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A Systematic Review on Multidisciplinary Technological Approaches in Higher Education

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ABSTRACT

Multidisciplinary has become increasingly popular in higher education, especially in the digital era. However, the different focus of the existing literature, which indicates the effectiveness of applying multidisciplinary technological approaches, has not been sufficiently discussed despite its profound significance in the higher learning setting. To fill such a gap, the PRISMA guidelines and two supporting databases, Scopus and Web of Science, were employed to examine recent studies conducted over the last decade. Significant findings from the 19 selected articles indicate the issues of sustainability, student employability, complex thinking, pre-service teacher training, and teaching innovation were the five key themes that prove the benefits of multidisciplinary technological methods to improve the quality of higher education. This review holds significant implications for educational practitioners, policymakers, and researchers, offering valuable insights that may guide the adoption and implementation of multidisciplinary technological approaches in higher education.

Keywords:

Multidisciplinary technological approach,
higher education, PRISMA

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1. Introduction

Sustainable development is being implemented in higher education institutions, considering all dimensions of their functioning and involving academic and administrative subsystems [10]. The COVID-19 pandemic has also led to rethinking university practices, focusing on digital transformation and technological innovation [1,6]. Universities have introduced interdisciplinary studies or subjects to provide students with different ways of knowing and prepare them for a global knowledge economy [5]. Multidisciplinary technological approaches in higher education have been evolving and gaining importance since the 1990s. Multidisciplinary technological approaches in higher education are important because they foster interdisciplinary collaboration, develop critical thinking and problem-solving skills, align with the demands of the digital era, and promote innovation and creativity. These approaches aim to work across different disciplines and technologies to enhance learning outcomes, address specific problems, and develop professional skills by drawing on a range of expertise [3,4].

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They also emphasise the use of innovative technologies, such as software, ICT and social media, additive, mobile learning systems or apps, and digital and artificial intelligence, to break the barriers in the classroom and modernise the traditional educational environment [17,22,29,30], which may also make the lessons more fun and meaningful [19]. Adopting these approaches can better prepare students for future challenges and provide them with the necessary skills and knowledge to thrive.

Therefore, the purpose of this systematic review is to review the latest trends and research in multidisciplinary technological approaches in higher education with the following research question:

RQ: What are the benefits of multidisciplinary technological approaches in Higher Education?

2. Methodology

This section examines the method adopted to retrieve articles related to the topic of the implementation of multidisciplinary technological approaches in higher education. Two main databases, Scopus and Web of Science (WoS), were utilised for this purpose, and they are widely acknowledged as prominent databases within the field of systematic review due to their extensive coverage and advanced search functionalities. While using two databases may limit the comprehensiveness of a literature search compared to a more extensive search across multiple databases, these databases were chosen based on their comprehensive coverage, advanced search capabilities, multidisciplinary focus, and reliability of the results. Guided by PRISMA, this research encompasses three primary stages: identification, screening, and inclusion, as shown in Figure 1.

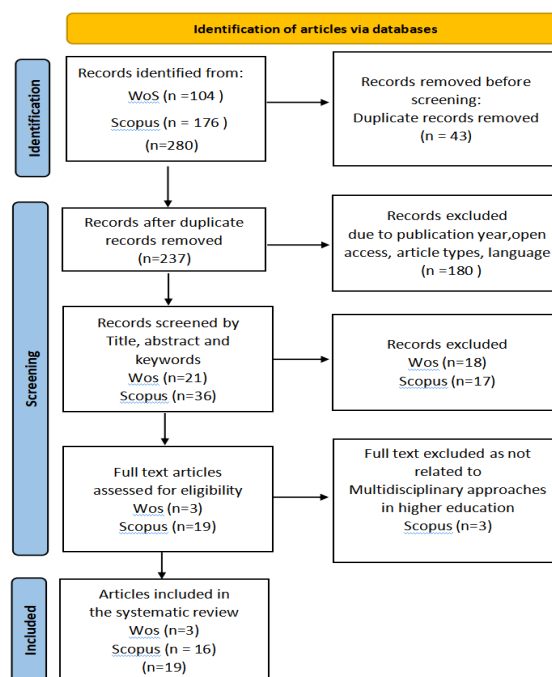


Fig. 1. PRISMA application flow chart

3.1 Identification

The initial stage, identification, involves examining related terms, synonyms, and forms for the primary research keywords, namely "multidisciplinary approaches" and "higher education." This stage

aims to provide supplementary choices for the designated database to obtain more pertinent articles for inclusion in the comprehensive assessment. This procedure relied on previously utilised keywords, an internet-based thesaurus, and keywords recommended by the selected two databases.

