Applying Universal Design for Learning and its Impact on Teaching Quality

A Case Study of Business Administration Students at Tabuk University

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Abstract: This study investigates the integration of Universal Design for Learning (UDL) principles in inclusive education, particularly how teaching quality dimensions, student perception, and emerging technologies interact within this framework. Using structural equation modeling (SEM) through AMOS software, data from 167 students were analyzed to identify significant relationships. The results demonstrated strong, positive associations between emerging technologies and teaching quality, reinforcing the idea that modern digital tools can enhance pedagogical effectiveness. Additionally, a notable negative relationship between technological barriers and student perception of teaching quality was identified, indicating that obstacles such as unreliable internet or digital tool malfunctions can significantly hinder the learning experience. These findings align with recent literature, supporting the notion that addressing technological barriers is essential for the successful implementation of UDL in fostering an inclusive educational environment. This research contributes to the broader discussion on how UDL, when supported by emerging technologies and free from technical barriers, can improve teaching practices and student outcomes in diverse learning contexts.

INTRODUCTION

In the context of rapidly evolving higher education systems, Universal Design for Learning (UDL) has emerged as one of the most flexible and inclusive approaches to support student diversity and enhance teaching quality.

UDL aims to create a learning environment that accommodates the needs of all students, regardless of their differences or educational challenges, by offering multiple means of representing content, expressing understanding, and engaging actively in the learning process [1-2].

During the global COVID-19 pandemic, the effectiveness of UDL in supporting online learning was validated, as it helped improve the student experience by providing flexible content that could be revisited and fostering dynamic interactions with the learning material. Studies have shown that UDL-focused professional development for teachers significantly enhances inclusive teaching quality in higher education institutions, helping educators adapt to diverse student needs [3,4,5].

The University of Tabuk is a prime example of implementing inclusive online education, with its Blackboard platform offering dedicated services to support students with special needs. However, there remains a need to evaluate the effectiveness of this application and its impact on teaching quality in an online environment. This study aims to explore the extent to which UDL principles are applied at the University of Tabuk and their impact on teaching quality, through an investigation of student and faculty experiences, and an analysis of strategies to enhance inclusivity in higher education.

Despite the significant progress made in adopting e-learning in universities, the key challenge remains ensuring that these online environments are inclusive of all students, particularly through the application of UDL principles[6]. In this context, the study poses the following questions: How effectively are UDL principles applied in the University of Tabuk? What is the impact of this application on teaching quality in an online setting? Furthermore, the study addresses the challenges faced by faculty and students in applying UDL principles and explores ways to improve the e-learning experience at the university to ensure greater inclusivity.

In response to these questions, the study reviews relevant literature on the application of UDL in higher education, followed by a detailed examination of the methodology employed to collect and analyze data on UDL implementation at the University of Tabuk. Finally, the results are presented, along with recommendations on improving the application of these principles to enhance teaching quality.

Globally, the application of Universal Design for Learning (UDL) has continued to gain momentum, as educational institutions recognize its potential to create more inclusive learning environments. By addressing the diverse needs of students, UDL has transformed how educators approach teaching, moving beyond a one-size-fits-all model to offer personalized, adaptable learning experiences. Studies from the United States, Canada, and Europe demonstrate that UDL implementation enhances student engagement, retention, and academic performance by making learning accessible to all students, regardless of their abilities or learning styles [8-9].

Furthermore, countries such as Finland and Australia have integrated UDL principles into their national education policies, fostering a more equitable and accessible education system for all students [9-10].

MATERIALS AND METHODS

Literature of Review

This literature review aims to explore the global application of Universal Design for Learning (UDL), its role in higher education, and its impact on teaching quality. The review will also address challenges faced by institutions in adopting UDL and examine strategies for overcoming these obstacles. By analyzing studies from the United States, Canada, Australia, and other regions, the review seeks to provide a comprehensive understanding of UDL's effectiveness and offer insights into its future potential in improving inclusive education and teaching practices.

In recent years, the implementation of Universal Design for Learning (UDL) in higher education has gained considerable attention as a method to foster inclusivity and improve teaching quality. However, challenges persist in fully adopting UDL principles across diverse educational contexts, particularly in adapting teaching practices to accommodate varied learning needs. Despite its potential, limited empirical evidence exists on the effective integration of UDL in online and hybrid learning environments within higher education, especially in non-Western educational systems [5-8]. This study aims to address this gap by examining the application of UDL principles in higher education institutions, focusing on both faculty and student perspectives.

History and Development of UDL:

The concept of Universal Design for Learning (UDL) emerged from the broader philosophy of Universal Design (UD) in architecture, which sought to create spaces and products accessible to everyone, regardless of their physical abilities or limitations. In the 1990s, David Rose and his colleagues at CAST (Center for Applied Special Technology) adapted this principle to education, recognizing that many students face similar barriers to learning. UDL was thus developed to promote flexibility in how educational content is delivered, assessed, and engaged with, making learning accessible to all students regardless of their abilities or challenges [11].

Studies from countries like the United States and Canada show that implementing UDL has not only benefited students with disabilities but also the general student population by promoting active engagement and catering to different learning styles [8]. As educational environments become more diverse, the adoption of UDL has played a crucial role in making learning more inclusive and accessible. However, the success of UDL is not just about accessibility; it represents an innovative approach to pedagogy that enhances teaching quality for all students [12].

Universal Design for Learning (UDL) originates from the broader philosophy of Universal Design in architecture, which aimed to create spaces and products accessible to everyone, regardless of physical abilities or limitations. In the 1990s, David Rose and his colleagues at the Center for Applied Special Technology (CAST) adapted this principle to education, recognizing that many students encounter similar barriers to learning. UDL was developed to enhance flexibility in how educational content is delivered, assessed, and engaged with,

making learning accessible to all students regardless of their abilities or challenges (CAST, 2018).

UDL revolves around three core principles:

• Multiple Means of Representation: Providing content in different formats such as text, visuals, and audio.

• Multiple Means of Action and Expression: Allowing students to demonstrate their knowledge in various ways, such as through written assignments, presentations, or projects.

• Multiple Means of Engagement: Offering diverse options to engage students in the learning process based on their interests and motivations.

Research from regions like the United States and Canada illustrates that implementing UDL not only benefits students with disabilities but also enhances the educational experience for the general student population by promoting active engagement and accommodating diverse learning styles [8]. As educational environments become increasingly diverse, the adoption of UDL plays a pivotal role in making education more inclusive and accessible. Moreover, UDL represents an innovative pedagogical approach that improves the quality of teaching for all students[12].

Application of UDL in Higher Education:

In higher education, UDL has gained traction as institutions seek to meet the needs of increasingly diverse student populations. Research from Australia, Finland, and North America highlights how universities have successfully integrated UDL into their teaching practices, with positive outcomes in terms of student engagement, retention, and academic achievement. For example, UDL has been shown to significantly improve retention rates among students in courses where its principles were applied, as demonstrated in a recent study by Espada & all [8]. Additionally, national education policies in countries like Finland and Australia have embraced UDL as a means of enhancing equity and inclusivity across all levels of higher education, ensuring that all students have equal access to quality education [8].

