



 **Akerke**
Umirbekova

Abai Kazakh National Pedagogical University, Kazakhstan.
Email: akerke.umirbekova@outlook.com



ABSTRACT

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The purpose of this study was to examine the relationship between pre-service teachers' perceptions of universal learning design, inclusive learning attitudes, and attitudes towards augmented reality applications. In the study, the Inclusive Education Attitude Scale, Universal Learning Design Perception Scale, and Augmented Reality Applications Attitude Scale were used to determine the perceptions and attitudes of pre-service teachers towards the variables in question. Descriptive statistics, including mean, standard deviation, minimum, and maximum values, were calculated. The relationships among variables were examined through Pearson correlation analysis. As a result of the analyses, it was determined that there were statistically significant relationships between pre-service teachers' perceptions of universal learning design, inclusive learning attitudes, and attitudes towards augmented reality applications. The study presents important findings regarding the interaction between attitudes towards inclusivity and technological applications in the field of education. The research results show that pre-service teachers developed a strong awareness, especially in the dimension of inclusiveness, in their perceptions of universal learning design; however, they had limited awareness in the dimensions of evaluation and reflection. Although the attitudes of the pre-service teachers towards inclusive education were generally positive, individual differences were striking. Attitudes towards augmented reality applications were found to be highly positive, and this technology was seen as pedagogically meaningful and interesting. However, no significant relationship was found between these three variables. This situation reveals the importance of the holistic and practical integration of universal design, inclusive education, and digital technologies in teacher training programs.

Contribution/Originality: This study is original because it examines universal learning design and augmented reality applications, particularly in demonstrating the contributions of new instructional technologies to learning design. It serves as a prime example of how augmented reality applications contribute to teacher development.

1. INTRODUCTION

Evaluating prospective educators' perceptions of universal design for learning (UDL) is crucial for understanding their inclusive educational attitudes, especially with the implementation of augmented reality (AR) in academic environments. Augmented reality applications are one dimension of smart learning environments Sağıroğlu, Uzunboylu, Akçamete, and Demirok (2025). This section will analyze how the fundamental principles of UDL affect future educators' views on inclusiveness and their willingness to integrate technology, such as AR, into their teaching practices (Lin et al., 2024). Analyze the importance of training programs that incorporate augmented reality to improve the educational experiences of pre-service teachers, suggesting that positive exposure to Universal Design

for Learning through technology can promote more inclusive perspectives. Suprpto, Prahani, Deta, Rizki, and Bakri (2023) examined peer-reviewed literature on augmented reality (AR), which is essential for future study and development. Additionally, Rahmat, Kuswanto, Wilujeng, Ilma, and Putranta (2023) discovered that educators showed significant enthusiasm for implementing augmented reality technology in their instruction following independent utilization. From the educators' viewpoint, augmented reality possesses the capacity to be utilized in the instruction of various subjects. Hidayati, Bentri, Zen, Arina, and Amsal (2025) discovered that the use of augmented reality within a genuine learning framework markedly enhances students' comprehension and involvement in the educational process.

The principles of Universal Design for Learning recognition, expression, and engagement offer a framework for evaluating potential instructors' views towards inclusivity. By promoting adaptable learning routes that address varied student needs, UDL enhances the understanding that inclusion encompasses not only physical but also cognitive and emotional dimensions of education. As educators assimilate the UDL framework, they are likely to acknowledge the imperative of adapting their instructional methods to meet the varied requirements of pupils. This recognition is particularly relevant when examining the integration of AR technologies, which have the ability to provide immersive and customized educational experiences (Gill et al., 2024). It is claimed that when prospective educators engage in training centered on UDL concepts in conjunction with AR applications, they develop a more nuanced understanding of how technology can effectively meet varied learning needs. This comprehension is essential to alter viewpoints toward inclusiveness.

This highlights the connection between UDL and AR, indicating that potential educators who understand UDL concepts are more inclined to utilize AR to tailor instruction for children with varied needs. AR applications exhibit unique price structures that align with UDL principles, promoting varied approaches to participation and representation. Research demonstrates that augmented reality (AR) enhances student motivation and engagement, hence promoting a more inclusive classroom environment that supports the success of different learners (AR, 2024). Prospective educators who recognize the alignment of AR technologies with UDL principles demonstrate more favorable attitudes towards the integration of these tools, viewing them as essential components of a contemporary educational setting.