In addition, boolean operators such as "AND" and "OR", along with phrase searching and double quotation marks and asterisks, are employed on the Scopus and Web of Science databases to enhance the existing keywords and generate a comprehensive search string. To initiate the preliminary literature research, a predefined sequence of search strings is entered into both databases. The keywords utilised in this process are selected based on their similarity or association with multidisciplinary technological approaches and higher education, as specified in Table 1. The search string employed in the first phase of the systematic review yielded 280 articles from the search process conducted on Scopus and Web of Science.

Table 1

The search string used in the first stage of the systematic review

Database	Search String used
Scopus	TITLE-ABS-KEY (("multidisciplinary approach*" OR "interdisciplinary approach*" OR "cross-disciplinary approach*" OR "transdisciplinary approach*" OR "multidisciplinary method*" OR "interdisciplinary method*" OR "cross-disciplinary method*" OR "transdisciplinary method*" OR "multidisciplinary strategy*" OR "interdisciplinary strategy*" OR "cross-disciplinary strategy*" OR "transdisciplinary strategy*") AND ("technological" OR "high-tech") AND ("method*" OR "approach*" OR "strategy*") AND ("higher education" OR "higher education institution*" OR " university*" OR "college*" OR "higher learning"))
Web of Science	TS= (("multidisciplinary approach*" OR "interdisciplinary approach*" OR "cross-disciplinary approach*" OR "transdisciplinary approach*" OR "multidisciplinary method*" OR "interdisciplinary method*" OR "cross-disciplinary method*" OR "transdisciplinary method*" OR "multidisciplinary strategy*" OR "interdisciplinary strategy*" OR "cross-disciplinary strategy*" OR "transdisciplinary strategy*") AND ("technological" OR "high-tech") AND ("higher education" OR "higher education institution*" OR " university*" OR "college*" OR "higher learning"))

2.2 Screening

Upon identification of the articles, the screening process ensues. The initial step in this stage involves excluding duplicate articles that appeared in more than one database. As a result of the initial screening step, 43 duplicate articles were eliminated, leaving 237 articles deemed eligible for further screening.

More importantly, the flow chart illustrates the inclusion and exclusion criteria adopted in screening literature, as shown in Table 2. To manage many articles and ensure no important, relevant documents were missed in the screening process, the article selection criteria were applied to all literature without duplicates and automatically sorted on the two chosen databases.

Only articles that genuinely met the criterion were included in the following steps. These remaining 237 articles were examined based on publication year, article types, language, and open access status. More specifically, the inclusion criteria involved articles published in the last ten years, indicating the period from 2014 to 2023. Following this first screening step, 43 articles were eliminated, leaving 237 articles that met the criteria for further screening. These 237 articles were also screened through their article types. Books or chapters in books, review articles and conference papers did not meet the inclusion criteria in this study.

Additionally, these articles went through a simple filtered process and were written in English to reduce the misunderstanding caused by the language barrier. Thus, articles that were written in

Spanish or Russian were excluded. Lastly, articles unrelated to multidisciplinary approaches in higher education and not openly accessible were all essential points for exclusion.

Table 2
 Inclusion and exclusion criteria

Criterion	Inclusion	Exclusion
Timeline	Between 2014 to 2023	Before 2014
Literature type	Journal article	Systematic reviews, books and book chapters, conference proceedings
Language	English	Non-English
Title, Abstract and Keywords	Related to multidisciplinary approach in higher education	Not related to the multidisciplinary approach in higher education
Accessibility	Full openly accessible	Not accessible

Consequently, 180 articles were excluded during this screening process, leaving 57 articles (21 from WoS and 36 from Scopus) to proceed to the subsequent screening phase. More importantly, during this stage, the titles, abstracts, and keywords of all the articles were thoroughly examined with the requirement that they should be relevant to the topic of multidisciplinary approaches in higher education and suitability for use in the present study to fulfil the research objectives. In light of this, 18 articles from WoS and 17 from Scopus were removed because they were not relevant to the aim of the study. Ultimately, 22 articles were deemed suitable for thorough examination through the full text. Following the final exclusion process, three articles from Scopus were removed due to their lack of relevance to the topic after carefully full-text reading by the author.