Despite its benefits, implementing UDL in higher education poses several challenges. Many institutions face obstacles such as limited resources, lack of faculty training, and resistance to change. Faculty members often require comprehensive training and support to apply UDL effectively in their teaching. Additionally, the adoption of UDL necessitates a cultural shift within institutions, focusing on inclusivity and flexibility rather than traditional teaching methods [9].

The COVID-19 pandemic has further highlighted the significance of Universal Design for Learning (UDL) in online education, emphasizing the need for flexibility and inclusivity to support student success. UDL's framework promotes various means of content representation, interaction, and expression, making it particularly effective for both online and hybrid learning environments[13]. For instance, the NSF-REU STEM program, redesigned with UDL principles during the pandemic, demonstrated how flexible learning opportunities, including recorded lectures and asynchronous participation,

enhanced engagement and accommodated students with varying needs, including those with disabilities . This flexibility has proven essential in helping students succeed in the challenging environment posed by online learning during the pandemic [14]. In Saudi Arabia, the adoption of UDL principles is evident in institutions like the University of Tabuk, which uses platforms such as Blackboard to support inclusive education. The platform's tools for assisting students with disabilities, such as customizable learning materials and various means of content representation, reflect a growing commitment to applying UDL principles to create a more equitable learning environment [15]. As Saudi Arabia continues to prioritize inclusive education, the integration of UDL frameworks across its higher education institutions will be key to ensuring that diverse student needs are met in both online and traditional learning settings[16].

UDL's Impact on Teaching Quality:

Universal Design for Learning (UDL) has fundamentally reshaped the way educators think about teaching quality by promoting an inclusive, student-centered approach to education. Traditional teaching methods often assume that all students learn in the same way, which can alienate those with different learning styles or abilities. UDL shifts this dynamic by emphasizing flexibility in teaching methods, content delivery, and assessment strategies.

Research by Singleton et al (2019) demonstrates that UDL leads to improved student engagement and retention, as it allows for multiple forms of content representation (visual, auditory, textual), ensuring that all students can access and process information in a way that suits their individual needs [17]. This is particularly significant in higher education, where diverse student populations are the norm. By embracing UDL, educators can create more engaging and equitable learning environments that cater to all students, not just those with disabilities. Moreover, the study by Rusconi & Squillaci (2023) highlights that UDL does not only benefit students but also improves the pedagogical competencies of educators [18]. By training teachers to develop more inclusive lesson plans and assessment methods, UDL fosters a deeper understanding of diverse learning needs and encourages continuous professional growth. In this sense, UDL is transformative because it promotes a culture of ongoing reflection and adaptation, where educators are empowered to refine their teaching practices continuously.

We believe that UDL's true strength lies in its capacity to foster teaching innovation. As educators become more aware of diverse student needs and are equipped with tools to address these needs, they can provide more personalized learning experiences. This, in turn, elevates the overall quality of teaching by making it more responsive, dynamic, and inclusive.

Challenges in Implementing UDL:

While the theoretical benefits of UDL are clear, its implementation presents numerous practical challenges. The most prominent issue is the lack of adequate faculty training. Many educators are unfamiliar with UDL principles, and even those who may struggle to integrate them into their teaching without

proper support. This creates a significant gap between UDL's potential and its actual application in higher education settings.

For example, Singleton et al (2019) points out that institutions often fail to provide comprehensive training programs that help faculty adopt UDL[17]. As a result, educators may resist adopting UDL because they perceive it as a burden that adds complexity to their teaching practices without clear benefits. This resistance is further compounded by the institutional inertia that often accompanies attempts to implement new teaching models. Faculty members who are accustomed to traditional teaching methods may be reluctant to shift toward a more inclusive, flexible approach, especially if they do not fully understand its advantages.

In addition, Hromalik et al. (2023) explored the challenges of UDL implementation in online education, where the need for technological infrastructure and leadership support becomes even more critical [19]. They found that many institutions lack the necessary digital tools to fully realize UDL's potential in online learning environments, and this technological gap can limit the effectiveness of UDL. Additionally, the success of UDL implementation depends heavily on the institution's leadership and their commitment to fostering a culture of inclusivity.

We believe that addressing these challenges requires a multi-level approach. At the institutional level, there must be a commitment to investing in faculty development and providing the necessary resources to support UDL. This includes not only training but also ongoing support, such as mentorship programs and access to instructional designers who can help faculty integrate UDL principles into their courses. On a broader scale, there needs to be a shift in institutional culture, where inclusivity is seen as a core value that permeates all aspects of the educational experience.

Despite the numerous challenges that hinder the implementation of UDL, the emergence of modern technologies presents promising solutions to enhance the effectiveness of this approach in higher education. With the growing use of artificial intelligence and interactive technologies like virtual reality, these challenges can be transformed into opportunities for growth and innovation.

The Future of UDL in Higher Education:

Looking ahead, the future of UDL is intrinsically linked to the evolving landscape of educational technology. Emerging technologies such as artificial intelligence (AI), virtual reality (VR), and adaptive learning platforms have the potential to revolutionize how UDL is implemented in higher education. These technologies allow for more personalized learning experiences by adapting content delivery and assessment methods to meet the individual needs of students in real-time.

For instance, AI-driven platforms can analyze a student's learning patterns and suggest tailored resources or activities to enhance their understanding of a subject. This aligns perfectly with UDL's core principle of providing multiple means of engagement, as it ensures that each student can interact with the content in a way that suits their unique learning style. Similarly, VR can create

immersive learning experiences that make abstract concepts more tangible, thereby enhancing student engagement and retention. Rusconi & Squillaci (2023) emphasize that integrating these technologies with UDL principles will be key to ensuring that UDL remains relevant and effective in the future[18]. As higher education continues to embrace online and hybrid learning models, UDL will play a crucial role in making these digital environments more inclusive and accessible to all students.

The future of UDL holds immense promise, but its success will depend on how well institutions embrace technological innovations while maintaining a focus on equity and accessibility. We believe that institutions that invest in both technological infrastructure and faculty development will lead the way in creating truly inclusive learning environments. However, it is essential to ensure that these technologies are accessible to all students, including those from underserved communities who may not have the same access to digital tools.

The effectiveness of UDL can be significantly influenced by cultural and social factors. Differences in cultural contexts can impact the reception and implementation of UDL principles, necessitating adaptations to suit various educational systems and maximize benefits [20].

The Future of UDL in Higher Education: Harnessing Emerging Technologies

Emerging technologies, such as artificial intelligence (AI), virtual reality (VR), and adaptive learning platforms, hold immense potential to revolutionize the implementation of Universal Design for Learning (UDL) in higher education. These technologies provide innovative ways to enhance personalization, making learning more inclusive by allowing real-time adaptation of content and assessments based on individual student needs [18].

AI-driven systems can track students' progress and learning preferences, offering tailored resources and personalized feedback. Such systems can help educators identify students who may need additional support or adjustments in their learning environment, aligning perfectly with UDL's goal of making learning accessible to all [21].

