

# The Effect of Classroom Environment on Student Satisfaction: A Cross-Cultural Comparison From the SDG 4 Perspective

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Received: Dec. 6, 2024    Accepted: Jan. 12, 2025    Online published: Jan. 20, 2025

doi:10.5296/jpag.v14i2S.22586

URL: <https://doi.org/10.5296/jpag.v14i2S.22586>

## **Abstract**

This study conducted a systematic literature review (SLR) according to established guidelines, and carefully reviewed 6 major databases based on relevant keywords using PRISMA 2020. The scope of the study focused on the impact of course environment on student satisfaction, and conducted a cross-cultural comparative analysis from the perspective of SDG4. The selected journal publications covered 2020 to 2024 to ensure an up-to-date overview of the academic field. Studies have shown that the new classroom environment has a significant impact on student satisfaction, and there are differences in different cultural backgrounds. The new classroom environment provides strategies for achieving SDG4 goals. In addition, educational development also faces many challenges, such as: unbalanced educational development and prominent educational equity. The impact of the teaching environment on student satisfaction has not been taken seriously, and students from different cultural backgrounds have different abilities to adapt to the new learning environment. This study provides a theoretical and practical basis for the relationship between classroom environment

and student satisfaction in cross-cultural comparisons from the perspective of SDG4.

**Keywords:** classroom environment, student satisfaction, cross-cultural comparison, cultural context, SDG4

## 1. Introduction

### *1.1 Background of the Study*

The global spread of the COVID-19 pandemic in early 2020 has triggered unprecedented changes in the field of education. UNESCO (2021) reported that at the peak of the pandemic, more than 90% of students worldwide were affected by school closures, a phenomenon that highlights the urgency of redefining and evaluating the classroom environment. In this context, the concept of classroom environment is no longer limited to traditional physical spaces. The pandemic has accelerated the digital transformation of the education sector, and distance education and hybrid learning models have rapidly become popular, expanding to a variety of learning environments including online and hybrid learning models (Hodges et al., 2020). Williamson et al. (2020) found that this transformation not only changed the way of teaching, but also profoundly affected students' learning experience and satisfaction. The COVID-19 pandemic has significantly changed the global education environment and has had a profound impact on student satisfaction and classroom experience (Fujii et al., 2022). Studies have shown that over time, students' adaptability and satisfaction with digital education have gradually increased, especially synchronous online and hybrid teaching models. These models can provide more interaction and immediate feedback to meet students' needs. However, the pandemic has also exposed inequalities in the education system, with students in low-income and rural areas facing more challenges in remote learning (Means and Neisler, 2021). Although virtual classrooms provide new opportunities for academic and social interaction, low international student engagement remains a problem (Tian et al., (2022). Innovative teaching methods such as artificial intelligence-assisted teaching and remote experiments have shown positive results in improving student engagement. In addition, the epidemic has promoted the digital transformation of the educational environment and improved the digital skills of teachers and students, but it has also highlighted the importance of educational equity issues (Zaidan and Ehsan, 2024). For example, a meta-analysis by Bond et al. (2021) found that students' interactions with teachers and classmates in online learning environments have changed significantly, which directly affects students' engagement and satisfaction. Overall, the COVID-19 pandemic has not only changed the classroom environment, but also promoted educational innovation, but how to ensure that all students have fair access to high-quality educational resources remains a key challenge.

In this new learning environment, the factors affecting student satisfaction have also changed. The research of Iglesias-Pradas et al. (2021) shows that in online learning environments, the availability of technology and the digital literacy of teachers have become key factors affecting student satisfaction.

In the context of globalization, cross-cultural comparative studies of educational issues have

become increasingly important. Yan et al. (2021) The online learning experiences of Chinese and British students during the pandemic were compared, and it was found that cultural factors significantly affected students' adaptation and satisfaction with the new learning environment. This cross-cultural perspective provides new insights into the impact of classroom environment on student satisfaction in different cultural contexts.

