active learning methodologies, their findings reinforce the need to examine how such approaches are operationalized and sustained within this context.

At the same time, active learning methodologies are not exempt from criticism. Kirschner, Sweller, and Clark (2006) argue that minimally guided instructional approaches may hinder learning, particularly among students with limited prior knowledge. This perspective introduces a critical counterpoint, emphasizing that the effectiveness of active learning depends fundamentally on the conditions of its design, implementation, and contextualization.

Notwithstanding the increasing relevance of this field, there remains a significant gap in Mozambican scientific production concerning the critical synthesis of empirical evidence on active learning in higher education, particularly within Natural Sciences and Mathematics. Existing studies tend to address pedagogical practices, teacher education, or educational innovation in a fragmented manner, lacking an integrated analytical perspective capable of identifying implementation patterns, recurring constraints, and emerging trends.

Against this backdrop, the present study is guided by the following research question: how does the scientific literature characterize the implementation of active learning methodologies in Mozambican higher education, particularly in the fields of Natural Sciences and Mathematics? Accordingly, the study aims to systematically and critically analyze the existing scientific production, focusing on levels of implementation, associated challenges, and trends identified in the literature.

By addressing this objective through a structured narrative review, this study seeks to advance the academic debate on pedagogical practices in Mozambican higher education. It provides a rigorous and context-sensitive synthesis that articulates national empirical evidence with established theoretical frameworks, while explicitly accounting for the institutional and epistemological specificities that shape the implementation of active learning methodologies in this context.

II. THEORETICAL–CONCEPTUAL FRAMEWORK

- *Teaching Methodologies and Instructional Strategies: A Conceptual Distinction*

The distinction between teaching methodologies and instructional strategies is widely discussed in educational research and constitutes a critical element for conceptual clarity in studies on pedagogical practices in higher education. Biggs and Tang (2011) conceptualize teaching methodologies as overarching pedagogical orientations, grounded in theories of learning, curricular models, and epistemological assumptions that structure the teaching–learning process. In contrast, instructional strategies refer to specific procedures employed by lecturers to operationalize a given methodology within concrete classroom contexts.

Hattie (2012) reinforces this distinction by differentiating between broad pedagogical approaches and specific instructional techniques, arguing that the effectiveness of the latter is contingent upon their alignment with the underlying methodological framework. According to the author, isolated strategies, when detached from a coherent pedagogical orientation, tend to produce limited effects on learning outcomes.

Within higher education, Entwistle (2009) emphasizes that student-centered methodologies require the intentional orchestration of strategies that promote deep cognitive engagement, meaningful social interaction, and self-regulated learning. In this study, therefore, active learning methodologies are conceptualized as comprehensive pedagogical frameworks, whereas practices such as problem-solving, group work, structured debates, and peer instruction are treated as instructional strategies.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

➢ *Active Learning Methodologies in Higher Education: Theoretical Foundations*

Active learning methodologies in higher education are grounded in constructivist and socioconstructivist perspectives, which posit that knowledge is actively constructed by learners through interaction with problems, content, and social contexts (Freeman et al., 2014). A substantial body of empirical evidence indicates that approaches fostering active participation lead to significant learning gains when compared to predominantly lecture-based methods.

Crisol-Moya, Romero-López, and Caurcel-Cara (2020) identify key characteristics of active learning methodologies, including student agency, peer interaction, engagement with authentic problems, and the integration of theory and practice. These features have been consistently associated with increased student engagement and motivation. Meta-analyses and systematic reviews further corroborate these findings, demonstrating robust positive effects on academic performance and knowledge retention in higher education settings (Theobald et al., 2020).

Carless, Kwan, and Kwok (2020) extend this perspective by emphasizing that the effectiveness of active learning is strongly linked to the quality of formative feedback and the structuring of pedagogical interactions, highlighting the central role of dialogue and self-regulation in the learning process.

➢ *Typologies of Active Learning Methodologies and Associated Strategies*

International research has identified a relatively consolidated set of active learning methodologies in higher education, particularly within STEM fields. Among the most prominent are Problem-Based Learning, Project-Based Learning, Collaborative Learning, Peer Instruction, and the Flipped Classroom (Theobald et al., 2020; Carless, Kwan, and Kwok, 2020).