2.3 Included

The search results in the chosen databases revealed that, based on the table above, three articles were selected from WoS and sixteen from Scopus for the third stage, known as Included. The research objectives of the studies were all related to the application of cross- disciplinary methods in higher education, including universities and colleges. In a word, 19 articles were prepared for further research, displayed in the Appendix.

3. Results and Discussion

3.1 Application of Various Innovative Technologies and Interdisciplinary Integration

All nineteen reviewed studies indicate the widespread application of innovative technologies in higher education to improve the quality of the educational process and enhance students' skills and abilities. These beneficial approaches aim to ensure the achievement of pedagogical goals and increase the effectiveness of the educational process.

Examples of such approaches include the use of web tools [12] or web-based approaches [12], and new information and communication technologies, such as virtual classrooms [15], for interdisciplinary collaboration and learning. Specific initiatives such as the STEM-TPACK website and STEMQuests [2] have been designed to promote students' interdisciplinary thinking and problem-solving skills. Additionally, TPACK Model, Information and Communication Technologies (ICT) [27], and recordings software technique analysis software [16] have been employed to realise educational innovation experience. Telecollaboration [8] has been implemented to cultivate students' learning autonomy and to reduce instructional monotony, while the Social Cognitive Theory [9] has been

utilised as an interdisciplinary framework. Moreover, practices involving the combination of technological advancements, cognitive technologies, and interdisciplinary approaches [13].

Other studies reveal the importance of providing courses involving collaboration among students with different majors [11,25,28], as well as the need for the integration of different fields, such as STEM education [20], STEAM education [23], which combines digital technologies and Arts-based methods, and urbanism education, merging disciplines of spatial planning, urban design, and landscape architecture [26], MILMESA education [14] integrating digital platforms and social networks, visual art education [18] and the hybridisation of communication faculties [24]. These researches highlight the significance of applying technology and interdisciplinary methods in higher learning, including the integration of language skills with technical knowledge to prepare students for the future professional job market [7,12]. However, such specific technological approaches are not explicitly mentioned.

To summarize, combining multidisciplinary approaches and innovative technologies in higher education provides several advantages, including improving the quality of education, fostering interdisciplinary skills, integrating theory with technology, facilitating collaboration among students from diverse fields, and preparing students for future career opportunities.

3.2 Different Focus of Study

However, the focus of each research is different, although they have some overlap or share some similarities, which are shown in Table 3. This table can compare and analyse the emphasis on other areas in multidisciplinary approaches across studies, summarising sustainability, student employability, complex thinking, pre-service teacher training, and teaching innovation. The first column represents the different focus of the studies, and the second one indicates the relevant articles. It can be seen that some studies focus on multiple areas, while others focus on only one aspect. Among these, teaching innovation and student employability are the most mentioned areas.

Table 3

Focus of study of the application of multidisciplinary approaches

Focus of Study	Study
Sustainability	[9][11]
Student Employability	[9][12][15][21][25][27]
Complex Thinking	[13][15]
Pre-service Teacher Training	[2][7][13][26]
Teaching Innovation	[8][9][11][13][14][15][16][20][21][23][27]

(1) Sustainability

The nineteen articles are based on the following: Though only two articles emphasise sustainable development in applying cross-disciplinary strategies in higher education, the importance of sustainability can not be denied.

As for the interpretation of sustainability, one of the studies [9] discusses the need for sustainable strategies that enable higher education institutions to adapt, evolve, and succeed in the long term. It defines sustainability as encompassing factors such as students' employability, technology education, and institutional developmental sustainability. Another study [11] It has defined sustainability as a multidimensional concept that necessitates interdisciplinary collaboration, international engagement, and the ability to address complex global challenges through integrated scientific approaches.

For the research focus, firstly, the purpose of the designed multidisciplinary course “Principles of Interdisciplinary Sustainability Research”, was to cultivate graduate students’ cross-disciplinary teamwork skills in the field of sustainability science to address complex sustainability issues, such as the threats to ecosystems and the economic and social well-being [11]. Comparatively, the sustainability problem discussed in another research [9] It was narrowed down to the survival problem of the universities. The results highlighted the importance of an interdisciplinary approach to solving complex issues and advancing sustainability in higher education enrollment. They creatively applied social cognitive theory to make a comprehensive analysis of whether various effective evaluation criteria of technical education and students' employability can improve the enrollment rates of the universities against the crisis of hyper-competitive and low birth rates.