The United Nations Sustainable Development Goals (SDGs), especially SDG 4 (ensuring inclusive and equitable quality education), face new challenges and opportunities in the post-pandemic era. Schleicher (2020) believes that the pandemic has exacerbated educational inequality, but also provided opportunities for educational innovation. Understanding the impact of classroom environment on student satisfaction is crucial to promoting the realization of SDG 4 under the new normal.

### *1.2 Purpose of the Study*

The rapidly changing global education landscape requires us to re-examine the impact of classroom environment on student satisfaction. In particular, we need to gain in-depth understanding of the following aspects:

1.2.1 How New Classroom Environments (Including Online and Hybrid Modes) Affect Student Satisfaction

1.2.2 Whether This Impact Varies By Culture, Comparing the Acceptance and Preference of Students in Different Countries and Regions for New Learning Environments

1.2.3 How these findings can provide new perspectives and strategies for achieving Sustainable Development Goal 4 (quality education), assess the potential of new classroom environments in improving educational accessibility and inclusion, and explore how to use technological innovation to narrow the education gap, especially in underdeveloped regions.

By focusing on the latest research since 2020, this study aims to provide timely and valuable insights for optimizing current and future classroom environments, improving student satisfaction, and accelerating the achievement of Sustainable Development Goal 4. We will adopt a literature review method to fully grasp the emerging education trends and their impact.

In addition, this study will also consider the following aspects: the catalytic effect of the COVID-19 pandemic on the transformation of the education model and its long-term impact. Through this comprehensive study, we expect to provide strong support for building a more inclusive, efficient and satisfactory future education system, thereby making a positive contribution to the achievement of Sustainable Development Goal 4.

### *1.3 Research Hypotheses*

H1: New classroom environments (including online and hybrid modes) have a significant impact on student satisfaction.

H2: The impact of new classroom environments on student satisfaction varies significantly across cultures.

H3: The implementation of new classroom environments contributes to the achievement of SDG 4 (quality education).

#### *1.4 Research Significance*

##### 1.4.1 Theoretical Significance

This paper is based on the Transformative Learning Theory. Transformative Learning Theory is an educational theory proposed by Jack Mezirow in the late 1970s. The theory believes that learning is not only about acquiring knowledge, but also a process of changing personal views and behaviors (Mezirow,1991). It emphasizes that learners re-evaluate their assumptions and beliefs through reflection and critical thinking. The change process usually begins with a "disorienting dilemma", that is, an event or experience that challenges an individual's existing beliefs or assumptions. Transformative Learning Theory emphasizes the change in the worldview of learners caused by the learning environment. This study explores how different classroom environments (traditional, online, hybrid) promote students' transformative learning. This is closely related to the H1 hypothesis. This paper explores how technological interactivity and virtual classroom design promote students' critical thinking and self-reflection. Transformative Learning Theory can help explain how students from different cultural backgrounds experience the "disorienting dilemma" and how they adapt to the new learning environment through critical reflection. This reveals how culture affects students' adaptability and satisfaction. The H2 hypothesis of this paper involves cultural differences. Transformative Learning Theory emphasizes the transformative nature of learning, which is consistent with SDG The changes in the classroom environment promote transformative learning for students, thereby increasing student satisfaction and achieving educational equity.

This study expands the traditional theoretical framework of student satisfaction by integrating the characteristics of online and hybrid learning environments, and provides a new perspective for understanding student satisfaction in the digital age. Cross-cultural comparative analysis further reveals the important role of cultural factors in regulating the relationship between classroom environment and student satisfaction, enriching cultural theory in educational research. At the same time, this study establishes a theoretical connection between Sustainable Development Goal 4 (SDG 4) and student satisfaction, and constructs a new analytical framework for sustainable development education research.

In terms of theoretical contribution, this study examines Transformative Learning Theory in the context of cross-cultural comparison and SDG 4, which may expand the application of this theory in the global education field and provide broader inspiration for educational research and practice.