These methodologies are operationalized through specific instructional strategies. Problem-Based Learning, for instance, relies on case studies, problem analysis, and collaborative work, while Peer Instruction incorporates conceptual questioning, individual voting, peer discussion, and immediate feedback (Mazur, 2014). Empirical evidence indicates that the effectiveness of these methodologies depends fundamentally on the coherence between the adopted pedagogical framework and the instructional strategies employed (Alvarado, 2025).

➢ *Active Learning in Natural Sciences and Mathematics Education*

In the context of Natural Sciences and Mathematics education, active learning methodologies have been increasingly investigated as alternatives to predominantly lecture-based approaches, which are often associated with superficial learning and high failure rates in STEM disciplines (Freeman et al., 2014). Empirical evidence suggests that engaging students in cognitively demanding activities enhances conceptual understanding, scientific and mathematical reasoning, and the ability to apply knowledge in novel contexts.

Meta-analytical studies demonstrate that students exposed to active learning approaches achieve statistically significant learning gains and exhibit lower failure rates compared to those taught through exclusively expository methods (Theobald et al., 2020). Within Mathematics and Natural Sciences specifically, approaches such as Peer Instruction and Problem-Based Learning have proven particularly effective in fostering conceptual understanding and addressing misconceptions (Mazur, 2014; Carless, Kwan, and Kwok, 2020).

These findings underscore the relevance of examining the implementation of active learning methodologies in Natural Sciences and Mathematics education, not only in terms of their formal adoption but also with regard to the instructional strategies employed and the institutional constraints that shape their enactment, particularly within the Mozambican higher education context.

III. METHODOLOGY

➢ *3Research Design and Rationale*

This study adopts a qualitative, theoretically grounded, and analytically oriented design, developed through a structured narrative review of the literature. The choice of this methodological approach is informed by the typologies proposed by Grant and Booth (2009) and by established guidelines for narrative reviews in educational research (Green, Johnson, and Adams, 2006).

A structured narrative review differs from systematic reviews and meta-analyses in that it does not aim for statistical exhaustiveness or quantitative aggregation of findings. Instead, it prioritizes the critical, contextualized, and interpretative integration of a limited and heterogeneous body of studies. This approach is particularly appropriate for the field under investigation, which is characterized by: (i) an incipient body of scientific production in the Mozambican context; (ii) methodological and analytical diversity across studies; (iii) the absence of large-scale longitudinal or experimental research; and (iv) a strong reliance on context-specific analyses.

➢ *Search Strategy and Data Sources*

Sources were identified through systematic searches in major international and regional databases, including Scopus, Web of Science, ERIC, SciELO, and Google Scholar. In addition, institutional repositories of Mozambican universities, African journals in Education and Science Education, and

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

databases of theses and dissertations were consulted, given their relevance to the national academic context.

The search strategy combined descriptors in both Portuguese and English, including, but not limited to: "metodologias ativas," "active learning," "higher education," "Natural Sciences," "Mathematics," "Mozambique," and "Africa." These terms were used both independently and in combination to maximize search sensitivity and minimize the risk of omitting relevant studies. The purpose of the search process was not to construct a statistically representative sample, but rather to identify conceptually and empirically relevant studies capable of addressing the research questions.

➢ *Inclusion and Exclusion Criteria*

Studies were included if they met the following criteria: (a) peer-reviewed scientific publications, doctoral theses, or institutionally recognized academic studies; (b) explicit focus on higher education; (c) engagement with pedagogical practices, active learning methodologies, or teaching–learning processes aligned with student-centered approaches; (d) direct relevance to the Mozambican context; and (e) publication preferably within the last ten years, with exceptions made when justified by conceptual or contextual relevance.

Studies were excluded if they were purely opinion-based, lacked minimum methodological description, constituted duplicate records, or did not focus on higher education or on the fields of Natural Sciences and Mathematics.

➢ *Explicit Delimitation of the Analytical Corpus*

Based on the established criteria, three empirical studies conducted within the Mozambican higher education context were identified and included as the core analytical corpus of this structured narrative review.

The selected studies are: (1) Fortes et al. (2021), which examine students' perceptions of the use of active learning methodologies in Physics teaching at UniRovuma; (2) Singo (2020), which addresses the implementation of active pedagogical strategies in professional education and higher education institutions; and (3) Ussivane and Dantas (2025), which discuss teacher education and professional development in Mozambican higher education, with direct implications for the adoption of innovative pedagogical practices. The limited number of studies does not constitute a methodological limitation per se, but rather reflects the current state of national scientific production on the topic—an aspect that is itself critically examined in the results.