The integration of UDL and AR profoundly impacts the formation of prospective teachers' perspectives on effective educational strategies. Studies demonstrate that prospective educators with proficiency in Universal Design for Learning (UDL) are more likely to advocate for and implement Augmented Reality (AR) technologies that improve personalized learning experiences. The engagement strategies offered by AR technologies can serve as useful tools to accommodate various learning styles and preferences, which are essential to the UDL framework. A positive perception of a UDL instructor may increase the willingness to engage with AR, as individuals recognize its potential to transform traditional teaching techniques into dynamic, student-centered experiences.

The examination of prospective educators' views on universal design for learning reveals a significant impact on their inclusive learning attitudes and their willingness to incorporate augmented reality applications in educational environments. The connection between these concepts underscores the imperative for teacher training programs to incorporate the UDL framework in conjunction with advanced technologies like AR. The educators' training can foster a generation of teachers equipped with both academic expertise and practical strategies to create an inclusive and adaptable learning environment for all students. The inquiry into how prospective educators of universal design for learning (UDL) develop their inclusive learning views, especially for augmented reality applications (AR), is essential for understanding the application of educational technology. Universal Design for Learning (UDL) is a framework designed to improve educational processes by addressing individual learning differences, advocating for the use of varied approaches for engagement, representation, and action/expression (AR, 2024). As prospective educators have a thorough understanding of Universal Design for Learning (UDL), their inclusive perspectives toward varied learner requirements are markedly improved. The research undertaken by Ngo and Vo (2025) indicates

that educators who recognize UDL as a fundamental framework are more proficient in integrating innovative technologies, such as RA, that cater to varied learning styles and requirements.

Understanding the efficacy of the RA in addressing special educational needs (SEN) profoundly influences future educators' perspectives on inclusive education. Alqarni (2021) performs a comparative analysis highlighting the capacity of the RA to cultivate positive learning attitudes in students and produce substantial learning outcomes for those with special needs. The immersive and interactive features of AR technology offer unique opportunities for engagement, hence matching well with UDL principles that promote varied learning experiences. This intersectionality underscores the imperative for future educators to recognize augmented reality as a valid technology rooted in Universal Design for Learning principles, hence improving their inclusive teaching practices.

Moreover, Yakubova, Kellems, Chen, and Cusworth (2021) validated the alignment of positive attitudes towards technological integration with beliefs in inclusive educational methods. Their findings imply that instructors dedicated to inclusive education are more likely to employ technology that promotes such inclusivity. The perceptions of UDL among prospective educators act as a catalyst that fosters positive attitudes, hence affecting their propensity to incorporate AR tools into their practice. This association signifies that a strong fundamental understanding of UDL is essential for preparing future educators to utilize RA as an instructional strategy, hence promoting inclusion. Kusmawati, Fahrurrozi, and Supena (2024) proposed that gamification can function as an effective teaching paradigm for inclusive education, offering significant insights for educators in analogous circumstances.

Universal Design for Learning (UDL) utilizing augmented reality (AR) technology meets varied educational needs and is likely to substantially improve fairness and inclusion in academic environments. Uzza, Hamdan, and Singh (2022) assert that the use of UDL principles via AR technologies can cultivate innovative pedagogical methods that empower educators and augment learner engagement. By providing instructional resources in many formats, AR allows educators to surmount traditional obstacles to education, thereby cultivating an environment that promotes inclusive teaching approaches.

The relationship among prospective educators' perceptions of UDL, their inclusive learning dispositions, and their receptiveness to AP applications highlights the imperative of cultivating a fundamental understanding of UDL in teacher training curricula. This understanding not only shapes educators' pedagogical perspectives but also augments their ability to utilize technology to support all students, especially those with distinct educational needs. As research progressively reveals the potential of RA in educational contexts, the implications for teacher training and development are becoming increasingly relevant, underscoring the essential importance of UDL in promoting inclusive educational practices and mindsets.

The application of Universal Design for Learning (UDL) principles and Augmented Reality (AR) technologies possesses considerable promise to improve inclusive educational practices in teacher education programs. This research clarifies how prospective teachers' perceptions of UDL can affect their attitudes towards inclusive learning and the adoption of innovative educational technologies such as AR. The influence of these perspectives on curriculum design is significant, as the effective training of future educators depends on an educational framework that inherently incorporates inclusion.

