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Designing a Fractal Curriculum Model for Virtual Learning with an Intercultural Approach at Farhangian University

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A B S T R A C T

Purpose: This study aimed to design a Fractal Virtual Curriculum Model with an Intercultural Approach for Farhangian University.

Methodology: The research employed a qualitative approach using inductive content analysis within a grounded theory framework. Data were collected through semi-structured interviews with 16 experts in curriculum studies, virtual education, and intercultural pedagogy, selected via snowball sampling. The interview transcripts were coded in three stages: open, axial, and selective coding. MAXQDA software was used to manage and categorize data. The coding process identified recurring patterns and thematic relationships to construct a comprehensive model. Trustworthiness was ensured through member checking, peer review, and intercoder agreement.

Findings: The final model consists of nine core elements: objectives, content, learning activities, teaching-learning strategies, space, time, grouping, educational materials, and evaluation. Each element includes specific subcategories and indicators grounded in the principles of fractal theory and intercultural education. The objectives focused on cultural cohesion and educational equity; content emphasized multicultural literacy and cultural intelligence; learning activities included participatory and diversity-driven tasks. Teaching strategies centered on flexibility and multicultural competence, while spatial and temporal components addressed virtual inclusivity. Grouping practices promoted intercultural collaboration, materials supported multilingual and multimodal access, and evaluation incorporated qualitative, quantitative, and multicultural dimensions. The model allows recursive adaptation across educational settings, mirroring the self-similar and dynamic nature of fractals.

Conclusion: The proposed Fractal Virtual Curriculum Model addresses the cultural, technological, and pedagogical complexities of modern learning environments, supporting inclusive and context-sensitive curriculum development.

Keywords: *Fractal curriculum, intercultural education, virtual learning, higher education, qualitative research, curriculum model, digital pedagogy.*

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1. Introduction

Fractal theory, characterized by non-linear, self-similar, and recursive patterns, has recently emerged as a potent metaphor in curriculum studies. Unlike traditional linear curriculum models, fractal models accommodate variability, contextual adaptation, and multi-layered learning experiences. Shahbazi et al. (2020a) argue that fractal structures reflect the organic, evolving nature of knowledge in multicultural academic contexts. In this model, the curriculum is conceptualized not as a rigid sequence of content but as a living structure composed of interrelated components, each reflecting the whole while allowing for adaptive transformation across educational environments (Shahbazi, 2020). Shahbazi et al. (2020b) further explain that such models are uniquely suited to intercultural education because they promote the recognition of cultural differences while revealing underlying human commonalities (Shahbazi et al., 2020).

The need for an intercultural approach in virtual curriculum development has been emphasized across a variety of studies. As noted by Eini et al. (2018), education systems must move beyond monocultural paradigms to integrate the diverse cultural identities of learners into pedagogical content and processes (Eini et al., 2018). Similarly, Mostafazadeh et al. (2019) contend that multicultural education is not merely an ethical imperative but a foundational necessity in the design of modern curricula (Mostafazadeh et al., 2019). These insights are particularly relevant in virtual settings where physical boundaries are removed, yet cultural divides may persist or become amplified. The incorporation of multicultural literacy, intercultural communication skills, and cultural sensitivity into virtual curricula helps cultivate inclusive academic environments and global citizenship.

While virtual education offers unprecedented flexibility in terms of time, location, and pacing, it also introduces challenges that demand pedagogical innovation. Islam and Azad (2015) emphasize that student satisfaction and continued engagement in online environments are contingent upon not only technical usability but also cultural alignment and relevance (Islam & Azad, 2015). The fragmentation of learning experiences, if not carefully structured, may result in alienation rather than empowerment. Addressing this, Ghanbari et al. (2019) propose an evaluation framework for virtual learning environments that integrates cultural context into quality assurance metrics, ensuring the system supports diverse learner needs (Ghanbari et al., 2019). Likewise, Savari and Savari (2022), in their study of students' lived experiences during the pandemic, report that culturally blind instructional strategies in virtual settings can lead to cognitive overload and disengagement (Savari & Savari, 2022).

In higher education, the curriculum is increasingly regarded as a multi-dimensional, context-sensitive framework that must evolve with societal, technological, and institutional shifts. Ornstein and Hunkins (2018) articulate curriculum as a conceptual map that encompasses foundational principles, educational goals, and pedagogical philosophies aligned with contemporary needs (Ornstein & Hunkinks, 2018). Bezi et al. (2024) operationalize this notion through their environmental education model, suggesting that curriculum development must involve both vertical depth—anchored in philosophy and learning theory—and horizontal breadth—spanning disciplines and cultural contexts (Bezi et al., 2024). In this context, the fractal model becomes particularly compelling because of its ability to accommodate such layered complexity while maintaining coherence.