➢ *Differentiated Use of Sources Across Sections*

In addition to the studies included in the analytical corpus, other national and international scholarly works were mobilized exclusively to support the theoretical framework and to deepen the discussion of results.

These additional sources are not part of the empirical corpus and are not counted among the studies included in the results. Their use is restricted to three clearly defined functions:

- conceptual definition and clarification of key constructs;
- contextualization of findings within international and African research landscapes; and
- support for the critical interpretation of results through theoretical convergence and divergence.

➢ *Data Analysis Procedures*

The analysis followed a systematic, iterative, and interpretative process. Initially, an exploratory reading of the selected studies was conducted to identify research objectives, institutional contexts, pedagogical approaches, and key findings. This was followed by an in-depth analytical reading guided by categories aligned with the research objectives.

The analytical categories included: (a) typologies of active learning methodologies and instructional strategies in Natural Sciences and Mathematics; (b) forms and levels of implementation in Mozambican higher education; (c) pedagogical and institutional contexts of application; (d) identified challenges, constraints, and limitations; and (e) trends and gaps in both implementation and scientific production on active learning methodologies.

The analytical synthesis prioritized the identification of patterns, convergences, and divergences across studies, without employing statistical meta-synthesis techniques, in accordance with the nature of the narrative review.

➢ *Scientific Rigor and Study Limitations*

Scientific rigor was ensured through the explicit articulation of the research design, transparent selection criteria, clear delimitation of the analytical corpus, and systematic description of analytical procedures. All sources used are traceable and academically recognized.

It is acknowledged that narrative reviews entail inherent limitations, particularly their reliance on qualitative interpretation and the inability to support statistical generalization. These limitations do not undermine the study but rather define its analytical scope, and they are explicitly considered in the interpretation of findings and the formulation of conclusions.

IV. RESULTS

In line with the methodological procedures previously outlined, the selected studies were analyzed systematically, considering their educational context, the nature of the pedagogical interventions, data collection and analysis methods, as well as the main findings and reported challenges, without anticipating the thematic categories developed in the subsequent subsections.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

Overall, the studies included in the analytical corpus are characterized by a predominance of qualitative and descriptive-analytical approaches, drawing on questionnaires, interviews, classroom observations, and analyses of participants' perceptions. The investigations primarily focus on the implementation of active learning methodologies in concrete teaching situations, including group work, collaborative strategies, active classroom practices, and the reconfiguration of the student's role in the learning process (Fortes et al., 2021; Singo, 2020; Subuana, Angst, and Francisco, 2024).

Regarding contexts and participants, the analyzed studies encompass both higher education and professional education institutions, with a primary focus on students, while also addressing pedagogical dynamics shaped by lecturers. Specific disciplinary contexts, such as Physics education, are represented, alongside cross-disciplinary approaches within the Natural Sciences and professional training domains. This diversity enables the identification of common patterns in the adoption of active learning strategies across different levels and modalities of education.

Table 1 presents a synthesized characterization of the empirical studies included in the results section, highlighting only the essential elements required to understand the analytical corpus. This systematization is intended to provide a global overview of the studies, without redundancy or premature anticipation of the thematic analysis developed in the following subsections.

Table 1 General Characterization of Empirical Studies Included in the Results Section

Author(s)	Year	Area / Context	Focus of the Study	Main Reported Challenges
Fortes et al.	2021	Higher education – Physics (UniRovuma)	Active learning methodologies in Physics teaching	Infrastructural limitations; need for pedagogical teacher training
Singo	2020	Professional education and higher education	Implementation of active pedagogical strategies	Resistance to pedagogical change; insufficient resources
Subuana; Angst; Francisco	2024	Higher education	Use of active methods with emphasis on group work	Time management; pedagogical preparation of lecturers

Source: Authors (2026)

Table 1 indicates that the empirical studies analyzed converge in recognizing the benefits of active learning methodologies for student participation, collaboration, and learning outcomes, while simultaneously pointing to recurring challenges, particularly infrastructural limitations, weaknesses in pedagogical teacher training, and organizational constraints. This empirical overview provides the foundation for the thematic analysis developed in the subsequent subsections, beginning with the identification of the typologies of active methodologies and strategies effectively implemented in the Mozambican contexts under analysis.