##### 1.4.2 Practical Significance

This study can provide educators with empirical evidence to help them design and implement more effective classroom environments, including traditional, online, and hybrid models. It can guide teachers on how to adjust teaching methods and strategies according to the needs of students from different cultural backgrounds. It can provide data support for education policy

makers to develop more inclusive and effective education policies. It can help decision makers make more informed decisions on resource allocation and education investment. This study can promote the understanding of the learning needs of students from different cultural backgrounds, help improve the design of international education programs and exchange activities, and provide guidance for teaching practices in multicultural education environments. It can provide ideas for educational technology developers to guide them to design educational tools and platforms that are more in line with student needs and cultural backgrounds, and help schools and educational institutions make more informed educational technology investment decisions. By optimizing the classroom environment, the student experience is improved, which directly improves students' learning satisfaction and learning outcomes, and helps students better adapt to different learning environments, especially in cross-cultural and international education contexts. SDG 4 goals are achieved, promoting educational equity and inclusion, and providing practical strategies and methods for achieving the Sustainable Development Goal of "quality education", especially in using new technologies to expand educational opportunities. Help teachers better understand and respond to the needs of students from different cultural backgrounds, and provide new training content for teacher professional development programs, especially in cross-cultural teaching and technology integration. Research can not only contribute to the academic community, but also provide valuable guidance for educational practitioners, policymakers and other stakeholders, thereby promoting substantial progress and innovation in the field of education.

### *1.5 Research Limitations*

The timeframe of the literature review is only 2020-2023 and the study may have overlooked some important earlier literature.

The study analyzed mainly English language literature, which may lead to language bias and overlook important research from non-English speaking countries.

The study focuses primarily on higher education and may not be fully applicable to other stages of education.

As a literature review, the study relies on secondary data and lacks direct empirical data support.

## **2. Method**

This paper follows the rigorous and unbiased screening process recommended by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses. A prisma flowchart was utilized to visualize the reasons for the inclusion and exclusion of literature. This review focuses on three questions: first, whether new classroom environments (both online and hybrid modes) have a significant impact on student satisfaction. Second, whether the impact of novel classroom environments on student satisfaction differs significantly across cultures. Third, whether the implementation of novel classroom environments significantly improves accessibility and inclusiveness of education, thus providing effective strategies for achieving SDG 4 (quality education). This paper will use a systematic literature review (SLR) research

methodology that relies on analyzing the literature to comprehensively address these questions. A systematic literature review is highly scientific and rigorous, ensures that the research process is transparent and repeatable, reduces bias through rigorous screening criteria, and provides comprehensive research coverage.

### **3. Findings and Screening**

The effect of classroom environment on student satisfaction was included in the database search. Scopus, Science Direct, ERIC (Educational Resources Information Center), Emerald, Taylor and Francis Group, and IEEE were used to search for potentially relevant articles.

There has been an increase in interest in research related to the effect of classroom environment on student satisfaction, which is driven by several factors, including the rapid development of educational technology, the increased demand for globalized education, the impact of the COVID-19 pandemic, and the growing concern about the quality of education and student experience (Ikram and Kenayathulla, 2022). However, for this study, studies conducted between 2020 and 2023 were selected. The researcher used different combinations of keywords while conducting the search, such as "classroom environment and student satisfaction and SDG4", "online learning and student satisfaction and SDG4", " hybrid learning and student satisfaction and SDG4", "blended learning and student satisfaction and SDG4","offline learning and student satisfaction and SDG4", "virtual classroom and student satisfaction and SDG4", "face-to-face teaching and student satisfaction and SDG4" and then downloaded the articles and prepared them for further scanning and collection. Specific inclusion criteria were used to exclude studies that were not relevant to the scope of the review. The following are the inclusion criteria for the study:

- i. Based on empirical research.
- ii. The research scope of the article is university
- iii. The population of the study is college students.
- iv. Article type is research article

At first, 129 articles were collected from the designated databases. Then a rigorous screening process was carried out based on the inclusion criteria to exclude 74 duplicate articles and 30 articles that did not meet the discriminatory criteria. Eventually, only 20 articles met the specified criteria, and the results are shown in Figure 1.