The inclusion of intercultural elements in virtual curricula has demonstrated measurable benefits in student learning outcomes, particularly in health and social sciences. Arruzza and Chau (2021), through their review of cultural competence education, show that students exposed to culturally responsive curricula develop higher levels of knowledge acquisition, improved attitudes, and greater satisfaction with learning experiences (Arruzza & Chau, 2021). These findings parallel those of De Hei et al. (2019), who argue that collaborative learning in international education fosters the development of intercultural competence and prepares students for global labor markets (De Hei et al., 2019). In line with this, de Melo Ghisi et al. (2023) advocate for structured, group-based virtual education models that support cultural exchange and mutual learning in medical training programs (de Melo Ghisi et al., 2023).

Nonetheless, the transformation of curriculum into a culturally relevant digital framework requires more than content adaptation. As Corbin and Strauss (2021) note, qualitative inquiry and grounded theory are essential for understanding the nuanced social realities that influence educational engagement and effectiveness (Corbin & Strauss, 2021). This study employs qualitative methodology to analyze expert insights and to design a contextually grounded curriculum model that embodies fractal structure

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and intercultural substance. Hariri (2020) and Mostafaei and Hoseini (2021) both stress the importance of stakeholder engagement and iterative validation in qualitative educational research, especially when addressing complex social constructs like culture, identity, and learning (Hariri, 2020; Mostafaei & Hoseini, 2021).

The design of virtual curriculum must also consider the physical and symbolic learning environments in which it is embedded. According to Shahbazi et al. (2020b), fractal designs permit a symbolic representation of "unity in diversity" through educational spaces that embody cultural plurality. These spaces, both digital and conceptual, offer students opportunities for global interaction, intercultural dialogue, and mutual recognition (Shahbazi et al., 2020). Lavasani et al. (2020) found that teachers who had positive lived experiences with multicultural education processes were better equipped to implement culturally responsive pedagogies in digital classrooms (Lavasani et al., 2020).

In response to systemic changes in global education, particularly the shift from centralized models to transnational, learner-centered systems, new paradigms are needed to bridge technological infrastructure with pedagogical philosophy. As reported by the Department of Labor (2015), the future of education and employment increasingly demands adaptive skills, intercultural competence, and digital fluency (Department of Labor & Training, 2015). Lisa et al. (2016) echo this by calling for the personalization of professional development pathways in higher education to better address cultural and technological diversity (Lisa et al., 2016). Shahbazi et al. (2020a) thus assert that a curriculum structured on fractal logic is well-positioned to meet such transdisciplinary and intercultural demands.

Recent studies have also examined how virtual educational cultures are constructed and interpreted by students. Baghershahi et al. (2023) found that learners in higher education perceive virtual education not only as a technological shift but as a cultural experience in itself—one that requires negotiation, adaptation, and resilience (Baghershahi et al., 2023). Hu (2023), in his mathematical modeling of legal disputes using fractal theory, reinforces the idea that fractal thinking is applicable to complex human systems, including education, where patterns of behavior, interaction, and perception exhibit recursive and self-similar properties (Hu, 2023). The fractal model of curriculum thus captures both the structural integrity and cultural dynamism necessary for inclusive virtual education.

Furthermore, Warren et al. (2021), in their work on virtual curriculum development in Southeast Asia, underscore the importance of establishing partnerships and contextualizing digital resources to local cultural realities. They argue that effective virtual curricula must be regionally relevant, globally informed, and culturally flexible (Warren et al., 2021). This aligns closely with the objectives of the present study, which seeks to develop a scalable, flexible, and culturally grounded curriculum model suited to Iranian higher education while being adaptable to broader intercultural contexts.

This study aims to design a Fractal Virtual Curriculum Model with an Intercultural Approach at Farhangian University, guided by the conviction that effective virtual curricula must mirror the complexity and interconnectedness of global cultural and educational systems.

2. Methods and Materials

This research is applied in terms of its objective and qualitative in terms of methodology, employing inductive content analysis. The statistical population in the phase of literature review and examination of theoretical foundations included scientific documents such as articles and research papers, organizational research projects, expert and researcher investigations, relevant authored books, and master's and doctoral theses from universities and higher education institutions related to the research topic. It also included circulars and directives from the Ministry of Education and its subordinate departments. The national online scientific databases utilized were Magiran, Noormags, Nashriat.ir, Ensani.ir, and SID.ir, and the international online scientific databases used included Elsevier, EBSCO, ScienceDirect, Springer, PubMed, Wiley, CABI, and ERIC.gov.