Virtual reality (VR) brings learning experiences to life, particularly for students who may struggle with traditional learning methods. By immersing students in virtual environments, VR can break down barriers to understanding complex concepts and provide diverse ways of engaging with course material. This aligns with UDL's principles of offering multiple means of representation and engagement, thereby catering to different learning styles [22].

Additionally, adaptive learning platforms powered by AI enable the continuous adjustment of learning pathways based on individual progress. These platforms can create custom experiences for students, ensuring that each learner engages with the content in the most effective way for their unique abilities and preferences [23].

However, while the promise of these technologies is immense, challenges remain. Ensuring equitable access to these tools, particularly for underserved students, will be crucial for institutions aiming to harness the full potential of

emerging technologies in implementing UDL [24]. Investment in infrastructure, as well as training faculty to effectively use these technologies, will be essential for the successful integration of these tools into the learning process.

In conclusion, the future of UDL in higher education is intrinsically linked to the effective use of emerging technologies. By embracing AI, VR, and adaptive learning platforms, institutions can create more inclusive, engaging, and responsive learning environments, ensuring that the diverse needs of all students are met.

Development of Hypotheses

The development of the hypotheses in this study is grounded in a review of existing literature on Universal Design for Learning (UDL), particularly its impact on teaching quality, inclusivity, and the use of emerging technologies to overcome barriers in education.

UDL's Impact on Teaching Quality

Numerous studies demonstrate the positive effects of UDL on teaching quality by enhancing student engagement, retention, and academic performance. For instance, research conducted in the United States, Canada, and Europe has shown that UDL principles—such as offering multiple means of representation, engagement, and expression—significantly improve students' learning outcomes, making education more inclusive and effective for diverse learners [2]. However, these studies often focus on short-term impacts and do not provide in-depth insights into the long-term effects of UDL on teaching quality, especially in non-Western educational contexts. Hence, this study hypothesizes that:

Hypothesis 1: The implementation of UDL at the University of Tabuk significantly enhances teaching quality by increasing student engagement, retention, and academic performance.

Barriers to UDL Implementation:

Faculty Readiness and Resource Availability While UDL is widely recognized as a flexible framework for inclusive education, its successful implementation often encounters significant barriers, particularly related to faculty readiness and resource availability [17-19]. Many educators are unfamiliar with UDL principles, and institutional support for UDL implementation—especially in terms of providing adequate resources and professional development opportunities—varies greatly across higher education institutions. In Saudi Arabia, the challenges of implementing UDL are further compounded by cultural and institutional factors, which create additional resistance to adopting these inclusive practices. To address these issues, this study posits:

Hypothesis 2: UDL implementation at the University of Tabuk faces barriers related to faculty readiness and access to resources, limiting its overall impact on inclusive education practices.

Emerging Technologies as Facilitators for UDL

Implementation Emerging technologies such as artificial intelligence (AI), virtual reality (VR), and adaptive learning platforms offer promising solutions to overcome traditional barriers in implementing UDL. AI systems, for instance,

can provide personalized learning experiences by tracking students' progress and offering tailored resources, while VR can offer immersive learning experiences that appeal to diverse learning all [21-22]. However, despite the potential of these technologies, limited empirical evidence exists regarding their specific role in enhancing UDL's effectiveness, especially in higher education institutions that face resistance to change. Therefore, this study explores the extent to which emerging technologies can facilitate UDL implementation, hypothesizing that:

Hypothesis 3: The application of emerging technologies (e.g., artificial intelligence and virtual reality) within UDL frameworks at the University of Tabuk contributes to overcoming traditional barriers of implementation, such as faculty resistance and accessibility issues.

Student Perceptions of UDL

While UDL is intended to benefit all students by accommodating diverse learning needs, previous research has not sufficiently addressed how students' prior experiences and technological exposure might influence their perceptions of UDL. Studies suggest that students who are familiar with digital learning environments or have higher technological literacy tend to benefit more from UDL frameworks, whereas students with limited technological access or experience may face difficulties in fully engaging with UDL's digital components [15-14]. To further investigate these individual differences, this study proposes:

Hypothesis 4: Students' perceptions of UDL-driven teaching methods vary significantly based on their prior educational experiences and exposure to technology, affecting the perceived effectiveness of UDL in enhancing teaching quality.

METHODOLOGY

This section outlines the research design, sampling method, data collection procedures, and analysis techniques employed to examine the application of Universal Design for Learning (UDL) in higher education. The chosen methods are aimed at addressing the research hypotheses and ensuring a comprehensive understanding of the subject matter.

Research Design

This study employs a mixed-methods research design, combining both quantitative and qualitative approaches. This design facilitates a holistic exploration of UDL's impact on teaching quality by capturing measurable outcomes alongside more detailed personal insights [22]. The integration of both data types ensures a well-rounded understanding of UDL, where quantitative surveys assess specific improvements in teaching quality, and qualitative interviews explore the underlying reasons behind these results [26].

Sample and Participants

The sample consists of both faculty members and students from the University of Tabuk. Approximately 137 students and 30 faculty members from

diverse academic disciplines will participate in the study. The student sample will be selected through stratified random sampling, ensuring that students from various departments are represented to capture a broad spectrum of experiences with UDL (Flick, 2014) [27]. For faculty members, purposive sampling will be employed to target individuals with varying levels of familiarity with UDL, allowing for a comparative analysis of their insights based on their experience levels (Patton, 2015) [28]. In addition to the quantitative data, in-depth qualitative interviews will be conducted with 15 faculty members to further explore their perspectives on UDL implementation, the challenges they face, and their views on the resources available for supporting inclusive education.

Data Collection Methods

To collect data, two complementary tools will be utilized:

• Surveys: Separate questionnaires will be developed for students and faculty members. The student survey will measure perceptions of UDL's impact on their learning engagement, retention, and academic performance, while the faculty survey will focus on their experiences with UDL implementation and its effectiveness in enhancing teaching quality. The surveys will utilize a 5-point Likert scale to quantify these perceptions, supplemented by open-ended questions for more detailed feedback [29].

• Semi-Structured Interviews: In addition to surveys, semi-structured interviews will be conducted with 10 faculty members and 10 students to gain in-depth insights into their experiences with UDL. These interviews will explore themes such as barriers to UDL implementation, the role of technology in enhancing inclusivity, and suggestions for improving teaching quality [30].

This mixed-methods approach allows the research to benefit from the strengths of both quantitative and qualitative data collection, thereby addressing the research questions from multiple angles [31].

Data Analysis

The collected data will be analyzed using both quantitative and qualitative methods:

• Quantitative Analysis: Descriptive statistics, such as mean, median, and standard deviation, will be used to summarize the survey responses. Inferential statistics, including regression analysis and ANOVA, will be conducted to test relationships between the implementation of UDL (independent variable) and teaching quality (dependent variable) [32]. Additionally, Exploratory Factor Analysis (EFA) will identify underlying dimensions of UDL that most significantly contribute to improvements in teaching quality [33].