- *Typologies of Active Learning Methodologies Identified in the Literature*

The analysis of the empirical studies included in this narrative review enabled the identification of a set of active learning methodologies and pedagogical strategies effectively implemented in Mozambican educational contexts, albeit in a non-systematic manner and only partially integrated into dominant pedagogical practices. These typologies emerge from concrete experiences and localized initiatives, and in most cases coexist with traditional lecture-based teaching models (Fortes et al., 2021; Singo, 2020; Subuana, Angst, and Francisco, 2024).

Within the domain of Natural Sciences, particularly in Physics education, Fortes et al. (2021) identify practical and laboratory-based activities as the primary expression of active learning methodologies in the analyzed context. According to the authors, such activities promote student engagement, interaction with scientific phenomena, and the active construction of knowledge, partially shifting the focus from content transmission to student participation. However, their implementation is strongly conditioned by infrastructural, material, and organizational constraints, which limit their regularity and consolidation.

Still within the Natural Sciences, Fortes et al. (2021) also report the use of simplified inquiry-based approaches, in which students are encouraged to observe phenomena, discuss results, and actively participate in classroom activities. While these practices incorporate core principles of active learning, they are not configured as formally structured methodologies, but rather as context-adapted pedagogical strategies implemented on an occasional basis.

From a cross-disciplinary perspective, Singo (2020) highlights the adoption of active pedagogical strategies such as collaborative work, guided classroom discussions, problem-oriented tasks, and the promotion of student participation in the learning process. These strategies are implemented across both professional education and higher education institutions, typically as complementary practices rather than as replacements for traditional teaching models.

Similarly, Subuana, Angst, and Francisco (2024) identify group work as one of the most prominent active methods in the analyzed context. This strategy is associated with enhanced student interaction, the development of social competencies, and collaborative learning processes. However, its effectiveness depends on factors such as pedagogical planning, time management, and lecturers' preparedness to facilitate

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

structured participatory activities, which constrains its consistent implementation.

Overall, the findings indicate that the typologies of active learning methodologies identified in the Mozambican empirical literature are characterized by terminological diversity, localized application, and partial integration into existing pedagogical practices. Active methodologies and strategies predominantly function as complementary initiatives to lecture-based teaching, strongly conditioned by institutional contexts, material resources, and lecturers' pedagogical training. These findings directly address the research question concerning the typologies of active learning methodologies in the Mozambican context and provide the basis for examining their levels of implementation and associated challenges.

Beyond typological identification, the analysis also reveals that the implementation of active learning methodologies in Mozambican contexts is heterogeneous, localized, and predominantly partial, with no evidence of advanced adoption or systematic institutionalization. This observation allows for a direct response to the research question regarding levels of implementation, based on the available empirical data (Fortes et al., 2021; Singo, 2020; Subuana, Angst, and Francisco, 2024).

At an incipient level, active learning methodologies appear primarily as isolated initiatives, integrated sporadically into traditional pedagogical practices. Singo (2020) notes that, in both higher education and professional education, strategies such as student participation, classroom discussion, and collaborative work are used intermittently, without substantially altering curricular organization, assessment practices, or the central role of the lecturer. Although recognized as innovative, these practices do not constitute structural transformations of the dominant pedagogical model.

At a partial level of implementation, Fortes et al. (2021) describe more consistent experiences in Physics teaching, where practical and laboratory activities are recurrently integrated into classroom practice. These experiences contribute to increased student engagement and reflect a shift toward active learning. However, they remain confined to specific disciplines and individual lecturer initiatives, lacking articulation with broader institutional policies or curricular reforms.

Similarly, Subuana, Angst, and Francisco (2024) identify partial implementation in the use of group-based active methods, which yield positive outcomes in terms of interaction, collaboration, and peer learning. Nevertheless, these approaches are constrained by limitations related to pedagogical planning, time management, and lecturer preparation, preventing their consolidation as systematic pedagogical practices.

Importantly, the analyzed studies provide no empirical evidence of intermediate or advanced levels of implementation within the Mozambican context. The absence of structured institutional programs, continuous pedagogical training policies, or curricula explicitly oriented toward active learning suggests that the adoption of these methodologies remains dependent on isolated initiatives, lacking sustained organizational support.

In summary, the findings indicate that the implementation of active learning methodologies in Natural Sciences and Mathematics in Mozambique is predominantly situated at incipient and partial stages. It is characterized by localized application, reliance on individual lecturer engagement, and the absence of institutionalization. These results provide a robust empirical foundation for the subsequent analysis of the challenges and constraints affecting the adoption and consolidation of active learning methodologies in the Mozambican higher education context.