In the interview phase, experts and specialists were consulted to ensure the validity of the interviews. The qualitative phase of the research included semi-structured content analysis of interviews with curriculum experts, textbook authors, higher education planners, and specialists in virtual education and intercultural approaches. The criteria for selecting experts included: academic background in curriculum models, virtual education, intercultural approaches, and fractal models, as well as having published articles, books, or research projects relevant to the topic.

For sampling in the content analysis of the interviews, the "snowball sampling" method was used. This method is effective in accessing samples that are otherwise difficult to

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reach, relying on social networks and individuals with shared characteristics. Once the researcher identified a few initial samples with the required traits, those individuals were asked to refer others with similar attributes. Ultimately, 16 experts were selected using this sampling method until theoretical saturation was achieved. The researcher encountered data saturation after the 13th interview but continued the process up to the 16th interview to ensure data adequacy. Sixteen individuals were selected according to the information presented in Table 1.

Table 1

Interviewee Information

Row	Gender	Field of Study	Academic Degree	Area of Expertise	Experience (Years)	Job Title	Analysis Code
1	Male	Educational Management	PhD Candidate	Educational Management	27	Faculty Member, Islamic Azad University	N1
2	Male	ICT Engineering	PhD	Information and Communication Technology	19	Faculty Member, Ministry of Science	N2
3	Male	ICT Engineering	PhD Candidate	Information and Communication Technology	29	Faculty Member, Islamic Azad University	N3
4	Female	Curriculum Planning	PhD	Curriculum Planning	19	Faculty Member, Islamic Azad University	N4
5	Male	Educational Management	PhD	Higher Education Management	27	Faculty Member, Payame Noor University	N5
6	Female	Educational Management	PhD	Educational Management	28	Faculty Member, Islamic Azad University	N6
7	Female	Educational Management	PhD Candidate	Educational Management	19	Faculty Member, Islamic Azad University	N7
8	Female	Educational Management	PhD	Educational Management	17	Faculty Member, Farhangian University	N8
9	Male	Curriculum Studies	PhD	Curriculum Planning	11	Faculty Member, Ministry of Science	N9
10	Female	ICT Engineering	PhD Candidate	Information and Communication Technology	18	Faculty Member, Farhangian University	N10
11	Male	Curriculum Planning	PhD	Curriculum Planning	26	Faculty Member, Ministry of Science	N11
12	Male	Curriculum Planning	PhD	Curriculum Planning	23	Faculty Member, Ministry of Science	N12
13	Female	Curriculum Planning	PhD	Curriculum Planning	9	Faculty Member, Ministry of Science	N13
14	Male	ICT Engineering	PhD Candidate	Information and Communication Technology	17	Faculty Member, Farhangian University	N14
15	Male	Educational Management	PhD Candidate	Educational Management	18	Faculty Member, Islamic Azad University	N15
16	Female	Educational Management	PhD Candidate	Educational Management	14	Faculty Member, Islamic Azad University	N16

Semi-structured interviews were used as the data collection instrument. To determine the validity and reliability of the qualitative instrument, the following measures were used: acceptability (expert review), confirmability (expert re-examination), and intra-subject agreement. Specifically, to assess validity, the typed texts of the first five interviews, along with their initial coding results, were returned to the experts who had been interviewed. These experts were asked to evaluate the researcher's interpretations and inferences from their interviews. If discrepancies or corrections were needed in the typed transcripts, adjustments were made to ensure that the intended meanings of the experts were accurately analyzed.

To establish reliability, the final categories were returned to several initial participants for review and confirmation. Their suggestions were incorporated. In the intra-subject agreement method, two coders (evaluators) from among the experts were asked to participate as co-researchers (coders). Necessary training and coding techniques were provided. In each interview, codes that matched between the two evaluators were classified as agreements, while differing codes were marked as disagreements. The accuracy and reliability of the research were assessed accordingly.

Given the objective of the study, content analysis with a qualitative approach was used to analyze the text of expert interviews. There are both similarities and differences among various qualitative analysis methods. Despite some

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similarities between content analysis and other qualitative methods such as thematic analysis and grounded theory, the distinguishing feature of the present study's method is its potential to incorporate quantitative analyses using various statistical tests alongside qualitative data interpretation. The data analysis comprised three types of coding: (1) open coding (initial), (2) axial coding, and (3) secondary coding.

Open Coding (Initial): Open coding is an analytical process through which concepts are identified, and their properties and dimensions are discovered within the data. During open coding, the data are broken down into discrete parts and carefully examined to identify similarities and differences. Questions related to the phenomena represented in the data are posed.