• Qualitative Analysis: The interview data will undergo thematic analysis to identify recurring themes related to the challenges and advantages of UDL. This process will be supported by NVivo software to assist in coding and categorizing the interview transcripts [34]. By combining these approaches, the study aims to uncover patterns and insights that are both statistically significant and personally meaningful to the participants [35].

Ethical Considerations

This research adheres to the ethical standards of the British Educational Research Association [36], ensuring that informed consent is obtained from all participants and that their confidentiality and anonymity are maintained throughout the study. Approval for the study was granted by the Institutional Review Board (IRB) of the University of Tabuk, and participants will be made aware of their right to withdraw from the study at any point.

RESULTS

Quantitative Analysis

Descriptive Analysis and Differences in Applying UDL Principles

The descriptive analysis of the data related to teaching quality, challenges associated with the application of Universal Design for Learning (UDL), and emerging technologies indicates that both students and faculty members generally agree on the positive benefits that UDL offers in improving the learning environment. The results showed that the averages related to the application of UDL on teaching quality ranged between 4.45 and 4.65 for students, reflecting a strong agreement that the use of these principles contributes effectively to enhancing teaching quality. Faculty members also showed close averages ranging from 4.40 to 4.57, indicating clear support for these principles. However, there are slight differences between the two groups regarding the challenges they face in applying UDL, with faculty members expressing some reservations about the available resources and support.

Regarding the challenges associated with applying UDL, certain variables showed statistically significant differences between students and faculty members. For instance, Barriers_Q1 (which measures challenges related to resources and support) revealed significant differences, with the average response of faculty members being 4.23 compared to 4.49 for students. This difference suggests that faculty members face greater challenges in accessing the necessary resources or support for effectively applying UDL principles. One factor that may explain these findings is the unavailability of internet in all classrooms. This is due to the isolation system used in the buildings, which can affect internet signal reception, leading to weak internet connectivity in many classrooms. Although faculty members heavily rely on emerging technologies in the educational process, the unavailability of the internet at certain times hinders their ability to access digital resources or use technological tools that are essential for applying UDL. This lack of consistent connectivity poses a challenge to fully and continuously implementing these technologies, which impacts the quality of the educational experience provided.

Additionally, Barriers_Q3 also showed statistically significant differences between the two groups, reinforcing the hypothesis that faculty members face greater challenges in dealing with the application of UDL. Although the differences between the averages were not very large (faculty members' average was 4.40 compared to students' 4.42), the results indicate the

existence of certain technical difficulties, such as the availability of infrastructure or specialized educational programs that facilitate the application of inclusive learning principles. These results emphasize the need to enhance efforts to support faculty members through intensive training programs and additional resources to bridge the gap between expectations and the actual application of these principles.

For example, Microsoft services, such as ClassPoint, which could play a significant role in supporting inclusive education through real-time student interaction with educational content, are not available in the version of Microsoft Office provided by the university. Despite the significant efforts made by the university in offering comprehensive training programs to support faculty members and enable them to apply UDL, some of these technical challenges still require additional attention to ensure a smooth and continuous application. For instance, relying on digital learning platforms without stable internet access poses a major challenge, and some specialized technological tools that require specific licenses may not always be available to faculty members, which could affect their ability to deliver content in an innovative and inclusive way.

In summary, these findings clearly show that there is strong alignment between students and faculty members regarding the benefits that UDL offers in enhancing teaching quality. However, the differences shown in some of the challenges highlight the gap between the groups in dealing with these principles, particularly concerning the availability of resources and support. Faculty members appear to need more support, both in terms of training and access to the necessary resources for effectively applying these principles. A key factor here is the impact of internet unavailability in some classrooms, which hinders the full utilization of emerging technologies and the digital resources necessary. Emerging technologies can play a more effective role in overcoming these challenges if the infrastructure for internet access in educational institutions is improved. Therefore, the main recommendation here is to strengthen partnerships between universities and providers of educational technology solutions to ensure a comprehensive educational environment that aligns with UDL principles.

Final Thoughts:

Based on the descriptive analysis and the comparison between students and faculty members, it can be concluded that the application of UDL principles requires continuous provision of resources and training for faculty members to reduce the challenges they face. Educational institutions should adopt strategies that leverage emerging technologies to facilitate the implementation of these principles. At the same time, the overall level of satisfaction with teaching quality remains high among both students and faculty members, which reinforces the importance of UDL in improving the educational process comprehensively.

Exploratory Analysis (Results and Their Relationship to Hypotheses)

Through exploratory factor analysis of the variables related to the implementation of Universal Design for Learning (UDL) and its impact on teaching quality, challenges in implementation, and the role of emerging technologies, several points can be drawn that support the hypotheses and highlight the differences between students and faculty members.

• Hypothesis 1: "Improving Teaching Quality Through UDL Implementation"

The results indicate a strong correlation between the variables related to teaching quality (Teaching Quality), with high factor loadings on the third factor (for example, TeachingQuality_Q1 = 0.781 and TeachingQuality_Q2 = 0.820). These findings support the first hypothesis that UDL implementation contributes to improving teaching quality for both groups: students and faculty members. By applying UDL principles, such as providing multiple means of learning and expression, student engagement and academic performance were enhanced, and faculty members were empowered to deliver a more inclusive educational experience.

• Hypothesis 2: "Challenges Related to Faculty Readiness and Resource Availability"

The results concerning challenges (Barriers) showed clear differences between students and faculty members. Although the factor loadings were high in both groups, the results indicate that faculty members face greater challenges related to the availability of resources necessary to implement UDL (e.g., Barriers_Q1 = 0.849 and Barriers_Q2 = 0.851). This reflects that challenges related to the availability of infrastructure and necessary technology are the main obstacles faced by faculty members compared to students. Sometimes, faculty members encounter issues related to the availability of internet access in classrooms or the inability to fully utilize technology, which supports the second hypothesis that UDL implementation faces challenges concerning resource readiness.

It's important to note that the university provides intensive training programs to support faculty members in applying UDL; however, certain technical challenges, such as the absence of services like ClassPoint or internet limitations in some classrooms, remain occasional obstacles. This underscores the need for further improving infrastructure and offering more comprehensive technological solutions.

• Hypothesis 3: "The Role of Emerging Technologies in Facilitating UDL Implementation"

The results related to emerging technologies show that both students and faculty members believe that modern technologies such as artificial intelligence (AI) and virtual reality (VR) play a significant role in facilitating UDL implementation (for example, EmergingTech_Q3 = 0.905 and EmergingTech_Q5 = 0.882). These technologies offer both students and faculty new ways to interact with educational content and personalize the learning experience to meet the needs of all learners. These findings support the third hypothesis, which states that emerging technologies help overcome traditional

barriers to UDL implementation and make the learning experience more inclusive and effective.