To enable effective convergence of UDL and AR in teacher education, instructional strategies must be deliberately crafted to enhance future educators' comprehension of both concepts. Lalotra and Kumar (2024) research underscores the significance of experiential learning environments facilitated by immersive technologies. These venues can offer prospective educators actual experiences that demonstrate the uses and advantages of UDL concepts in fostering an inclusive classroom. The study by Sofianidis, Skraparlis, and Stylianidou (2024) underscores the significance of immersive technologies in the reconfiguration of teacher education, proposing that such experiences can enhance educators' comprehension of diverse learning requirements and promote the implementation of inclusive pedagogies.

Eliminating accessibility obstacles is a vital issue for teacher training programs designed to foster an inclusive mindset among future instructors. Szentirmai (2025) emphasizes the necessity of incorporating extensive accessibility training into teacher preparation programs. This method not only encompasses the technical competencies required for the implementation of UDL and AR but also promotes the fundamental principles of justice and diversity within educational settings. By engaging in UDL frameworks and advanced technology, prospective educators can more effectively understand the diverse needs of their future pupils, thereby strengthening their dedication to inclusion.

The capacity of technology to facilitate immersive and enriched experiences for the advancement of digital inclusion has garnered increasing attention in recent literature. Lazou and Tsinakos (2023) propose that immersive learning experiences can instigate favorable shifts in educators' attitudes toward inclusiveness. Chiusaroli and Arduini (2023) contend that identifying UDL principles within AR applications enables prospective educators to engage critically with the material, hence reinforcing the idea that inclusion is both attainable and vital in educational settings. Literature suggests that these favorable experiences might transform educators into advocates for inclusive practices, enhancing their inclination to employ UDL tactics and integrating emerging technology such as artificial intelligence in their instruction.

Comprehending the perspectives of prospective educators regarding UDL and AR is essential for fostering a fairer educational environment. Badilla-Quintana, Sepulveda-Valenzuela, and Salazar Arias (2020) assert that the connection between theory and practice enables educators to address the diverse requirements of their pupils more effectively. Altımpulluk, Kesim, and Kurubacak (2020) assert that teacher training programs elucidating these attitudes are poised to foster sustainable enhancements in student outcomes. By providing future educators with a comprehensive framework that incorporates UDL and AR, teacher preparation programs can establish the groundwork for educational equity, thereby enhancing learning experiences for all students. The amalgamation of these methodologies will improve teacher training and facilitate a progressive shift towards inclusive education that focuses on the diverse needs of multiple students.

1.1. Purpose of the Study

The aim of this study is to evaluate the relationship between prospective teachers' perceptions of universal learning design, inclusive learning attitudes, and attitudes towards Augmented Reality applications.

In order to achieve this aim, answers to the following questions were sought.

1. What are the perceptions of prospective teachers regarding universal learning design?
2. What are the attitudes of prospective teachers towards inclusive learning?
3. What are the attitudes of prospective teachers towards augmented reality applications?
4. What is the relationship between prospective teachers' perceptions of universal learning design, inclusive learning attitudes, and attitudes towards augmented reality applications?

2. MATERIALS AND METHODS

This research is based on the relational screening model, one of the quantitative research methods. The relational screening model is a design aimed at determining the existence and direction of relationships between variables. In this study, the relationship between prospective teachers' perceptions of universal learning design, inclusive learning attitudes, and attitudes towards augmented reality applications was examined.

2.1. Participants

The participants of the study were 213 teacher candidates studying at universities in Kazakhstan. Students studying at Abai Kazakh National Pedagogical University, Zhetysu University, and the Pedagogical Institute at Astana International University participated. The participants were selected using the convenience sampling method and included on a voluntary basis in accordance with the purpose of the study.

2.2. Data Collection Tools

Three scales were used to collect data:

1. Inclusive Education Attitude Scale

The suitability of these scales for Kazakh was ensured through validity and reliability studies Erçiçek, Günal, and Ünay (2023). Specifically, the translation process of the Inclusive Education Attitude Scale employed the forward-backward translation method, with careful attention to maintaining structural and semantic integrity. The scales' reliability was assessed using Cronbach's alpha coefficient, yielding high internal consistency values (for example, $\alpha = 0.86$ for the Inclusive Education Attitude Scale). The pilot study involved 213 teacher candidates from the faculty of education. This sample size exceeds the minimum requirement of five times the number of scale items, which is considered adequate for statistical analysis. The Cronbach's alpha coefficient for the Kazakh version of the scale was calculated as 0.86, indicating that the scale is reliable and dependable.