Axial Coding: Axial coding is the process of relating categories to subcategories and linking them at the level of properties and dimensions.

Secondary Coding: At this stage, the various conditions (categories) identified during axial coding are merged, and a comprehensive analysis is conducted.

3. Findings and Results

The central axis of the study pertained to the exploration and identification of influencing factors regarding the main category, subcategories, and indicators related to the *"Fractal Virtual Curriculum Model with an Intercultural Approach at Farhangian University"*, which constituted the core concept of the research. To achieve this aim, the main category, subcategories, and indicators were identified through initial, axial, and secondary coding of data obtained from in-depth, exploratory interviews with key experts, followed by refinement of the conceptual codes. Accordingly, for initial coding, the data from each interview were analyzed at the level of sentences and phrases, and conceptual codes were extracted from the transcripts. In the next phase, through reduction and refinement, the indicators were organized into subcategories and named through constant comparative analysis. In secondary coding, the subcategories were grouped and named under main categories. To ensure proper organization of the main and subcategories, interview transcripts were re-examined by reviewing the indicators until logical saturation was achieved for each category. Initial and axial coding stopped once a meaningful classification emerged after several transcript reviews.

A – Goal Element

Step 1: Initial Coding: In the open coding phase, from an initial set of 33 codes, 21 were eliminated due to repetition. The remaining 12 codes were finalized and grouped under subcategories.

Step 2: Axial Coding: Table 2 presents the results of identifying the subcategories, with the goal of establishing relationships between the developed criteria.

Table 2

Results of Subcategory Classification for the Objective Element

Criterion	Subcategory	Code
[N1-1] Enhancing understanding and respect for cultural differences		
[N2-1] Encouraging student participation from diverse cultural backgrounds		
[N4-1] Encouraging students to reflect on the impact of cultural diversity on society	Cultural Cohesion	1
[N12-2] Developing essential skills for effective collaboration with individuals from different cultures		
[N5-1] Ensuring equal access to educational resources for all students		
[N10-1] Providing a supportive and equitable environment for students with special needs		
[N7-1] Teaching methods based on students' needs and abilities	Educational Equity	2
[N15-2] Reducing educational disparities among students from different cultural and economic backgrounds		
[N8-2] Encouraging research and learning about different customs		
[N14-2] Interactive activities for practicing intercultural communication skills		
[N16-2] Addressing issues related to living in multicultural societies, such as bias and discrimination	Understanding Multicultural Concepts	3
[N1-2] Identifying and understanding cultural differences among individuals		

Step Three: Selective Coding

The results of selective coding are presented in the table below. In this phase, 12 final codes categorized under 3 subcategories were integrated into 2 core categories.

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Table 3

Classification of Core Categories, Subcategories, and Indicators for the Objective Element

Code	Core Category	Number of Subcategories	Subcategory	Number of Indicators
1	Cultural Interaction and Participation	2	Cultural Cohesion - Understanding Multicultural Concepts	8
2	Knowledge and Operational Aspects	1	Educational Equity	4

B. Content Element

Step One: Initial Coding

During the open coding phase, 28 initial codes were identified. After reviewing and eliminating duplicate codes, 16 codes were removed, leaving 12 final codes categorized under subcategories.

Step Two: Axial Coding

The results of the subcategory classification for the "Content" element are presented in the table below. The purpose of this stage was to establish relationships among the generated criteria.

Table 4

Results of Subcategory Classification for the Content Element

Criterion	Subcategory	Code
[N1-3] Curriculum content includes resources from various cultures addressing cultural diversity and its richness		
[N2-3] Incorporates examples and stories from different cultures to explain multicultural concepts		
[N4-3] Promotes respect and sensitivity toward cultural differences, linguistic and religious diversity	Multicultural Content	1
[N3-3] Helps students understand challenges related to intercultural interactions		
[N5-3] Includes information about customs, languages, and traditions of various cultures		
[N13-4] Identifies and analyzes cultural issues such as discrimination, inequality, and bias		
[N10-4] Fosters respect for cultural differences and encourages its development	Multicultural Literacy	2
[N7-3] Encourages respect and acceptance of diverse cultures		
[N4-4] Activities and exercises to enhance intercultural communication skills and conflict resolution		
[N6-4] Raises cultural awareness and fosters a deeper understanding of different perspectives		
[N7-4] Strengthens students' ability to adapt to diverse cultural environments	Cultural Intelligence	3
[N16-3] Introduces various cultures, their histories, customs, and lifestyles		

Step Three: Selective Coding

The results of selective coding are presented in the table below. In this phase, 12 final codes categorized under 3 subcategories were integrated into 2 core categories.