• Hypothesis 4: "Differences in Perceptions of UDL Among Students and Faculty Based on Their Prior Technological Experience"

The exploratory analysis revealed that perceptions of both students and faculty regarding UDL vary based on their prior experience with technology. Variables related to the perceptions of both groups (StudentPerception and TeachingQuality) showed strong correlations with the extracted factors, indicating that technological experience plays a role in determining the perceived effectiveness of UDL (e.g., StudentPerception_Q3 = 0.921 and StudentPerception_Q2 = 0.862). Both students and faculty members with prior experience using emerging technologies were more optimistic about the impact of UDL on enhancing education, compared to those with less experience.

The following chart illustrates the means and standard deviations of the various variables analyzed in this study, highlighting the differences between students and faculty members in their evaluation of teaching quality, the challenges associated with UDL implementation, the use of emerging technologies, and student perceptions. This visual representation helps to facilitate the understanding of the results and enhances the presentation of the data in a more engaging manner for readers.

The findings from the exploratory factor analysis clearly support all the hypotheses presented. UDL implementation has proven effective in improving teaching quality for both students and faculty members, although challenges remain regarding the availability of technological resources. Emerging technologies play a significant role in facilitating UDL implementation, highlighting the importance of further developing technological infrastructure at the university. Finally, the results reflect the varying perceptions between students and faculty regarding UDL based on their prior technological experience, emphasizing the need for continuous training for both groups to ensure the most effective application of these principles.

Confirmatory Analysis

First: Relationships Pertaining to the Hypotheses

1. Relationship between Emerging_Tech and Teaching_Quality (0.781)

This strong relationship (β = 0.781, p < 0.001) confirms the hypothesis that emerging technologies significantly enhance teaching quality. These findings align with recent studies that demonstrate how technological innovations improve student engagement and comprehension. For example, Zhao et al. (2022) [37] found that the integration of emerging technologies fosters a more interactive and flexible learning environment, ultimately leading to improved teaching quality.

2. Relationship between Teaching_Quality and Student_Perception (0.044)

The relationship between teaching quality and student perception was weak and statistically insignificant (p = 0.642). This suggests that improvements in teaching quality alone may not be sufficient to substantially change students' perceptions. Additional factors such as the learning environment or

more interactive methods may be needed. Wang et al. (2021) [38] support this perspective, stating that teaching quality must be complemented by other elements to significantly impact student perceptions.

3. Relationship between Barriers and Student_Perception (0.072)

Similarly, the relationship between barriers and student perception was weak (p = 0.279), indicating that barriers—whether technological or environmental—do not have a strong influence on how students perceive their education in this context. However, this does not entirely negate the impact of barriers on the student experience. Gkrimpizi et al. (2023) [39] found that technological barriers could have varying effects depending on the educational context.

4. Relationship between Emerging_Tech and Student_Perception (0.783)

This strong relationship (ß = 0.783, p < 0.001) confirms that emerging technologies significantly influence students' perceptions. Students exposed to such technologies tend to view their education as more positive and flexible. Almufarreh et al. (2023) [40] support this finding, showing that emerging technologies enhance student interaction and ease of access to information, thereby improving their overall educational experience.

Second: Analysis of the Newly Discovered Relationships

1. Relationship between e24 and e22 (0.629)

This strong relationship indicates a significant connection between students' perceptions of emerging technology and their overall educational experience. This supports the idea that technology directly affects how students perceive their educational journey as a whole. Cranfield et al. (2021) [41] similarly found that integrating modern technology into education enhances student satisfaction and the overall learning experience.

2. Relationship between e21 and e24 (0.370)

This moderate relationship suggests that improving teaching quality can have an indirect positive effect on student perceptions. While the direct impact may not be significant, it indicates that students' perceptions can be improved when teaching quality is coupled with other factors, such as the use of technology. Wang et al. (2021) [38] found similar results, noting that the combination of high teaching quality and technological integration positively impacts students' evaluation of their learning experiences.

3. Relationship between e14 and e15 (0.381)

The connection between teaching quality variables suggests that enhancing one aspect of teaching quality can lead to improvements in other areas. This holistic improvement of teaching quality can have a broader impact on the student experience. Garcia et al. (2023) [42] found that improvements in teaching methods often lead to overall enhancements in student outcomes, particularly when these improvements are implemented across different teaching dimensions simultaneously.

4. Relationship between e18 and e22 (0.618)

This strong relationship shows that emerging technologies play a key role in overcoming educational barriers. Technologies can help break down time and

space barriers that hinder student learning. Cranfield et al. (2021) [41] also concluded that emerging technologies mitigate the negative effects of various barriers in educational settings, leading to more equitable and accessible learning experiences.

The analysis reveals that emerging technologies significantly enhance both teaching quality and student perceptions, while barriers play a less prominent role in shaping these outcomes. The findings strongly support hypotheses related to the positive effects of technology, while highlighting the importance of complementary factors such as teaching methods and the learning environment in shaping student perceptions. The results underscore the pivotal role of technology in modern education, as supported by recent research, but suggest that further integration with other pedagogical approaches may be needed to achieve optimal outcomes.

Qualitative Analysis

Through the interviews conducted with faculty members at the University of Tabuk, a comprehensive picture emerged regarding the university's significant efforts to support Universal Design for Learning (UDL). It became clear that there is a strong awareness among faculty members about the importance of UDL and the need to adapt it to meet the diverse needs of students. At the same time, the university offers many training courses and workshops that focus on developing modern teaching skills, including how to use educational technology and active learning applications.

Participants mentioned that the courses provided by the university are advanced and cover current topics, helping faculty members stay up-to-date with the latest developments in educational technologies. These courses are not limited to training them on using modern technological tools but also enhance their skills in understanding students' needs and applying flexible strategies that suit different learning styles.

Some participants also pointed out that the university offers free Microsoft Office services to all faculty members and students, which supports the educational process. However, they indicated that some additional tools, such as Microsoft ClassPoint—an interactive educational tool that allows students to actively participate in lessons—are not available in the provided Office package as it is sold separately. This may result in faculty members missing out on the advantages of this tool, which supports UDL. ClassPoint helps enhance real-time interaction between students and instructors by integrating questions and surveys into presentations. Additionally, it improves the overall learning experience by actively engaging students and assessing their understanding of the material in a seamless and immediate way. Minor challenges related to the technical infrastructure in some classrooms were also mentioned, such as the lack of stable or continuous internet access in certain rooms due to the building's isolation system, which is a technical issue that could be improved.

Despite these significant efforts, there were some observations regarding the descriptions of certain courses. Some faculty members mentioned that the descriptions, which are established according to quality and accreditation

standards set by the National Center for Academic Accreditation and Evaluation (NCAAA), may need limited revision to provide greater flexibility, enabling them to apply more diverse strategies in UDL. This does not mean that the current courses do not align with modern educational principles, but there may be room for improvement in course descriptions to better fit the nature of UDL, giving faculty more freedom to introduce interactive methods.

It is worth noting that the university's commitment to quality and academic accreditation standards is an essential element in maintaining the quality of education provided. Therefore, this type of revision may be necessary to enhance the application of UDL without compromising the quality of education or accreditation standards. For instance, some courses may rely heavily on traditional teaching methods, such as theoretical lectures. While these methods are effective, they could benefit from the greater integration of interactive educational techniques.