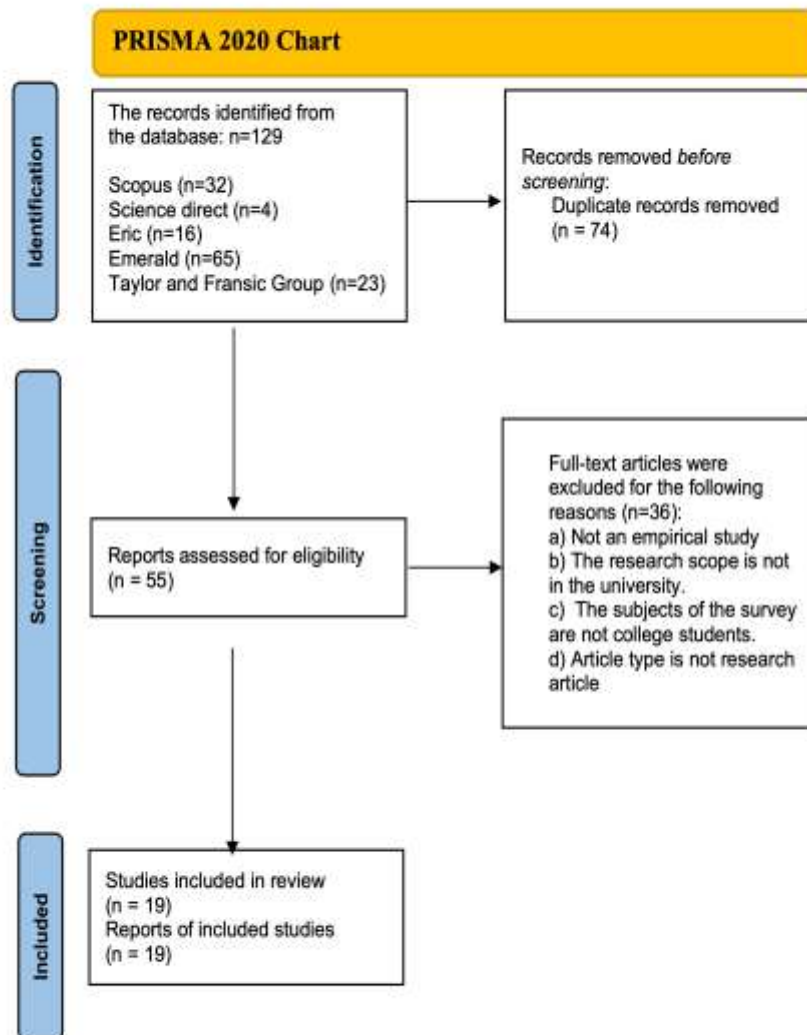


Figure 1. Research flowchart

Source: Adapted from Page et al (2021)