- *Pedagogical and Institutional Contexts of Active Learning Implementation*

The analysis of the empirical studies included in this narrative review indicates that the implementation of active learning methodologies occurs within specific pedagogical and institutional contexts, strongly shaped by organizational structures, curricular configurations, and prevailing teaching practices. These contextual dimensions are critical not only for understanding the modes of adoption of active learning methodologies, but also for explaining their limitations, in direct relation to the levels of implementation identified previously.

At the institutional level, the analyzed studies are predominantly situated within Mozambican public higher education institutions, characterized by limited material and infrastructural resources and by traditionally structured organizational models. Fortes et al. (2021), in their analysis of Physics teaching in a public university, demonstrate that the adoption of active learning methodologies takes place in environments where laboratory conditions, class size, and the availability of equipment directly constrain the regularity and diversity of active pedagogical practices. Such institutional constraints exert a decisive influence on how active methodologies are selected, adapted, and implemented.

From a pedagogical perspective, the studies consistently indicate that active learning methodologies are generally implemented in coexistence with traditional teaching practices. Fortes et al. (2021) observe that practical and laboratory activities, although promoting greater student engagement and participation, are embedded within instructional structures that remain predominantly lecture-centered. Similarly, Subuana, Angst, and Francisco (2024) identify group work as an active pedagogical strategy; however, its application is often sporadic and does not entail a

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

substantive reconfiguration of pedagogical dynamics or of the lecturer's role in the teaching–learning process.

Curricular organization emerges as a further critical dimension shaping implementation. The analyzed studies suggest that course programs prioritize extensive content coverage, thereby limiting the time available for the development of active learning activities. As a result, active strategies are frequently adopted in an adaptive and complementary manner, accommodating existing curricular demands rather than emerging from structured curricular reforms (Fortes et al., 2021; Subuana, Angst, and Francisco, 2024).

In addition, Singo (2020) highlights that, across both higher education and professional education contexts, the implementation of active pedagogical strategies is largely dependent on individual lecturer initiative. This occurs in institutional settings where clear pedagogical guidelines and systematic mechanisms for monitoring and evaluating such practices are largely absent. This dependence reinforces the localized and non-institutionalized character of active learning adoption.

In summary, the pedagogical and institutional contexts of active learning implementation in Mozambique, as documented by Fortes et al. (2021), Singo (2020), and Subuana, Angst, and Francisco (2024), are characterized by resource-constrained public institutions, relatively inflexible curricula, and the predominance of traditional pedagogical models. These contextual conditions help explain the incipient and partial levels of implementation observed and provide the empirical foundation for examining the challenges and constraints associated with the adoption of active learning methodologies.

- *Challenges and Constraints in the Adoption of Active Learning Methodologies*

The empirical studies included in this narrative review converge in identifying a set of interrelated challenges and constraints that limit the consistent and sustained adoption of active learning methodologies in the Mozambican educational contexts analyzed. These constraints are multidimensional in nature, encompassing infrastructural, pedagogical, curricular, and organizational factors.

One of the most recurrent challenges concerns infrastructural limitations and the availability of teaching resources. Fortes et al. (2021), in their analysis of Physics teaching, highlight that the scarcity of adequately equipped laboratories, experimental materials, and technological resources constrains the regular implementation of practical and laboratory-based activities commonly associated with active learning. These limitations reduce the range of pedagogical strategies available and hinder the consolidation of student-centered practices.

A further constraint relates to working conditions and pedagogical planning. Subuana, Angst, and Francisco (2024) emphasize that the implementation of active methods, such as group work, requires substantial investment in planning, organization, and continuous monitoring of student learning processes. However, high teaching loads and time constraints within classroom settings limit the systematic application of these strategies, resulting in their sporadic and often unstructured use.

Pedagogical constraints are also evident, particularly regarding lecturers' preparedness to implement active learning methodologies effectively. Subuana, Angst, and Francisco (2024) argue that the success of group-based approaches depends heavily on the lecturer's ability to facilitate interactions, define clear tasks, and guide learning processes. The absence of specific pedagogical training in active methodologies restricts their effectiveness and may compromise intended learning outcomes.