Table 5

Classification of Core Categories, Subcategories, and Indicators for the Content Element

Code	Core Category	Number of Subcategories	Subcategory	Number of Indicators
1	Cultural Awareness and Knowledge	2	Multicultural Content - Multicultural Literacy	8
2	Intercultural Skills and Abilities	1	Cultural Intelligence	4

C. Learning Activities Element

Step One: Initial Coding

During the open coding phase, 16 initial codes were identified. After reviewing and eliminating duplicate codes, 8 codes were removed, leaving 8 final codes categorized under subcategories.

Step Two: Axial Coding

Table below presents the results of subcategory classification for the "Learning Activities" element. The purpose of this stage was to establish relationships among the generated criteria.

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Table 6

Results of Subcategory Classification for the Learning Activities Element

Criterion	Subcategory	Code
[N1-4] Group projects requiring student collaboration and participation		
[N10-5] Encouraging students to join multicultural workgroups		
[N4-5] Utilizing collaborative activities to enhance intercultural skills, such as effective communication, conflict resolution, and mutual understanding	Collaborative Activities	1
[N3-6] Interaction and cooperation among students from different cultures		
[N8-5] Exploring cultural issues such as discrimination, stereotypes, and inequalities		
[N14-4] Gaining a better understanding of different cultures and engaging in cultural exchange		
[N7-5] Practicing intercultural skills such as respecting differences, effective communication, and resolving cultural conflicts	Multicultural Activities	2
[N13-5] Familiarizing students with diverse cultural perspectives and experiences		

Step Three: Selective Coding

Table below presents the results of selective coding, where 8 final codes categorized under 2 subcategories were integrated into 1 core category.

Table 7

Classification of Core Category, Subcategories, and Indicators for the Learning Activities Element

Code	Core Category	Number of Subcategories	Subcategory	Number of Indicators
1	Intercultural Interaction and Collaboration	2	Collaborative Activities - Multicultural Activities	8

D. Teaching-Learning Strategies Element

Step One: Initial Coding

During the open coding phase, 27 initial codes were identified. After reviewing and eliminating duplicate codes, 15 codes were removed, leaving 12 final codes categorized under subcategories.

Step Two: Axial Coding

Table below presents the results of subcategory classification for the "Teaching-Learning Strategies" element. The purpose of this stage was to establish relationships among the generated criteria.

Table 8

Results of Subcategory Classification for the Teaching-Learning Strategies Element

Criterion	Subcategory	Code
[N1-5] Helping students develop intercultural abilities		
[N14-5] Encouraging students to interact with individuals from different cultures and resolve cultural conflicts		
[N4-6] Reflecting on and analyzing intercultural experiences to improve students' skills	Multicultural Skills	1
[N15-7] Encouraging students to think critically about cultural and social issues		
[N11-6] Allowing the use of various teaching methods for students with different skill levels		
[N12-6] Enhancing teaching methods based on students' diverse needs and conditions		
[N12-7] Preparing teachers to handle unexpected situations and changes in the learning environment	Flexible Teaching	2
[N13-7] Strategies for quickly adapting to new conditions, such as changes in technology access or specific student needs		
[N1-6] Special training for teachers to manage cultural differences among students		
[N3-8] Guides and resources to assist teachers in addressing challenges related to teaching in multicultural environments		
[N15-6] Activities and exercises to help teachers develop intercultural communication skills	Multicultural Teachers	3
[N10-7] Guides and resources to help teachers address challenges related to teaching in multicultural environments		

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Step Three: Selective Coding

Table below presents the results of selective coding, where 12 final codes categorized under 3 subcategories were integrated into 2 core categories.

Table 9

Classification of Core Categories, Subcategories, and Indicators for the Teaching-Learning Strategies Element

Code	Core Category	Number of Subcategories	Subcategory	Number of Indicators
1	Development of Intercultural Skills and Abilities	2	Multicultural Skills - Multicultural Teachers	8
2	Adaptability and Flexibility in Teaching	1	Flexible Teaching	4

E. Space Element

Step One: Initial Coding

During the open coding phase, 16 initial codes were identified. After reviewing and eliminating duplicate codes, 8 codes were removed, leaving 8 final codes categorized under subcategories.

Step Two: Axial Coding

Table below presents the results of subcategory classification for the "Space" element. The purpose of this stage was to establish relationships among the generated criteria.