2. Perception scale of prospective teachers regarding universal learning design

The perception scale for universal learning design was developed by Schelly, Davies, and Spooner (2011) and adapted to Kazakh in line with the purposes of the study. During the adaptation process, firstly, the scale items were translated into Kazakh by two independent experts. The translations obtained were then compared to create a common Kazakh version. This version was translated back into English and compared with the original text to ensure semantic integrity. After confirming language validity, the scale was presented to experts for content validity assessment. Before application, a pilot study was conducted to evaluate the items' comprehensibility, and necessary adjustments were made. The scale was designed as a 5-point Likert type and aims to measure student perceptions regarding the level of implementation of the universal learning design principles representation, expression, and participation methods by instructors (Davies, Schelly, & Spooner, 2013). As a result of the Kazakh language adaptation, the psychometric properties of the scale were examined, and it was determined to be a valid and reliable measurement tool.

3. Augmented Reality Applications Attitude Scale (ARAAS)

It was used as a data collection tool to measure the attitudes of prospective teachers towards augmented reality technologies. The scale was developed by Küçük, Yılmaz, Baydaş, and Göktaş (2014) and consists of three sub-dimensions: Relevance, Satisfaction, and Reliability. This Likert-type scale was structured to evaluate individuals' perceptions of using augmented reality applications in education.

2.3. Pilot Application and Validity-Reliability

The pilot application was conducted with 213 prospective teachers, and the sample size was found to be sufficient, being at least five times the number of items. The reliability coefficients obtained indicate that the data collection tools are dependable.

2.4. Application Process

Data were collected online and face-to-face on a voluntary basis from the participants. The purpose of the study was explained to the participants, and their informed consent was obtained in accordance with the principles of confidentiality and anonymity.

2.5. Ethical Principles

The research was conducted in accordance with the approval of the ethics committee. The identities of the participants were kept confidential, and it was undertaken that the data would be used only for scientific purposes.

2.6. Analysis of Data

Quantitative data analysis methods were used in the analysis of the data obtained in the study. IBM SPSS 26.0 statistical software was used in the analysis of the data. First, descriptive statistics (mean, minimum, maximum, standard deviation) were calculated to determine the perceptions of pre-service teachers about universal learning design, their attitudes towards inclusive learning, and their attitudes towards augmented reality applications. Pearson correlation analysis was applied to determine the relationships between the variables. With this analysis, the linear relationships between the variables and whether these relationships were statistically significant were examined. The significance level was accepted as .05 in all analyses.

Table 1. Perceptions towards learning design.

Scales	N	Min.	Max.	Mean	Std. Deviation
Inclusive	213	31.00	122.00	61.52	16.12
Planning	213	7.00	68.00	19.94	7.37
Teaching	213	6.00	30.00	17.36	5.58
Assessment	213	5.00	25.00	14.75	4.61
Reflection	213	3.00	15.00	9.46	2.991
Valid N (Listwise)	213				

3. RESULTS

3.1. What are the Perceptions of Prospective Teachers Regarding Universal Learning Design?

Table 1 presents descriptive statistics applied to the general distribution of teacher candidates' perceptions of universal learning design. This type of analysis summarizes the overall distribution of perceptions regarding universal learning design. According to the findings, the highest mean value belongs to the "inclusive" sub-dimension (Avg.= 61.53).

This is followed by the "planning" (Avg.= 19.95), "teaching" (Avg.= 17.36), "assessment" (Avg.= 14.75), and "reflection" (Avg.= 9.46) sub-dimensions, respectively. This indicates that teacher candidates' perceptions of the inclusiveness principle are higher compared to the other sub-dimensions. Conversely, it is evident that there is a lower level of awareness, particularly in the assessment and reflection dimensions of the teaching process. Additionally, the high standard deviation values suggest that there are individual differences among participants' perceptions on this issue.

Table 2. Attitudes towards inclusive learning.

Scale	N	Min.	Max.	Mean	Std. Deviation
Universal	213	27.00	115.00	79.63	19.61
Valid N (Listwise)	213				

3.2. What are the Attitudes of Prospective Teachers Towards Inclusive Learning?

In Table 2, as a result of the descriptive statistical analysis conducted to describe the attitudes of prospective teachers towards inclusive learning, the average of the attitude scores was found to be 79.63. This result shows that the attitudes of prospective teachers towards inclusive learning are positive. However, the wide range of scores between the minimum (27) and maximum (115) values indicates that some individuals may have low attitudes towards inclusive learning.