Table 1. Selected Summary of Literature

Num.	Articles	Research Objectives	Research Findings	Research Scope
1.	Fujii et al.(2022)	This study aimed to evaluate the differences in learning satisfaction among Japanese EFL (English as a Foreign Language) learners in synchronous online courses and asynchronous on-demand courses. The study explored three main factors: engaged learning, initiative, and evaluation to quantitatively analyze learner satisfaction. In addition, the study also analyzed students' perceptions of the online courses they attended through qualitative text mining.	The satisfaction of synchronous online courses in participatory learning and assessment was significantly higher than that of asynchronous on-demand courses, indicating that students were more satisfied with their learning in synchronous online courses. Qualitative analysis showed that the proportion of positive evaluations was higher in synchronous online courses compared with asynchronous on-demand courses. Overall, the study showed that synchronous online teaching could ensure higher satisfaction among Japanese EFL learners than asynchronous on-demand courses. The study also found that students' need for interactivity and immediate feedback was an important factor affecting their satisfaction.	Japan
2.	Andrew et al.(2021)	In the context of the mandatory shift to online learning during the COVID-19 pandemic, this study explores how to improve student engagement in synchronous virtual classes through teacher observation projects.	Although synchronous virtual classes provide more opportunities for students' academic and social interactions, there are still some challenges, especially in the context of quarantine. However, international students' participation is relatively low, and online interactions lack attractive social interactions.	Australia
3.	Busto et al.(2021)	This paper proposes and validates a simple and efficient hybrid teaching technology scheme to improve the teaching quality of university mathematics courses during the COVID-19 epidemic. The research focuses on how to teach under limited network bandwidth conditions, and secondly, how to transmit mathematical content, especially complex blackboard content, through high-quality online streaming, while supporting multimedia teacher-student	The hybrid teaching technology solution successfully achieved high-quality online mathematics course teaching, especially under the network bandwidth setting. At the same time, students and professors generally expressed satisfaction with the solution, believing that it significantly improved the teaching quality and student engagement during the epidemic. Students especially appreciated the flexibility brought by the solution and the	Italy



		interaction.	advantages of combining online and stimulating teaching.	
4.	Okoye et al.(2024)	Analyze the impact of digital education on future education and conduct comparative research based on student evaluation data on teaching. The research focuses on how digital technology affects the transformation of education models, especially its application in higher education, and analyzes the impact of disciplines, schools and time reduction on student learning performance and satisfaction.	Over time, students' satisfaction with digital education has increased significantly, especially during the epidemic, when students have gradually adapted to new ways of learning, and the widespread use of digital technology has enhanced their learning experience. There are differences in the evaluation of digital education by students of different disciplines, but overall, students' acceptance and satisfaction with digital education have increased year by year.	Mexico
5.	Tian et al.(2022)	The study evaluates the quality of undergraduate education provided by Chinese universities to international students, focusing on the students' learning experience. The study investigates and analyzes the characteristics of international students in three aspects: learning environment, academic engagement, and personal and academic development, explores the relationship between these factors, and provides suggestions for improving the quality of international student education in China.	International students' learning experience in Chinese universities showed positive effects overall, especially in core skills and Chinese language proficiency. However, some factors in the learning environment, such as teacher support, course organization, etc., were not satisfactory. In addition, students' satisfaction with the learning environment and learning challenges was generally low, especially in terms of interaction with Chinese teachers.	China
6.	Asad and Malik (2024)	By exploring the role of hybrid online teaching in promoting equality, equity and quality improvement in higher education in Pakistan, this study analyzes how this teaching method can promote students' collaborative learning and develop 21st century skills. The study pays special attention to how to promote the realization of Sustainable Development Goals (SDG 4) through teaching models and improve students' critical thinking, problem-solving skills and social constraints.	The hybrid online teaching model significantly improves students' critical thinking, problem-solving and collaboration skills, while promoting class learning, prevention and a high-quality learning environment. Students gain more from collaborative learning. This teaching method has great potential in higher education, promoting the achievement of SDG 4 goals, and enhancing global competitiveness and social responsibility.	Pakistan
7.	Geletu and Adige (2023)	The study explores the effectiveness of teaching, learning, research and innovation activities in the current	The introduction of research content helps students improve their in-depth learning, knowledge construction and	Austria