Table 10

Results of Subcategory Classification for the Space Element

Criterion	Subcategory	Code
[N15-8] Providing students with opportunities to use virtual spaces to interact with students and instructors from different geographic locations		
[N16-6] Utilizing advanced technologies to create diverse virtual educational spaces and simulate various cultural settings		
[N6-7] Enhancing global skills and intercultural understanding through diverse educational experiences	Spatial Diversity with Fractal Characteristics	1
[N13-8] Allowing students to benefit from multicultural and international educational resources		
[N12-8] Incorporating elements from various cultures to help students familiarize themselves with different cultural contexts		
[N1-7] Designing spaces that represent different cultures and promote intercultural interactions		
[N2-8] Helping students develop cultural awareness and a deeper understanding of diverse cultures	Intercultural Space	2
[N3-9] Using tools and platforms that enable students to access and engage with global cultural resources		

Step Three: Selective Coding

Table below presents the results of selective coding, where 8 final codes categorized under 2 subcategories were integrated into 1 core category.

Table 11

Classification of Core Category, Subcategories, and Indicators for the Space Element

Code	Core Category	Number of Subcategories	Subcategory	Number of Indicators
1	Spatial Diversity and Intercultural Interaction	2	Spatial Diversity with Fractal Characteristics - Intercultural Space	8

F. Time Element

Step One: Initial Coding

During the open coding phase, 16 initial codes were identified. After reviewing and eliminating duplicate codes, 8 codes were removed, leaving 8 final codes categorized under subcategories.

Step Two: Axial Coding

Table below presents the results of subcategory classification for the "Time" element. The purpose of this

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stage was to establish relationships among the generated criteria.

Table 12

Results of Subcategory Classification for the Time Element

Criterion	Subcategory	Code
[N2-9] Students' access to educational materials at any convenient time		
[N16-7] Flexibility in scheduling time for assignments and educational activities		
[N13-9] Adjusting the necessary time for activities based on individual pace and abilities	Diverse Scheduling	1
[N14-7] Time adaptability to students' different needs and conditions		
[N5-9] Scheduling educational sessions to allow students adequate time to understand concepts and skills		
[N6-8] Providing students with time for rest and review of educational materials		
[N8-9] Adjusting instructional time for students who require additional time for comprehension	Instructional Time Suitability	2
[N10-9] Allocating more time to challenging topics to encourage student interaction and inquiry		

Step Three: Selective Coding

Table below presents the results of selective coding, where 8 final codes categorized under 2 subcategories were integrated into 1 core category.

Table 13

Classification of Core Category, Subcategories, and Indicators for the Time Element

Code	Core Category	Number of Subcategories	Subcategory	Number of Indicators
1	Flexibility in Educational Timing	2	Diverse Scheduling - Instructional Time Suitability	8

G. Grouping Element

Step One: Initial Coding

During the open coding phase, 16 initial codes were identified. After reviewing and eliminating duplicate codes, 8 codes were removed, leaving 8 final codes categorized under subcategories.

Step Two: Axial Coding

Table below presents the results of subcategory classification for the "Grouping" element. The purpose of this stage was to establish relationships among the generated criteria.

Table 14

Results of Subcategory Classification for the Grouping Element

Criterion	Subcategory	Code
[N9-9] Guidelines for forming multicultural teams to ensure participation of students from diverse cultural backgrounds in educational groups		
[N10-10] Activities and projects requiring effective collaboration among team members from different cultures		
[N4-10] Activities designed to encourage students to learn about and accept cultural differences within educational teams	Multicultural Teams	1
[N11-9] Helping students identify and manage challenges arising from cultural differences in multicultural teams		
[N6-9] Providing resources and tools to help students address specific challenges of working in multicultural groups		
[N13-10] Encouraging students to engage in cultural exchange and learn from one another in multicultural groups		
[N15-10] Offering students opportunities in multicultural groups to receive feedback and improve intercultural skills	Multicultural Group Development	2
[N16-8] Helping students gain a deeper understanding of their group members' cultures and fostering mutual respect		

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Step Three: Selective Coding

Table below presents the results of selective coding, where 8 final codes categorized under 2 subcategories were integrated into 1 core category.

Table 15

Classification of Core Category, Subcategories, and Indicators for the Grouping Element

Code	Core Category	Number of Subcategories	Subcategory	Number of Indicators
1	Collaboration and Enhancement of Intercultural Interactions	2	Multicultural Teams - Multicultural Group Development	8

H. Educational Materials Element

Step One: Initial Coding

During the open coding phase, 28 initial codes were identified. After reviewing and eliminating duplicate codes, 16 codes were removed, leaving 12 final codes categorized under subcategories.

Step Two: Axial Coding

Table below presents the results of subcategory classification for the "Educational Materials" element. The purpose of this stage was to establish relationships among the generated criteria.