In a word, it's believed that applying multidisciplinary technological strategies can promote sustainable development for society and the world globally and resolve the enrollment crisis in higher learning institutions.

(2) Student's Employability

Student employability is another focus regarding applying trans-disciplinary approaches from the perspectives of teachers and students. The findings of the six articles indicate the significance of teaching students skills that may prepare them for the competitive job market after graduation. One of the studies demonstrated a new training program that has encouraged students’ active participation and self-directed learning, allowing graduates to design, implement, and manage their social media for job placement and professional specialization [27].

Other academic research resupplied the multidisciplinary research with a detailed analysis of the interactive relationships among technology education, students’ employability, and higher education enrollment sustainability in the future [9]. The research results showed that, in higher learning institution selection, various methods are used, and multiple factors from different fields are explored, "poverty, unemployment, and educational equitability" are the three most significantly considered elements by students during their higher education institution selection process.

In addition, the importance of using cross-disciplinary methods is also stressed because students could develop integrated knowledge and skills that may benefit their professional future [12]. Furthermore, some scholars emphasised the importance of using a multidisciplinary approach in Information technology education to teach soft skills, such as communication, ethics, leadership, and customer relations, required for IT professionals and establish a diverse learning track to prepare them to enter the IT industry [25]. Likewise, the results in the other two articles [15][24]. Integrating multidisciplinary technological methods in higher education can promote graduates' educational, social, and work experience.

To sum up, the findings of the relevant articles implied that the implementation of cross-border technical methods has the advantage of enhancing students’ professionalism and their capability to find an ideal job after graduation.

(3) Complex Thinking

Two articles pointed out that the multidisciplinary technological approach is a process of complicated thought patterns. On the one hand, one of the research indicated that complex thinking refers to an interdisciplinary approach that integrates problem-solving skills, technology utilisation, and critical reflection to address real-world challenges effectively in educational settings. This study was developed within two subjects: Communication Technology (TAC) and Cultural Heritage

Education, and the need for renewed interest in culture and the need to seek a deep understanding of knowledge was highlighted [13]. Only an open and willing attitude to the plurality of academic and popular knowledge can develop complex ideas and contribute to the development of capable citizens. On the other hand, Vázquez-Parra and their co-workers [28] defined complex thinking as a cognitive skill that involves integrated analysis and synthesis of information with a systemic and critical perspective, enabling creative decision-making in the face of complex realities or challenges. They explained the topic in a more specific way. Since there were differentiated behaviours in the formation and development of complex thinking based on the student's discipline of study, complex thinking is a cognitive skill that focuses on comprehensive analysis and synthesis of information to make innovative decisions facing complex realities or challenges.

In short, complex thinking is deemed a transdisciplinary competence that emphasises in-depth and comprehensive knowledge acquisition at the educational level. By possessing such ability, students will be more competent in various missions or positions in daily life and the workplace.

(4) Pre-service Teacher Training

Other scholars paid more attention to implementing multidisciplinary technological methods to train students who intend to be teachers in the future and enhance their professional competencies instead of only focusing on students' learning outcomes.

One of the educational experiments indicated that the multidisciplinary work carried out in the Bachelor of Science in Education studies can evaluate the specific and transferable abilities of initial teacher training [13]. Similarly, pre-service education was emphasised for STEM education teachers [26]. In contrast, the experience of Indonesian pre-service teachers in designing Content Knowledge for Science, Technology Engineering, and Mathematics Technology Teaching (STEM-TPACK) learning websites was shared in other findings [2]. Furthermore, other researchers stated that EFL lecturers must constantly learn and improve their digital and technical skills [7].

(5) Teaching Innovation

Most of the articles reviewed emphasised the importance of educational innovation in multidisciplinary technological strategies. Thirteen articles highlighted the importance of innovation in education in different teaching activities and courses.

Researchers have different reasons for advocating the integration of different subjects in higher education. One researcher highlighted the need for interdisciplinary education methods to address urgent global sustainable development issues [11]. Another study focused on problem-solving and learning-centred methodologies in innovative university education, which aimed to promote the use of technological resources and digital materials [13].