From a curricular and organizational standpoint, Singo (2020) observes that active pedagogical strategies are frequently implemented as complements to traditional teaching methods, without significant modifications to curricular structures or assessment models. The emphasis on extensive content coverage and conventional evaluation practices limits the space for the consistent adoption of student-centered approaches, reinforcing the adaptive and non-institutionalized character of active learning methodologies.

Finally, the studies point to conceptual challenges related to the understanding of active learning methodologies. Singo (2020) notes that isolated participatory practices, such as classroom discussions or group activities, are sometimes equated with active learning, despite lacking a clear theoretical foundation or structured pedagogical intent. This conceptual ambiguity complicates the evaluation of their impact and hinders their consolidation as coherent pedagogical approaches.

In summary, the challenges and constraints associated with the adoption of active learning methodologies, as identified by Fortes et al. (2021), Singo (2020), and Subuana, Angst, and Francisco (2024), are interdependent and contribute to the persistence of predominantly incipient and partial levels of implementation. These approaches remain largely dependent on individual lecturer initiative and are strongly conditioned by institutional contexts. The findings provide a robust empirical basis for the subsequent analysis of emerging trends and gaps in the scientific production on active learning methodologies in the Mozambican context.

- *Emerging Trends and Gaps in the Implementation and Scientific Production on Active Learning Methodologies*

The analysis of the empirical studies included in this narrative review allows for the identification of both emerging trends and persistent gaps in the implementation of active

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

learning methodologies and in the corresponding scientific production within the Mozambican context. These trends and gaps derive directly from the findings presented in the preceding subsections and contribute to a more integrated understanding of the current state of empirical research in this field.

With regard to emerging trends, the analyzed studies indicate a growing recognition of the potential of active learning methodologies to enhance student engagement, participation, and interaction within teaching–learning processes. Fortes et al. (2021) report positive student perceptions of practical and laboratory-based activities in Physics education, associating these experiences with increased motivation and classroom participation. Similarly, Singo (2020) and Subuana, Angst, and Francisco (2024) highlight the increasing valuation of active pedagogical strategies—such as collaborative work and student participation—as viable alternatives or complements to traditional lecture-based approaches.

Another notable trend concerns the gradual adoption of low-cost, operationally feasible active learning strategies, including group work, guided discussion, and problem-oriented tasks. These strategies can be implemented even in contexts characterized by infrastructural constraints, suggesting a form of contextual adaptation of active learning methodologies to existing institutional conditions, albeit in a partial and localized manner (Singo, 2020; Subuana, Angst, and Francisco, 2024).

Despite these developments, the empirical literature reveals significant gaps. A primary limitation lies in the scarcity of studies involving systematic pedagogical interventions. The reviewed studies are predominantly descriptive, focusing on perceptions and reported experiences, with limited evidence derived from rigorous designs capable of assessing the impact of active learning methodologies on student learning outcomes (Fortes et al., 2021; Singo, 2020).

A further gap concerns the absence of longitudinal research examining the implementation of active learning methodologies over time. The analyzed studies are largely restricted to isolated experiences or specific contexts, which constrains the understanding of the sustained effects of these approaches and their potential for institutional consolidation (Subuana, Angst, and Francisco, 2024).

Additionally, a conceptual and methodological gap is evident in the inconsistent systematization of active learning methodologies. As noted by Singo (2020), isolated participatory practices are sometimes labeled as active methodologies without a clear distinction between methodologies, strategies, and pedagogical techniques. This conceptual ambiguity limits comparability across studies and hinders the development of a more coherent and cumulative body of knowledge.

Taken together, these findings indicate that, although there is a discernible trend toward the increased recognition and adoption of active learning methodologies in Mozambican educational contexts, empirical scientific production remains at an incipient stage. It is characterized by descriptive approaches, localized experiences, and both methodological and conceptual limitations. These observations underscore the need for future research employing more robust methodological designs, broader disciplinary coverage, and longitudinal perspectives capable of capturing the complexity and sustainability of active learning implementation.