Table 16

Results of Subcategory Classification for the Educational Materials Element

Criterion	Subcategory	Code
[N1-10] Introducing students to the history, art, and literature of different cultures		
[N1-11] Addressing intercultural topics such as cultural differences, historical intercultural interactions, and social issues related to multiculturalism		
[N2-11] In-depth exploration of cultures, customs, and beliefs	Multicultural Knowledge	1
[N2-12] Contemporary content for students to better understand current global cultural and societal issues		
[N3-12] Providing resources from various academic and cultural domains to promote diversity		
[N14-10] Utilizing diverse educational resources, including written texts, videos, podcasts, and digital materials, to accommodate different learning styles		
[N12-11] Ensuring variation in format and types of resources to enhance comprehension and engagement	Diverse Resources	2
[N16-10] Providing educational materials in multiple languages for better accessibility		
[N6-10] Implementing programs for continuous updating and enhancement of software and hardware infrastructure		
[N8-11] Using Learning Management Systems (LMS) to ensure necessary security features for protecting student and teacher data		
[N15-11] Implementing appropriate hardware infrastructure, such as servers, storage devices, and high-speed networks, for delivering educational content	Software and Hardware Infrastructure	3
[N16-9] Continuous improvements in technology to optimize students' learning experiences		

Step Three: Selective Coding

Table below presents the results of selective coding, where 12 final codes categorized under 3 subcategories were integrated into 2 core categories.

Table 17

Classification of Core Categories, Subcategories, and Indicators for the Educational Materials Element

Code	Core Category	Number of Subcategories	Subcategory	Number of Indicators
1	Educational Content and Resource Diversity	2	Multicultural Knowledge - Diverse Resources	8
2	Technical and Infrastructure Support	1	Software and Hardware Infrastructure	4

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I. Evaluation Element

Step One: Initial Coding

During the open coding phase, 30 initial codes were identified. After reviewing and eliminating duplicate codes, 18 codes were removed, leaving 12 final codes categorized under subcategories.

Step Two: Axial Coding

Table below presents the results of subcategory classification for the "Evaluation" element. The purpose of this stage was to establish relationships among the generated criteria.

Table 18

Results of Subcategory Classification for the Evaluation Element

Criterion	Subcategory	Code
[N1-12] Assessing students' ability in analysis, critical thinking, and application of knowledge in real-world situations		
[N1-13] Providing qualitative evaluation feedback to help students identify strengths and weaknesses		
[N3-14] Utilizing diverse qualitative evaluation methods such as projects, portfolios, and presentations to assess student performance	Qualitative Evaluation	1
[N16-12] Allowing students to improve the learning process through qualitative feedback		
[N2-13] Using multiple-choice, true/false, and short-answer tests to measure students' understanding and knowledge		
[N4-13] Establishing specific and measurable criteria for quantitative student assessment		
[N9-12] Using quantitative evaluation results as a basis for providing academic guidance and counseling	Quantitative Evaluation	2
[N11-12] Applying statistical analyses to identify strengths and weaknesses in student learning and improve the educational process		
[N5-12] Designing evaluations to ensure that cultural differences do not affect final outcomes and to promote educational equity		
[N9-13] Helping students demonstrate their knowledge and understanding of multicultural issues through evaluation		
[N8-12] Including activities and questions that assess students' ability to interact and collaborate with individuals from different cultures	Multicultural Evaluation	3
[N14-12] Adjusting evaluation tools to prevent cultural bias and ensure equal opportunities for all students to succeed		

Step Three: Selective Coding

Table below presents the results of selective coding, where 12 final codes categorized under 3 subcategories were integrated into 2 core categories.

Table 19

Classification of Core Categories, Subcategories, and Indicators for the Evaluation Element

Code	Core Category	Number of Subcategories	Subcategory	Number of Indicators
1	Assessment and Evaluation Methods	2	Qualitative Evaluation - Quantitative Evaluation	8
2	Cultural Sensitivity and Adaptability	1	Multicultural Evaluation	4

Following the completion of the qualitative phase and the identification of main categories, subcategories, and indicators, the final *Fractal Virtual Curriculum Model with an Intercultural Approach* for Farhangian University is presented in Figure (1):

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Figure 1

Final Research Model

4. Discussion and Conclusion

The findings of the present study led to the development of a Fractal Virtual Curriculum Model with an Intercultural Approach tailored to Farhangian University. Through qualitative methodology and inductive content analysis, the study identified nine core curriculum elements—objectives, content, learning activities, teaching-learning strategies, space, time, grouping, educational materials, and evaluation—each containing associated main categories, subcategories, and indicators. The overall model embraces fractal logic, highlighting recursive, non-linear relationships among curriculum components and mirroring the structural and cultural complexity of higher education in virtual environments. This section discusses the research results in light of the theoretical framework and previous literature, supporting the model's applicability and relevance.