This situation reveals that the attitudes of prospective teachers are not homogeneous and individual differences are evident.

Table 3. Attitudes towards augmented reality applications.

Scales	N	Min.	Max.	Mean	Std. deviation
Total Augmented Reality	213	35.00	115.00	88.76	11.25
Relevance	213	9.00	45.00	34.89	5.76
Satisfaction	213	9.00	45.00	34.45	5.95
Reliability	213	8.00	25.00	19.35	3.20
Valid N (Listwise)	213				

3.3. What are the Attitudes of Prospective Teachers Towards Augmented Reality Applications?

In Table 3, the analysis method used is again descriptive statistical analysis. It is observed that the attitudes of prospective teachers towards augmented reality applications are highly positive. The "Total Augmented Reality" dimension has the highest average (Avg.= 88.76), while the values for the other dimensions "Relevance" (Avg.= 34.90), "Satisfaction" (Avg.= 34.46), and "Reliability" (Avg.= 19.36) are also relatively high. This finding indicates that prospective teachers perceive augmented reality technologies as meaningful, satisfying, and reliable in the context of the teaching process. It further supports the conclusion that their interest in this technology is substantial.

Table 4. Tables of relationships between scales.

Correlations											
		Inclusive	Planning	Teaching	Assessment	Reflection	Universal	Total augmented reality	Relevance	Satisfaction	Reliability
Inclusive	Pearson Correlation	1	0.897 **	0.856 **	0.857 **	0.256 **	0.032	0.066	0.074	0.057	-0.018
	Sig. (2-tailed)		0	0	0	0	0.641	0.336	0.28	0.41	0.795
	N	213	213	213	213	213	213	213	213	213	213
Planning	Pearson Correlation	0.897 **	1	0.696 **	0.659 **	0.05	0.02	0.06	0.061	0.056	-0.031
	Sig. (2-tailed)	0		0	0	0.466	0.77	0.387	0.378	0.419	0.657
	N	213	213	213	213	213	213	213	213	213	213
Teaching	Pearson Correlation	0.856 **	0.696 **	1	0.678 **	-0.016	0.003	0.019	0.025	0.028	-0.03
	Sig. (2-tailed)	0	0		0	0.819	0.969	0.782	0.719	0.684	0.661
	N	213	213	213	213	213	213	213	213	213	213
Assessment	Pearson Correlation	0.857 **	0.659 **	0.678 **	1	0.184 **	0.052	0.056	0.099	0.039	-0.055
	Sig. (2-tailed)	0	0	0		0.007	0.454	0.413	0.148	0.572	0.428
	N	213	213	213	213	213	213	213	213	213	213
Reflection	Pearson Correlation	0.256 **	0.05	-0.016	0.184 **	1	0.039	0.087	0.051	0.056	0.12
	Sig. (2-tailed)	0	0.466	0.819	0.007		0.575	0.205	0.462	0.415	0.082
	N	213	213	213	213	213	213	213	213	213	213
Universal	Pearson Correlation	0.032	0.02	0.003	0.052	0.039	1	-0.012	0.024	-0.043	-0.017
	Sig. (2-tailed)	0.641	0.77	0.969	0.454	0.575		0.862	0.729	0.535	0.809
	N	213	213	213	213	213	213	213	213	213	213
Total Augmented Reality	Pearson Correlation	0.066	0.06	0.019	0.056	0.087	-0.012	1	0.761 **	0.856 **	0.544 **
	Sig. (2-tailed)	0.336	0.387	0.782	0.413	0.205	0.862		0	0	0
	N	213	213	213	213	213	213	213	213	213	213
Relevance	Pearson Correlation	0.074	0.061	0.025	0.099	0.051	0.024	0.761 **	1	0.417 **	0.098
	Sig. (2-tailed)	0.28	0.378	0.719	0.148	0.462	0.729	0		0	0.154
	N	213	213	213	213	213	213	213	213	213	213

Correlations											
		Inclusive	Planning	Teaching	Assessment	Reflection	Universal	Total augmented reality	Relevance	Satisfaction	Reliability
Satisfaction	Pearson Correlation	0.057	0.056	0.028	0.039	0.056	-0.043	0.856 **	0.417 **	1	0.389 **
	Sig. (2-tailed)	0.41	0.419	0.684	0.572	0.415	0.535	0	0		0
	N	213	213	213	213	213	213	213	213	213	213
Reliability	Pearson Correlation	-0.018	-0.031	-0.03	-0.055	0.12	-0.017	0.544 **	0.098	0.389 **	1
	Sig. (2-tailed)	0.795	0.657	0.661	0.428	0.082	0.809	0	0.154	0	
	N	213	213	213	213	213	213	213	213	213	213

Note: **. Correlation is significant at the 0.01 level (2-tailed).