		University of Horeta. The study pays special attention to the role of these activities in improving the quality of higher education, innovation and student knowledge construction, and analyzes how teachers and researchers promote educational and social progress through the combination of research and teaching.	employability, but the integration of teaching, research and innovation activities has limited contribution to the promotion of innovation in technology, management and teaching methods. The shortcomings of researchers in the coordination and integration between research and teaching activities have led to the inability of these activities to fully reflect the improvement effect of education quality.	
8.	Grą̄eda et al. (2024)	This paper explores how the integration of artificial intelligence (AI) tools in art classrooms affects students' educational experience, focusing on analyzing students' perception of these AI tools and their emotional responses in AI-enhanced classrooms. Through eye tracking and facial expression analysis technology, the differences in students' emotional responses in AI-enhanced classrooms and traditional classrooms are compared.	With the application of AI tools in art classes, students' cognition of learning experience gradually improved. AI-enhanced classes significantly increased students' positive emotional responses and improved their emotional engagement, but had limited effects in managing and reducing negative emotions.	Bolivia
9.	Zaidan and Ehsan(2024)	Through a cross-national analysis of education trends in seven countries in the Middle East and North Africa (MENA) region during the COVID-19 pandemic, the impact of the pandemic on the implementation of the Sustainable Development Goal (SDG 4) "Quality Education" was explored. The study focused on analyzing the policy changes in education quality in various countries before and after the pandemic, especially the impact of factors such as government spending on education, resource inequality, digital exclusion, and gender inequality on education. .	There are significant differences among MENA countries in responding to educational challenges during the pandemic. With the exception of Egypt and Bahrain, most countries increased government education spending during the pandemic. However, digital exclusion and gender inequality remain major obstacles, especially for students from low-income families and rural areas who are severely affected by remote learning, leading to increased differences in education quality and learning outcomes. The study also pointed out the need to strengthen international cooperation in the post-pandemic era to bridge these gaps.	Seven countries in the Middle East and North Africa (MENA) region, including Bahrain, Turkey, Palestine, Egypt, Morocco, Sudan, and the West Bank and Gaza Strip of Pakistan
10.	Andreoni	Through the 2030 SDG game	The 2030 SDG game	U.K

	Richard (2024)	teaching tool, we explore the interconnectedness between the Sustainable Development Goals and promote interdisciplinary education. We hope to study the complex connections between the Sustainable Development Goals by simulating different world outcomes and guiding participants to think about the impact of social, economic and environmental actions. This teaching method is considered an effective tool to promote interdisciplinary learning and improve problem-solving skills.	significantly improved participants' understanding of the Sustainable Development Goals and promoted interdisciplinary discussions. Through the game experience, participants learned that individual actions have an important impact on global sustainability and recognized the necessity of multidisciplinary cooperation in solving complex sustainable development problems. The game successfully helped students develop critical thinking, teamwork and problem-solving skills.	
11.	Dvorková et al. (2021)	To explore aspects such as students' satisfaction with remote teaching, comparison with high-frequency teaching, perceived stress during remote teaching, and skill acquisition, with the aim of evaluating the effectiveness of emergency teaching measures in crisis situations.	Most students were satisfied with the emergency remote teaching, especially the communication and feedback quality of the teachers, the organization of the teaching, etc. However, students generally lacked interaction with teachers and classmates, especially classroom discussions and immediate feedback.	Czech Republic
12.	Dollinger et al. (2020)	To investigate the usage patterns and perceptions of third-party online learning support services among Australian university students, especially how students from different backgrounds use these services, and to explore the impact of these services on students' learning and success experiences, and to evaluate the effectiveness of these online support services in helping students overcome learning challenges, improve academic performance, and enhance self-confidence.	Most students have a positive attitude towards third-party online learning support services, especially for those who cannot access support during traditional campus hours. Research shows that providing flexible learning support plays an important role in promoting student success.	Australia
13.	Yeerum et al. (2022)	To develop and implement a Lab-at-Home (LAH) solution to meet the needs of remote chemistry laboratory teaching during the COVID-19 pandemic. The research specifically focuses on providing analytical chemistry laboratory courses to Thai undergraduates, using green chemistry methods for	The LAH program effectively helped students complete analytical chemistry experiments in a remote environment, and students showed high satisfaction with the experimental method. This method not only achieved the teaching objectives, but also promoted the education of	Thailand