In conclusion, despite some technical and infrastructural challenges that may hinder the widespread implementation of UDL, the general sentiment among faculty members is optimistic. With some adjustments to course descriptions and broader access to tools like ClassPoint, the university is well-positioned to enhance UDL practices. Faculty training programs, infrastructure improvements, and flexible curricula are all areas that can lead to greater success in implementing UDL.

DISCUSSION

Our analysis reveals strong and meaningful relationships between different dimensions of teaching quality, highlighting the interconnected nature of various instructional elements. Specifically, the positive correlation (r = 0.564) between different aspects of teaching quality, such as teacher interactivity and feedback clarity, demonstrates that improving one aspect of teaching can enhance the overall educational experience. This finding aligns with . Almufarreh et al. (2023) [40] who indicated that fostering student-teacher interaction positively influences other aspects like lesson clarity and feedback effectiveness. They affirmed also the synergy between these teaching dimensions, arguing that teachers who actively engage with students are better able to clarify complex topics and provide useful feedback. The strong relationship uncovered in our analysis suggests that in classrooms, focusing on one teaching quality can lead to broader improvements in instructional outcomes, thereby enhancing the overall learning environment.

In contrast, Cranfield et al. (2021) [41] found some dimensions, such as lesson clarity, to be relatively independent of student engagement, suggesting that certain instructional aspects may operate in silos. However, the differences in findings could be attributed to variances in sample populations and teaching methodologies. Our results emphasize the importance of a holistic approach to improving teaching quality, where enhancing one dimension, like

interactivity, cascades improvements across other areas of teaching effectiveness.

Turning to the relationship between technical barriers and student perceptions, the negative correlation ($r = -0.447$) underscores how technological difficulties can detract from the educational experience. When students face repeated technical issues, such as software malfunctions or poor connectivity, it hampers their ability to engage with the material, lowering their overall satisfaction. Gamage et al. (2022) [43] provided supporting evidence, indicating that unresolved technical barriers often lead to disengagement and dissatisfaction among students in online and hybrid learning environments. Similarly, Cranfield et al. (2021) [41] highlighted that technical issues significantly reduce student motivation, suggesting that technology disruptions, especially in online platforms, are critical barriers to successful learning.

However, some studies, such as Almufarreh et al. (2023) [40], suggest that certain students adapt more readily to technological issues, minimizing the impact on their learning. This variation in response could be due to different levels of technological support provided by institutions or the adaptability of students themselves. Nonetheless, our findings support the predominant view that technological barriers have a net negative effect on learning experiences, especially when not adequately addressed.

The strong correlation between various dimensions of technological barriers ($r = 0.618$) further supports the notion that one technical problem often leads to others. For instance, if students experience internet connectivity issues, this often prevents them from accessing other digital resources, compounding the problem. Gkrimpizi et al. (2023) [39], demonstrated similar findings, showing that technical problems are often interconnected, and resolving one issue does not necessarily solve the broader challenges students face. Cranfield et al. (2021) [41] similarly , however, found that some technical issues can be mitigated with appropriate technological interventions, although this does not appear to be the case in our analysis, where technical problems seem to be deeply intertwined.

Additionally, our analysis revealed a negative correlation ($r = -0.137$) between technical barriers and teaching quality, indicating that technical issues directly impede a teacher's ability to deliver high-quality instruction. This aligns with Cranfield et al. (2021) [36], who found that teachers struggle to maintain high teaching standards when they are consistently dealing with technical disruptions. Such issues not only affect the delivery of content but also disrupt the flow of lessons, thereby reducing the overall quality of education. While Garcia et al. (2023) [42] pointed out that some teachers may be able to navigate these challenges through alternative strategies, our findings indicate that, in general, technical barriers significantly reduce teaching effectiveness, particularly in tech-dependent environments.

Our personal analysis further extends these findings by acknowledging the critical need for integrating technological support into educational frameworks.

The interconnectedness of teaching quality dimensions suggests that institutions should not only focus on improving individual aspects of teaching but also adopt a more comprehensive approach to enhancing the entire learning experience. Likewise, addressing technical barriers should be a priority, as their cascading effects can detract from both student perceptions and teaching quality. Our study thus adds to the growing body of research advocating for more robust technological infrastructures in educational settings, particularly as more institutions adopt hybrid or fully online teaching models.

The strong positive relationship between e24 and e22 (r = 0.629) highlights the critical role that students' perceptions of emerging technologies play in shaping their overall educational experience. This finding aligns with prior studies indicating that as students perceive technologies like virtual learning platforms or digital tools positively, their engagement and satisfaction with learning improve. Zhao et al. (2022) [37] found that the integration of emerging technologies directly influences student satisfaction, while Wang et al. (2021) [38] emphasized that such technologies create more engaging and accessible learning experiences. From a Universal Design for Learning (UDL) perspective, these findings underscore the importance of leveraging technology to provide diverse means of engagement and representation, allowing students with varying needs to participate fully in the learning process. Our analysis confirms that technology, when perceived positively by students, plays a vital role in achieving inclusive education, as supported by Almufarreh et al. (2023) [40] in their findings on the complementary nature of technological and pedagogical approaches.

In examining the moderate relationship between teaching quality and students' perceptions (e21 ↔ e24, r = 0.370), it becomes evident that teaching quality enhances students' views of their educational experience. While teaching quality alone may not drastically change perceptions, its contribution, especially when paired with emerging technologies, has been acknowledged by scholars like Johnson et al. (2023), who found that high-quality teaching, when combined with technology, significantly improves student engagement and learning outcomes. This relationship is essential for UDL, as it emphasizes the need for high teaching standards alongside adaptive technological tools to foster an inclusive environment where all students can thrive.

The correlation between teaching quality variables (e14 ↔ e15, r = 0.381) supports the idea that improvements in one dimension of teaching quality, such as feedback provision, positively influence other aspects like student engagement. This finding is consistent with research by Hattie (2008) [43], who noted that the various components of teaching quality are interrelated, contributing to a holistic improvement in student learning. In a UDL context, this suggests that focusing on one area of teaching—such as providing diverse feedback methods—can enhance the overall learning experience, particularly for students who require different means of representation and assessment.

A particularly strong relationship is observed between the different dimensions of technological barriers (e18 ↔ e22, r = 0.618). This finding suggests that when one barrier—such as connectivity issues—arises, it often leads to additional problems, like restricted access to learning materials. Studies by Garrison & Vaughan (2008) [44] similarly concluded that technological barriers tend to be interconnected, exacerbating challenges for students, especially those reliant on digital tools for learning. This is particularly significant for UDL, where reducing such barriers is crucial to ensure that all students, regardless of their technological constraints, can access learning opportunities equitably.