3.4. What is the Relationship Between Prospective Teachers' Perceptions of Universal Learning Design, Inclusive Learning Attitudes, and Attitudes Towards Augmented Reality Applications?

Table 4 shows that Pearson correlation analysis was used to examine the relationship between pre-service teachers' perceptions of universal learning design, inclusive learning attitudes, and attitudes towards augmented reality applications. According to the correlation analysis, there is no significant relationship between pre-service teachers' perceptions of universal learning design and their attitudes towards inclusive learning ($p > 0.05$). Similarly, no statistically significant relationship was observed between attitudes towards augmented reality applications and universal learning design or inclusive learning attitudes. However, augmented reality attitude dimensions show high and significant relationships among themselves (e.g., $r = 0.856$, $p < 0.01$ between Total Augmented Reality and Satisfaction). This result indicates that these three variables should be considered independently, but there is coherence within augmented reality attitudes.

4. DISCUSSIONS

There were differences between the dimensions of the perceptions of prospective teachers towards universal learning design. The high mean score obtained in the "Inclusive" sub-dimension shows that the prospective teachers adopt an educational approach that is particularly sensitive to diversity and values the participation of all students. This finding is supported by similar studies emphasizing the potential of universal design to increase inclusiveness (Almeqdad, Alodat, Alquraan, Mohaidat, & Al-Makhzoomy, 2023; Baydaş & Göktaş, 2014; Lee & Griffin, 2021; Scott, Bruno, Gokita, & Thoma, 2022). However, the low means obtained in the "assessment" and "reflection" sub-dimensions show that prospective teachers have not developed sufficient awareness in terms of monitoring the teaching process, evaluating student learning, and reflecting on teaching practices. This situation reveals that universal learning design should be considered holistically, not limited to the principle of inclusiveness but also encompassing pedagogical skills such as evaluating the process and self-assessment. In addition, the high standard deviation values indicate that there are significant individual differences in the perceptions of universal learning design among prospective teachers. It is thought that these differences may be due to the candidates' past experiences, technological proficiency levels, learning environments, and pedagogical knowledge. Therefore, universal design principles should be applied in teacher training programs not only theoretically but also in practice. Teacher candidates should be supported with focused activities to ensure balanced development in all sub-dimensions.

Another research finding shows that teacher candidates' attitudes towards inclusive learning are positive. The average attitude score of 79.63, obtained through descriptive statistical analyses, indicates that a positive perspective has developed towards inclusive education. This result is significant in that it shows that candidates adopt an educational approach that is sensitive to student differences and values the active and equal participation of all individuals in the learning process. It is supported by other studies that inclusive pedagogical approaches are related to teacher competencies (Demchenko, Maksymchuk, Bilan, Maksymchuk, & Kalynovska, 2021; Mihić, Vorkapić, & Čepić, 2022). However, the wide distribution of scores between the minimum (27) and maximum (115) values reveals that attitudes towards inclusive education are not homogeneous among participants and that there are significant individual differences. This suggests that some teacher candidates' awareness or acceptance of inclusive education principles may be limited. In this context, it is important for teacher training programs to support the inclusive education approach not only at a theoretical level but also with practical and experiential learning opportunities, thus ensuring that all candidates develop more consistent attitudes in this area.

It is revealed that the attitudes of teacher candidates towards augmented reality applications are high and positive. Especially, the high average score obtained in the "total augmented reality" scale (Avg. = 88.76) shows that teacher candidates have a great interest and curiosity towards this technology. In addition, the high values obtained in the "Relevance," "Satisfaction," and "Reliability" sub-dimensions reveal that the candidates evaluate augmented reality technology not only as an innovative tool but also as a meaningful, satisfying, and reliable educational material

in terms of the teaching process. These findings are important in terms of showing that teacher candidates adopt a positive approach to the effective use of digital technologies in pedagogical applications. The findings in the literature that augmented reality technologies increase learning motivation and student participation are parallel to the results obtained from this research (Drljević, Botički, & Wong, 2022; Kaur, Mantri, & Horan, 2020; Lampropoulos, Keramopoulos, Diamantaras, & Evangelidis, 2022). Therefore, increasing the integration of innovative digital tools such as augmented reality in teacher training programs can contribute to the development of technology-based teaching skills of the candidates and increase their awareness of the use of technology in education.