Table 2 Integrative Synthesis of Narrative Review Findings

Analytical Dimension	Main Empirical Evidence	Reference Studies
Typologies of active learning methodologies	Predominance of operational active strategies: practical and laboratory activities, group work, guided discussion, and problem-solving tasks; complementary application to lecture-based teaching	Fortes et al. (2021); Singo (2020); Subuana, Angst, and Francisco (2024)
Levels of implementation	Implementation predominantly at incipient and partial levels; coexistence with traditional methodologies; absence of evidence of institutionalization or advanced adoption	Fortes et al. (2021); Singo (2020); Subuana, Angst, and Francisco (2024)
Pedagogical contexts	Localized adoption within specific disciplines; maintenance of lecturer centrality; occasional integration of active strategies into classroom practices	Fortes et al. (2021); Subuana, Angst, and Francisco (2024)
Institutional contexts	Predominance of public institutions; limited material and infrastructural resources; inflexible curricula; absence of explicit institutional guidelines for active learning	Fortes et al. (2021); Singo (2020)
Main challenges	Infrastructural limitations; high teaching loads; difficulties in pedagogical planning; insufficient preparation for facilitating active learning; curricular rigidity	Fortes et al. (2021); Singo (2020); Subuana, Angst, and Francisco (2024)
Emerging trends	Growing recognition of the value of active learning; adoption of low-cost strategies (group work, discussion); positive student perceptions	Fortes et al. (2021); Singo (2020)

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

Identified gaps	Scarcity of intervention-based studies; absence of longitudinal research; predominance of descriptive approaches; conceptual systematization weaknesses	Fortes et al. (2021); Singo (2020); Subuana, Angst, and Francisco (2024)

Source: Authors (2026)

V. DISCUSSION OF RESULTS

The findings of this narrative review indicate that the implementation of active learning methodologies in Mozambican higher education, particularly in the fields of Natural Sciences and Mathematics, remains limited, fragmented, and strongly conditioned by institutional, curricular, and pedagogical factors. Beyond describing specific instructional practices, these results provide a basis for critically examining the theoretical assumptions underpinning the understanding and appropriation of active learning methodologies within the analyzed context.

From a conceptual standpoint, the findings reveal a constrained appropriation of the foundational notion of active learning as articulated by Bonwell and Eison (1991), who define it as involving deliberate cognitive engagement, student responsibility for learning, and a shift away from exclusive content transmission. In the Mozambican studies analyzed, active learning is frequently interpreted as the incorporation of isolated participatory strategies within predominantly lecture-based instruction, reflecting only partial alignment with this foundational definition.

This pattern becomes more intelligible when considered in light of Prince (2004), who demonstrates that the mere inclusion of participatory activities does not, in itself, ensure meaningful learning, particularly when such activities are not embedded within coherent pedagogical designs, clearly defined objectives, and aligned assessment practices. However, a significant divergence emerges between the context examined by Prince and the Mozambican scenario identified in this review. In the former, active learning methodologies are often embedded within broader pedagogical reforms supported by institutional policies and structured faculty development—conditions that remain largely underdeveloped in the studies analyzed here.

This structural discrepancy also helps explain the contrast between the present findings and those reported by Freeman et al. (2014), whose large-scale study demonstrates robust improvements in academic performance when active learning replaces traditional lecture-based models in STEM education. In the Mozambican context, however, active learning methodologies rarely assume a substitutive role, instead coexisting with traditional practices. This configuration contributes to explaining why the analyzed studies emphasize positive student perceptions while providing limited empirical evidence of measurable academic impact.

A similar limitation emerges when engaging with Theobald et al. (2020), who report reductions in achievement gaps among underrepresented student groups in higher education contexts where active learning is systematically implemented. The findings of this review do not allow for the confirmation of such effects in Mozambique, primarily due to the absence of longitudinal studies and quasi-experimental designs—an omission that represents a significant divergence between national scientific production and the evidence reported in the international literature.

At the same time, a theoretically cautious interpretation of these findings requires engagement with the critique advanced by Kirschner, Sweller, and Clark (2006), who question the effectiveness of minimally guided instructional approaches, particularly in contexts where students lack sufficiently developed prior knowledge. The studies analyzed in this review do not indicate widespread adoption of minimally guided approaches; rather, they point to strongly teacher-guided practices. In this respect, a partial convergence with these authors can be observed, as the centrality of the lecturer may be interpreted as an adaptive response to contextual constraints, rather than as resistance to pedagogical innovation.

This interpretation gains further analytical depth when situated within the specific domains of Mathematics and Natural Sciences. The findings resonate with Hoyles and Lagrange (2010), who argue that the consistent implementation of active learning methodologies requires transformations that extend beyond classroom practices, encompassing curriculum design, assessment models, and the pedagogical use of technology. However, the empirical evidence reviewed here diverges from this perspective, as the Mozambican context is characterized by limited articulation between active learning practices and broader curricular or institutional reforms, thereby constraining their transformative potential.