The negative relationship between technological barriers and students' perceptions (e6 ↔ e23, r = -0.304) reflects how technological obstacles can diminish students' educational experiences. Garcia et al. (2021) [42] found that consistent technical difficulties, such as poor infrastructure or unreliable internet, negatively impact students' ability to engage with online learning environments. In our study, this relationship highlights the importance of addressing such barriers to ensure positive student outcomes. Within the UDL framework, minimizing these challenges is critical to providing inclusive, equitable access to education for all learners, particularly those in underserved or remote areas.

Finally, the negative relationship between barriers and teaching quality (e6 ↔ e14, r = -0.137) demonstrates how technological limitations can impede effective teaching. Cranfield et al. (2021) [41] noted that such barriers often hinder educators' ability to deliver high-quality instruction, particularly in virtual environments. However, some studies, like those by Almufarreh et al. (2023) [40], suggest that skilled teachers can adapt to these challenges through alternative strategies. Nevertheless, our findings underscore that in environments where technology plays a central role, reducing barriers is essential to maintaining high teaching standards and ensuring an inclusive and supportive learning environment, in line with UDL principles.

These relationships collectively contribute to our understanding of how UDL principles can be applied to enhance inclusive education. By focusing on reducing barriers, leveraging emerging technologies, and improving teaching quality, educational institutions can create a more flexible, adaptive, and supportive learning environment for all students. This research adds valuable insights to the growing body of work on UDL, particularly by highlighting the interplay between technology, teaching, and learning outcomes.

CONCLUSIONS

In conclusion, this research has brought forth significant insights regarding the role of Universal Design for Learning (UDL) in enhancing the overall quality of inclusive education. Our findings demonstrate that applying UDL principles—particularly the integration of emerging technologies and improving teaching quality—can substantially improve the learning experience by addressing the

diverse needs of all students. This study is particularly innovative in its examination of the reciprocal effects between teaching dimensions and students' interaction with technology, which showed a clear interdependence that fosters a more inclusive and effective educational environment.

One of the most prominent findings was the strong relationship between the dimensions of teaching quality (r = 0.564). This suggests that improving one aspect of teaching, such as teacher-student interaction or feedback, can positively influence other areas, such as clarity of instruction and student engagement. This unexpected result aligns with recent studies by Almufarreh et al. (2023) [40] , which confirm the interconnected nature of teaching quality factors. These studies assert that teachers who excel in feedback and interaction can significantly boost students' academic performance by making learning more comprehensive and accessible.

Another key finding is the negative relationship between technical barriers and students' perceptions (r = -0.447). This strong negative correlation highlights how frequent technical obstacles, such as device malfunctions or connectivity issues, can detract from students' overall learning experience. Studies such as Gamage et al. (2022) [38] and Cranfield et al. (2021[41] have similarly shown that technical issues reduce student motivation and participation, particularly in virtual learning environments. Although some research, like that by Brown and Evans (2022), suggests that students can adapt to technical barriers over time, our study supports the broader consensus that technical difficulties hinder learning, especially when institutional support is lacking.

Furthermore, the strong correlation between different types of technical barriers (r = 0.618) underscores the cumulative nature of these obstacles. A single technical issue, such as poor internet connectivity, can cascade into other problems, leading to a broader disruption of the learning process. This result aligns with Henderson and Reeves (2021), who found that technical barriers often reinforce each other, creating a compounded negative effect on the learning environment. However, other studies like Cranfield et al. (2021) [41] similarly suggest that with adequate technological support, these issues can be mitigated. Nevertheless, our research underscores the necessity of addressing technical barriers comprehensively to ensure an equitable educational experience.

The negative correlation between technical barriers and teaching quality (r = -0.137) further demonstrates how technical challenges undermine the effectiveness of instruction. This is particularly true in technology-reliant educational settings, where persistent technical problems prevent educators from delivering high-quality instruction. Cranfield et al. (2021) [41] confirm that technical issues directly impede teachers' ability to engage students and deliver material effectively. Although some educators may adopt alternative strategies, such as pre-distributing learning materials to counteract technical difficulties [40], our findings suggest that without sufficient technological support, teaching quality inevitably suffers.

Ultimately, this research provides both theoretical and practical contributions to the field of inclusive education using UDL. It not only reinforces existing theories about the relationships between technology, teaching quality, and technical barriers but also suggests actionable strategies for improving the quality of digital education. We hope these findings will inspire further research and practical applications aimed at creating more inclusive and effective educational environments.

PATENTS

REFERENCES

1. 1. Alfone, J.L. Implementing Universal Design for Learning-Focused Quality Teaching Rounds: A Strategic Research Project. Nova Southeastern University, 2024. Available online: NSUWorks (accessed on 19 October 2024).
2. 2. Montgomery, T.D.; Green, B.M.; Oliech, C.G.; Evanseck, J.D. Learning from a Pandemic: Redesigning with Universal Design for Learning in Postsecondary Education. Journal of Postsecondary Education and Disability, 2024, 37(1), 73-79. Available online: ERIC (accessed on 19 October 2024).

3. 3.   Schreiner, N., Rebagay, N., Cavendish, W. (2024). Universal Design for Learning in Higher Education to Improve Instruction in Inclusive Settings. In: Bennett, G., Goodall, E. (eds) The Palgrave Encyclopedia of Disability. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-031-40858-8_41-1

4. 4.   Redstone, A.E., Luo, T. Empowering Learners in Higher Education: Redesigning an Online Computer Science Course Through Universal Design for Learning Implementation. TechTrends 68, 869–881 (2024). https://doi.org/10.1007/s11528-024-00980-z

5. 5.   Al-Abdulwahab, R. A., & Saleh, S. R. A. (2024). Attitudes and Practices of Faculty Members toward Implementing Universal Design for Learning at Higher Education Institutions. Prince Sattam bin Abdulaziz University, https://search.mandumah.com/Record/1450723.

6. 6.   Al-Juhani, A., & Al-Qahtani, S. (2024). Universal Design for Learning in Light of Saudi Arabian and United States Legislation: A Comparative Study. Journal of Educational Policy Studies, 12(1), 75-95. Retrieved from https://search.mandumah.com/Record/1237649

7. 7.   Bracken, S., & Novak, K. (2024). Transforming Higher Education Through Universal Design for Learning: An International Perspective. Routledge.

8. 8.   Espada-Chavarria, R.; González-Montesino, R.H.; López-Bastías, J.L.; Díaz-Vega, M. Universal Design for Learning and Instruction: Effective Strategies for Inclusive Higher Education. Education Sciences 2023, 13(6), 620. DOI:10.3390/educsci13060620. MDPI

9. 9.   Ewe, L.P.; Galvin, T. Universal Design for Learning across Formal School Structures in Europe—A Systematic Review. Education Sciences 2023, 13(9), 867. DOI: 10.3390/educsci13090867 MDPI

10. 10. Villegas-Ch, W.; Govea, J.; Revelo-Tapia, S. Improving Student Retention in Institutions of Higher Education through Machine Learning: A Sustainable Approach. Sustainability 2023, 15(19), 14512. DOI: 10.3390/su151914512

11. 11. Meyer, A.; Rose, D.H.; Gordon, D. Universal Design for Learning: Theory and Practice. CAST, 2022. Available online: CAST's Clusive Platform (accessed on 19 October 2024).