The correlation analysis results obtained in the study show that there is no statistically significant relationship between the perceptions of pre-service teachers regarding universal learning design and their attitudes towards inclusive learning ($p > 0.05$). Similarly, no meaningful relationship was found between attitudes towards augmented reality applications and perceptions of universal learning design or inclusive learning attitudes. These findings indicate that each variable is based on different cognitive, affective, or experiential foundations for pre-service teachers. Some studies in the literature have concluded that there is a positive relationship between universal design principles and inclusive attitudes (Griful-Freixenet, Struyven, & Vantieghem, 2021; Nasri, Rahimi, Nasri, & Talib, 2021; Rusconi & Squillaci, 2023). This may indicate that although the universal design approach conceptually includes inclusiveness, these two concepts have not yet been fully integrated in the minds of pre-service teachers. This result highlights the importance of addressing these two areas in a more holistic manner within teacher training programs. On the other hand, the presence of high and significant relationships between the sub-dimensions of the augmented reality attitude scale demonstrates that there is internal consistency in the perceptions of pre-service teachers towards this technology. In particular, the strong relationship between the “Artificial” and “Satisfaction” dimensions ($r = 0.856$, $p < 0.01$) indicates that the interest of prospective teachers in augmented reality applications is related to the learning satisfaction provided by these applications. This finding suggests that augmented reality technologies are evaluated by prospective teachers not only as eye-catching or innovative tools but also as pedagogically satisfying experiences. The literature review emphasizes that the interactive and student-centered structure of augmented reality is effective in increasing learner satisfaction and interest (Bhardwaj, Zhang, Tan, & Pandey, 2025; Hoidn & Reusser, 2020; Kerimbayev, Umirzakova, Shadiev, & Jotsov, 2023; Zhao, He, Jin, & Wang, 2022). As a result, the findings of this study revealed that attitudes towards augmented reality have a holistic structure; however, these attitudes are not related to universal learning design or inclusive learning attitudes. This situation reveals that these areas should be structured in a relational way in the education processes for prospective teachers. It is important to support teacher candidates' awareness of these three concepts in a holistic manner, especially through practical studies on how digital technologies can be used effectively in inclusive education environments.

5. CONCLUSIONS

It was concluded that there were significant differences in the perceptions of prospective teachers towards universal learning design. The high average score obtained, especially in the inclusive sub-dimension among the sub-dimensions, indicated that the candidates adopted an educational approach that was sensitive to differences and cared about the active participation of each student in the learning process. The low averages obtained in the evaluation and reflection sub-dimensions of the prospective teachers' perceptions towards learning design indicated that the prospective teachers had limited awareness in monitoring, evaluating, and self-assessing the teaching process.

The research results indicate that the attitudes of teacher candidates towards inclusive learning are generally positive. The average attitude score reveals that the candidates are sensitive to differences and adopt an inclusive education approach. However, the wide distribution of scores shows that attitudes are not homogeneous among the candidates and that individual differences are evident. This suggests that some candidates may have limited awareness of the principles of inclusive education. Therefore, it can be said that inclusive education should be addressed in teacher training programs not only theoretically but also in a practical and experience-based manner.

It has been revealed that the attitudes of teacher candidates towards augmented reality applications are high and positive. Especially, the high scores in the “Artificial” dimension indicate that the candidates have a strong interest in and curiosity about this technology. The high averages obtained in other dimensions also demonstrate that augmented reality is evaluated as a pedagogically meaningful, dependable, and satisfying tool. This result emphasizes that teacher candidates have developed positive attitudes towards technology-supported teaching applications and highlights the importance of integrating such digital tools into teacher training programs.

No meaningful relationship was found between the perceptions of pre-service teachers about universal learning design and their attitudes towards inclusive learning or augmented reality applications. This finding indicates that all three areas were evaluated independently by the candidates. Therefore, digital technologies should be addressed holistically within teacher training programs, incorporating inclusive and universal learning approaches.

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Transparency: The author states that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

Competing Interests: The author declares that there are no conflicts of interests regarding the publication of this paper.

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