The persistence of lecture-based practices as the dominant instructional model can also be interpreted through the lens of Hattie (2012), who emphasizes that the impact of pedagogical strategies depends less on the methods themselves and more on the quality of instruction, clarity of learning objectives, and effectiveness of feedback. From this perspective, the limitations identified in this study appear to be less a function of methodological choice and more a reflection of the institutional and pedagogical conditions that shape teaching practices—an issue consistently highlighted across the Mozambican studies analyzed.

ISSN No:-2456-2165 https://doi.org/10.38124/ijisrt/26mar2099

It is precisely at this structural level that the contributions of Mohamade and Guiraguira (2025) become particularly salient. Their work demonstrates that the challenges associated with Natural Sciences and Mathematics education in Mozambican higher education are closely linked to the quality of teaching, the pedagogical preparation of lecturers, and the absence of consistent institutional policies supporting innovation. These findings converge directly with the results of the present review, suggesting that the limited adoption of active learning methodologies cannot be understood in isolation from broader systemic constraints affecting curriculum organization, teacher education, and academic working conditions.

Finally, when considered in relation to Mazur's (1997) work on Peer Instruction, the findings suggest that, although there is an increasing discursive alignment with the principles of active learning, their operationalization in the Mozambican context remains distant from the conditions required to achieve the positive outcomes documented in such studies. This gap does not undermine the relevance of active learning methodologies; rather, it underscores the need for context-sensitive, empirically grounded, and institutionally supported approaches to pedagogical innovation.

Overall, the results of this study indicate that the implementation of active learning methodologies in Mozambican higher education can be situated at an intermediate stage, characterized by conceptual convergence with the international literature but significant divergence in terms of institutionalization, pedagogical systematization, and empirical research production. These findings reinforce the relevance of the research problem and highlight the need for advancing both scholarly inquiry and institutional policies aimed at strengthening pedagogical innovation in the fields of Natural Sciences and Mathematics.

VI. CONCLUSION

This article aimed to systematically and critically analyze the scientific production on the use of active learning methodologies in Mozambican higher education, particularly in the fields of Natural Sciences and Mathematics, by addressing how the literature characterizes their implementation in this context. Based on a structured narrative review, the findings provide a coherent, empirically grounded synthesis of the current state of national scientific production on the topic.

The analysis of the selected corpus indicates that the implementation of active learning methodologies in Mozambican higher education remains at an incipient and weakly systematized stage. It is characterized by isolated initiatives, coexistence with traditional lecture-based practices, and a strong dependence on institutional conditions and lecturers' pedagogical preparation. The existing scientific production is predominantly focused on descriptive accounts of pedagogical experiences and on the perceptions of lecturers and students, exhibiting limited methodological diversity and a lack of robust evidence regarding measurable academic outcomes.

By synthesizing these findings, this study demonstrates that the adoption of active learning methodologies in the Mozambican context cannot be understood solely as an individual pedagogical choice. Rather, it constitutes a structurally conditioned phenomenon, shaped by institutional, curricular, and organizational factors that influence teaching practices in Natural Sciences and Mathematics. This insight underscores the need for context-sensitive approaches that are aligned with the actual conditions of the higher education system.

The primary contribution of this research lies in the critical systematization of a still fragmented field, clearly distinguishing between pedagogical discourse, effectively implemented practices, and gaps in national scientific production. In doing so, the study provides an original synthesis that organizes existing knowledge, identifies trends and limitations, and delineates the empirical contours of active learning implementation in Mozambican higher education.

Furthermore, by articulating national findings with well-established international literature on active learning, the article situates Mozambican scientific production within a broader academic dialogue, without resorting to unsupported generalizations. This articulation enables the identification of conceptual convergences alongside structural divergences, thereby contributing to a more rigorous and contextually grounded understanding of the topic.

Finally, the synthesis presented highlights the need for further empirical research in the Mozambican context, particularly through studies employing more robust methodological designs, including intervention-based and longitudinal approaches. It also points to the importance of institutional initiatives aimed at strengthening pedagogical training for lecturers and promoting the curricular integration of active learning methodologies. In this regard, the article establishes a solid foundation for future research and for the development of academic policies oriented toward pedagogical innovation in Mozambican higher education, especially within the fields of Natural Sciences and Mathematics.

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