When conducting urbanism education, which synthesises knowledge from different disciplines into coherent multiscale proposals, a teaching method called the Delft approach was applied [20]. This approach incorporated building types, urban open spaces, and landscape qualities, emphasising the relationship between research and design for urban development. Scholars concluded that interdisciplinary approaches in higher education enhance problem-solving skills, creativity, and critical thinking [23]. Some findings also emphasised student-oriented teaching practices and fostering student autonomy to address the challenges of university education during the COVID-19 pandemic [8]. In designing webinars for deaf students, researchers combined different fields of study to consider their learning styles and preferences [21].

Positive findings were revealed regarding e-innovation in teaching and learning, highlighting the importance of teachers' knowledge and skills in integrating technology effectively [27]. Educational e-innovation was proposed to facilitate progress in education, fostering critical vision and strategic thinking skills [9]. Technology, such as platforms, audio recordings, and motion technology analysis software, was also used to implement transdisciplinary hands-on activities [16]. Furthermore, digital transformation has led to versatile professional profiles incorporating humanistic and technical skills influenced by technological developments, emphasising a global vision and interdisciplinary approach.[24]. Similarly, Multiple studies reflect the urgent need for more significant technological interaction and interdisciplinary strategies in the higher education model [14,15,18].

All researchers of the selected articles have demonstrated the advantages of applying innovative techniques and interdisciplinary approaches. These methods enhance the overall education quality and foster the development of well-rounded and well-adjusted students. The practical implications of these technologies are evident in their facilitation of interdisciplinary collaboration and learning among students. They also underscore the importance of applying technology and interdisciplinary approaches in higher education, such as combining language skills with technical knowledge to prepare students for the professional job market of the future. For instance, by integrating ICT tools and resources, educators can create engaging and interactive learning experiences. This integration improves students' understanding of topics, promotes critical thinking, and enables them to use technology for learning effectively.

In addition, all studies focus differently on sustainability, student employability, complex thinking, pre-service teacher training, and teaching innovation. Some studies cover multiple areas, while others focus on one aspect, demonstrating the diverse interests of multidisciplinary approaches in higher education. This diversity underscores the practical benefits of these approaches, reassuring the audience about their relevance and effectiveness.

Teaching innovation and student employability were mentioned prominently, indicating recognition of the importance of innovative teaching methods to enhance the educational experience. The emphasis on sustainability reflects the recognition of addressing real-world environmental, social, and economic challenges through an interdisciplinary approach. The focus on student employability highlights the need for students to acquire the necessary skills for their future careers. Another essential theme identified in the review is that complex thinking is cultivated through a multidisciplinary approach that allows students to develop critical thinking and problem-solving skills. Pre-service teacher training is a crucial area where a multidisciplinary approach can improve the quality of teacher education programs and ensure that future educators are well-prepared and equipped with diverse skills and knowledge. Innovation in teaching is also highlighted as a theme to encourage innovative and creative teaching practices in higher education and to improve the overall quality of teaching and learning.

All in all, educational innovation plays a crucial role in multidisciplinary technological strategies in tertiary education. Integrating different subjects promotes problem-solving, critical thinking, creativity, learning-centred methodologies, and the utilisation of technological resources. In summary, the studies analysed reveal different emphases of multidisciplinary approaches in higher education. The table is a valuable tool for comparing and analysing research priorities. These aspects have been identified as key themes to demonstrate the benefits of a multidisciplinary technical approach in improving the quality of higher education and guiding future research and educational practice.

4. Conclusion

Based on the selected nineteen articles following the PRISMA methodology, this review focuses on multidisciplinary strategies in higher education. Studies prioritise various areas based on research objectives, highlighting their relevance and importance in specific contexts. Multidisciplinary technological approaches in higher education offer benefits such as improving education quality, fostering interdisciplinary skills, integrating theory with technology, facilitating collaboration, and preparing students for future careers. These approaches explore areas like sustainability, student employability, complex thinking, pre-service teacher training, and innovation in teaching and learning. These themes demonstrate the advantages of multidisciplinary technological approaches in enhancing higher education quality.

Overall, integrating multidisciplinary technological approaches in higher learning is a growing trend. More universities are embracing this field to enhance student learning experiences, develop practical skills, and ensure the quality of higher education.

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