12. 12. Almeqdad, Q.I.; Alodat, A.M.; Alquraan, M.F.; Mohaidat, M.A.; Al-Makhzoomy, A.K. The Effectiveness of Universal Design for Learning: A Systematic Review of the Literature and Meta-Analysis. Cogent Education, 2023, 10(1), Article 2218191. DOI: 10.1080/2331186X.2023.2218191.CAST (Center for Applied Special Technology). UDL Guidelines, Version 2.2. Available online: http://dx.doi.org/10.1080/2331186X.2023.2218191 (accessed on 19 October 2024).

13. 13. Seok, S., DaCosta, B., & Dinsmore, J. A Systematic Review of Empirically Based Universal Design for Learning: Implementation and Effectiveness of Universal Design in Education for Students with and without Disabilities at the Postsecondary Level. Open Journal of Social Sciences, 2018. Available from: mtholyoke.edu.

14. 14. Nyarko, K. Lessons Learned in Adopting a Multi-Site Combined REU/RET Program for Exclusive Remote Participation Due to the COVID-19 Pandemic. NSF PAGES, 2021. Available from: NSF REU SCR2 Program

15. 15. Alquraini, T.A., & Rao, S.M. (2020). "Assessing teachers' knowledge, readiness, and needs to implement Universal Design for Learning in

classrooms in Saudi Arabia." International Journal of Inclusive Education Ingenta Connect.

16. 16. Habbash, M. (2020). Computer Assisted Language Learning Integration Challenges in Saudi Arabian English as a Foreign Language Classes: The Case of EFL Teachers at Tabuk University. Arab World English Journal, 11(4), 474-489. Available at: ERIC Database ERIC.

17. 17. Singleton, K., Evmenova, A., Jerome, M. K., & Clark, K. (2019). Integrating UDL Strategies into the Online Course Development Process: Instructional Designers' Perspectives. Online Learning, 23(1), 206-235. Available at: ERIC Database.

18. 18. Rusconi, L.; Squillaci, M. Effects of a Universal Design for Learning (UDL) Training Course on the Development of Teachers' Competences: A Systematic Review. Educ. Sci., 2023, 13(5), 466. DOI: 10.3390/educsci13050466.

19. 19. Hromalik, C.D.; Lock, J.; Borup, J. UDL Infusion in Online Higher Education. Online Learning Journal, 2023, 27(1), 299-319. Available online: ERIC.

20. 20. Hitchcock, C., Meyer, A., Rose, D., & Jackson, R. (2002). Providing new access to the general curriculum: Universal Design for Learning. Teaching Exceptional Children, 35(2), 8-17.

21. 21. Holmes, W., Bialik, M., & Fadel, C. (2019). Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. The Center for Curriculum Redesign.

22. 22. Lin, X., Li, Y., & Zhang, W. (2024). Virtual Reality in Education: A Critical Review of Engagement and Learning Outcomes. Journal of Educational Technology, 58(1), 112-130. https://doi.org/10.3389/fpsyg.2024.1360574

23. 23. Luckin, R., Holmes, W., Griffiths, M., & Forcier, L. B. (2016). Intelligence Unleashed: An Argument for AI in Education. Pearson Education.

24. 24. Zawacki-Richter, O., Marín, V.I., Bond, M. et al. Systematic review of research on artificial intelligence applications in higher education – where are the educators?. Int J Educ Technol High Educ 16, 39 (2019). https://doi.org/10.1186/s41239-019-0171-0.

25. 25. Creswell, J.W., & Plano Clark, V.L. (2018). Designing and Conducting Mixed Methods Research. Sage Publications.

26. 26. Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed Methods Research: A Research Paradigm Whose Time Has Come. Educational Researcher, 33(7), 14-26. https://doi.org/10.3102/0013189X033007014

27. 27. Flick, U. (2014). An Introduction to Qualitative Research. Sage Publications.

28. 28. Patton, M.Q. (2015). Qualitative Research and Evaluation Methods. Sage Publications.

29. 29. De Vaus, D.A. (2014). Surveys in Social Research. Routledge.

30. 30. Brinkmann, S. (2015). Interview: Learning the Craft of Qualitative Research Interviewing. Sage Publications.

31. 31. Tashakkori, A., & Teddlie, C. (2010). Sage Handbook of Mixed Methods in Social & Behavioral Research. Sage Publications.

32. 32. Field, A. (2013). Discovering Statistics Using IBM SPSS Statistics. Sage Publications.

33. 33. Tabachnick, B.G., & Fidell, L.S. (2019). Using Multivariate Statistics. Pearson.

34. 34. Braun, V., & Clarke, V. (2006). Using Thematic Analysis in Psychology. Qualitative Research in Psychology, 3(2), 77-101.
35. 35. Miles, M.B., & Huberman, A.M. (2014). Qualitative Data Analysis: A Methods Sourcebook. Sage Publications.
36. 36. British Educational Research Association (BERA). (2018). Ethical Guidelines for Educational Research.
37. 37. Zhao, X., Li, Y., & Huang, Z. (2024). The role of emerging technologies in enhancing student engagement and teaching quality. Journal of Educational Technology, 34(2), 145-160. https://ijsrmst.com/index.php/ijsrmst/article/view/199
38. 38. Wang, Q., Huang, L., & Zhang, J. (2021). The interplay of teaching quality and educational technologies: Implications for student learning. Education Research International, 2021.
39. 39. Gkrimpizi, T., Peristeras, V., & Magnisalis, I. (2023). Classification of Barriers to Digital Transformation in Higher Education Institutions: Systematic Literature Review. Education Sciences, 13(7), 746. DOI: 10.3390/educsci13070746.
40. 40. Almufarreh, A., & Arshad, M. (2023). Promising Emerging Technologies for Teaching and Learning: Recent Developments and Future Challenges. Sustainability, 15(8), 6917. DOI: 10.3390/su15086917 MDPI
41. 41. Cranfield, D.J., Tick, A., Venter, I.M., Blignaut, R.J., & Renaud, K. (2021). Higher Education Students' Perceptions of Online Learning during COVID-19. Education Sciences, 11(8), 403. DOI: 10.3390/educsci11080403MDPI
42. 42. García-González, A., Inmaculada Aznar-Diaz., María Soledad Ramírez-Montoya., & José María Romero-Rodríguez (2022). Using Artificial Intelligence to Support Learning in Higher Education: A Systematic Review. Issues in Educational Research, 32(2), 529-557. Available online: https://www.iier.org.au/iier32/garcia-gonzalez.pdf.
43. 43. Gamage, K.A.A., et al. "Online and Hybrid Teaching and Learning: Enhance Effective Student Engagement and Experience." Education Sciences 2022, 12(10), 651. Available at: MDPI
44. 44. Hattie, J. (2008). Visible Learning: A Synthesis of Over 800 Meta-Analyses Relating to Achievement.
45. Garrison, D.R., & Vaughan, N.D. (2008). "Blended Learning in Higher Education: Framework, Principles, and Guidelines."