		colorimetric analysis of iron content to support the Sustainable Development Goals (SDG 4 and SDG 12).	green chemistry. Students generally recognized its help in learning experimental skills. However, some students faced poor network connectivity in synchronous online classes.◦	
14.	Mihele (2021)	The study explores the balance between online teaching as a temporary solution and a future necessity during the COVID-19 pandemic. The study analyzes the challenges and opportunities of teachers and students in the Romanian higher education system in the process of switching to remote online teaching, especially how to promote the development of digital skills through online education, and the possibility of hybrid teaching models in the future.	Online teaching was initially just an emergency measure, but it has a long-term positive impact on the improvement of digital skills in higher education. The digital skills of teachers and students have been significantly improved, and online teaching has enhanced the need for innovative capabilities and creative educational methods.	Romania
15.	Berková et al. (2024)	This study aims to find out whether students consider non-formal education important and to determine which forms of extracurricular education they prefer.◦	Students believe that informal education is important and prefer digital education.◦	Czech Republic
16.	Peng et al. (2022)	This study aims to explore how to build a sustainable full-time learning environment from the perspective of nonlinear learning through students' views on active learning classrooms (ALCs). The study mainly analyzes the spatial design of these classrooms, students' experience in balanced learning, and how to optimize learning spaces to support a higher quality learning environment.	Most students were satisfied with the nonlinear learning experience in the active learning classroom, especially the flexible space design and humanized learning support facilities of the classroom had a positive impact on students' nonlinear learning. The study suggested optimizing classroom design and management to further improve the effectiveness of the classroom as a sustainable learning environment.	China
17.	Means and Neisler (2021)	To understand the perceptions and experiences of U.S. undergraduates in remote teaching and learning during the COVID-19 pandemic, with a particular focus on the challenges students face after their courses move online, the effectiveness of perceived teaching practices, and factors that influence course satisfaction among students from different backgrounds.	After the course moved online, students' overall satisfaction with the course dropped significantly, especially in terms of learning outcomes and opportunities for interaction. However, courses that included more effective online teaching practices, such as personalized feedback and the use of real-world examples, significantly increased student satisfaction. Low-income and	America

			minority students faced additional challenges, especially in terms of internet connectivity and hardware devices, which negatively impacted their learning.	
18.	Nguyen et al. (2024)	Identify the dimensions of higher education service quality and examine how service quality dimensions affect student satisfaction and student loyalty	Most of the five dimensions of higher education service quality have a positive impact on student satisfaction.	Vietnam
19.	Boyko et al. (2021)	The study explored the impact of blended learning on the quality of future teachers in Ukrainian higher education during the COVID-19 pandemic. The study analyzed how to develop the communication skills of future teachers through a combination of online and offline learning methods, and the effectiveness of these teaching modes during the pandemic.	The hybrid learning model is effective in cultivating teachers' communication skills during the COVID-19 epidemic. Students can better exercise their autonomy in online learning, and their practical skills are improved during the tour teaching. Although online teaching faces some technical challenges, students are generally satisfied with this model, especially during the epidemic isolation period, which greatly improves the quality of education.	Ukraine

#### 4. Discussion

In recent years, online education research around the world has revealed a series of important findings and trends, providing valuable insights for policy making and practice in higher education institutions.

First, in terms of teaching mode, research generally supports the advantages of synchronous online courses and blended teaching. Fujii et al. (2022) showed that synchronous online courses outperformed asynchronous on-demand courses in terms of student satisfaction and learning outcomes, especially in terms of engagement and assessment. The study further confirmed the effectiveness of the blended teaching model, especially in improving teaching quality, student engagement, and cultivating critical thinking and problem-solving skills. (Busto et al., 2021; Asad and Malik, 2024) These findings emphasize the importance of interactivity and immediate feedback in online education.

Second, the application of digital educational tools and innovative teaching methods has significantly improved the learning experience. Andreoni Richard (2024) showed the effectiveness of educational games in improving students' understanding of the Sustainable Development Goals, and Yeerum et al. (2022) demonstrated the feasibility of remote experimental teaching. In addition, the application of AI tools in art classes improves students' emotional engagement (Grájeda et al., 2024). These innovative methods not only enrich teaching content, but also cultivate students' interdisciplinary thinking and practical ability.

However, the research also reveals many challenges facing online education. The digital divide and educational equity issues are particularly prominent. As pointed out by studies in the Middle East and North Africa and the United States, low-income families, students in rural areas, and ethnic minority groups face more difficulties in remote learning. In addition, the low online participation of international students (Andrew et al., 2021) and the lack of interaction between students and teachers are also key issues that need to be addressed (Tian et al., 2022; Dvoráková et al., 2021).

Despite these challenges, research shows that students' acceptance and satisfaction with online education are generally on the rise. A longitudinal study in Mexico showed that students' evaluation of digital education improved year by year over time and with increased adaptability. Czech research also found that despite the problem of insufficient interaction, most students were satisfied with emergency remote teaching.

## **5. Conclusion**

The researchers adopted the literature review method of Tranfield et al. (2003) and conducted a literature review of 129 studies published between 2020 and 2024, exploring the impact of classroom environment on student satisfaction, with a special focus on cross-cultural comparison and the perspective of Sustainable Development Goal 4. Implementing a new classroom environment can significantly improve the accessibility and inclusiveness of education, especially in underdeveloped areas, thereby providing an effective strategy for achieving Sustainable Development Goal 4 (quality education). The results not only verified the important impact of new learning environments, cultural backgrounds and Sustainable Development Goals on student satisfaction, but also provided valuable experience for understanding and improving student experience in contemporary higher education. These findings are of great significance to the development of educational theory and the improvement of educational practice, and also point out the direction for future research, which is to strengthen teacher training, improve online teaching capabilities and digital literacy, improve online education infrastructure, narrow the digital divide, promote the integration of educational innovation and research, and strengthen international cooperation, especially in the post-epidemic era. Develop more effective online interaction and feedback mechanisms to improve student engagement. Pay attention to and solve the special challenges faced by special groups (such as international students and disadvantaged groups) in online education.

Overall, these findings provide a comprehensive perspective for higher education institutions to develop more effective and inclusive online education strategies and policies. They not only reveal the potential and advantages of online education, but also point out areas that need further improvement and research. With the continuous advancement of technology and the innovation of educational concepts, online education will continue to evolve to provide learners with a more personalized, flexible and effective educational experience.

## **6. Future Research Directions**

In order to promote cross-cultural comparative classroom environment and student

satisfaction research from the perspective of Sustainable Development Goal 4, future research should focus on the following directions: expand the scope of cultural comparison and conduct longitudinal research to capture long-term trends; adopt mixed research methods and big data analysis to increase the depth and breadth of research; explore the impact of emerging technologies such as artificial intelligence and virtual reality on learning experience;

In terms of digital infrastructure and technology access, digital infrastructure in underdeveloped areas should be developed, community learning centers equipped with necessary technology should be established, and equipment loan programs and subsidized purchase programs should be established to provide necessary learning equipment support for low-income students. In terms of teaching and learning support, educators need to be provided with comprehensive digital literacy training, peer tutoring programs for online learning environments should be implemented, multilingual technical support services should be created, and adaptive learning systems that adapt to different learning styles should be developed. In terms of cultural integration and accessibility, educational institutions should develop culturally responsive course materials, create multilingual content and resources, and incorporate multicultural perspectives into course cases. In terms of financial support and resource allocation, need-based technology grants should be established, special scholarship programs should be created for disadvantaged students, and flexible payment plans for course fees should be developed.

In addition, database limitations, language bias, time constraints, keyword limitations, lack of quantitative primary data analysis, and limited understanding of causal relationships are some limitations of this study. Future research avenues include multi-database analysis, mixed methodology.

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