The objective element of the model included subcategories such as cultural cohesion, educational equity, and familiarity with multicultural concepts. These components reflect the broader aim of promoting intercultural understanding and social justice in virtual curriculum design. This finding aligns with Mostafazadeh et al. (2019), who emphasized the foundational role of multicultural education in creating peaceful coexistence, cultural tolerance, and equal opportunity for all learners (Mostafazadeh et al., 2019). Similarly, Eini et al. (2018) argue that curriculum objectives must reflect the realities of pluralistic societies and actively engage learners in critical reflection on diversity and cultural dynamics (Eini et al., 2018). The model's emphasis on educational equity also echoes the findings of Lavasani et al. (2020), who concluded that educators with positive experiences of multicultural practices are more likely to foster inclusive learning goals and address systemic inequities in student engagement (Lavasani et al., 2020).

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The content element identified multicultural content, multicultural literacy, and cultural intelligence as core themes. These results are consistent with Arruzza and Chau (2021), who found that the inclusion of culturally relevant material enhances students' knowledge acquisition, attitudes, and satisfaction (Arruzza & Chau, 2021). Likewise, Bezi et al. (2024) demonstrated that content diversity—when aligned with educational philosophy—can support the holistic development of learners and the internalization of global perspectives (Bezi et al., 2024). The integration of content drawn from diverse histories, traditions, and worldviews positions the learner to become a culturally aware global citizen, which is especially critical in virtual classrooms where boundaries between local and global knowledge blur. The fractal structuring of content also reflects the recursive layering and interconnection of learning experiences, as conceptualized by Shahbazi et al. (2020a) in their application of fractal theory to doctoral curriculum design (Shahbazi, 2020).

In the realm of learning activities, the model emphasized participatory and multicultural experiences that facilitate cultural interaction and cooperative engagement. This is supported by De Hei et al. (2019), who emphasized that collaborative learning in international higher education contributes significantly to the development of intercultural competence (De Hei et al., 2019). The findings of the current study suggest that incorporating group projects, intercultural dialogue, and reflective exercises enhances not only knowledge but also empathy and cross-cultural communication. According to Shahbazi et al. (2020b), such practices are essential to achieving the symbolic "unity in diversity" inherent in intercultural curriculum models, where complex interactions among learners replicate the intricate patterns of fractal systems (Shahbazi et al., 2020).

Teaching-learning strategies were found to be most effective when centered on multicultural skills, flexible pedagogy, and teacher preparedness. This is consistent with Lisa et al. (2016), who argue that personalizing professional development based on faculty cultural responsiveness and adaptability significantly improves teaching quality in diverse classrooms (Lisa et al., 2016). The model confirms that flexibility in instructional methods and responsiveness to cultural differences are not optional features but fundamental requirements for virtual learning environments. Similarly, de Melo Ghisi et al. (2023) highlight the necessity of equipping educators with a toolkit of pedagogical and technological strategies to support intercultural instruction in online settings (de Melo Ghisi et al., 2023). Shahbazi et al. (2020a) also assert that educators must be conceptualized as dynamic agents in a fractal curriculum model, continuously adapting their strategies to meet evolving learner needs and contexts (Shahbazi, 2020).

The spatial element, conceptualized through "spatial diversity with fractal logic" and "intercultural space," underscores the importance of designing inclusive digital environments that reflect and support diverse cultural identities. This result affirms the arguments made by Baghershahi et al. (2023), who found that students perceive virtual educational platforms not merely as neutral technologies but as cultural spaces that shape interaction, identity, and learning (Baghershahi et al., 2023). Hu (2023) supports this idea through his application of fractal theory to human systems, illustrating how complex recursive structures can model dynamic social environments—including educational ones (Hu, 2023). From this perspective, virtual learning environments must be intentionally designed to foster cultural exchange, simulate real-world diversity, and support intercultural learning trajectories.

Temporal flexibility, captured in the elements of "scheduling diversity" and "instructional time relevance," emerged as essential in supporting intercultural learners. Islam and Azad (2015) argue that temporal adaptability—allowing students to learn at their own pace and in alignment with their schedules—is a critical predictor of satisfaction in learning management systems (Islam & Azad, 2015). In addition, Warren et al. (2021) found that virtual curricula must accommodate variable learning times and cultural rhythms to support knowledge retention and learner confidence in diverse regional contexts (Warren et al., 2021). By integrating flexible time management into the model, this study confirms that curricular time is not neutral—it carries sociocultural weight and must be adapted accordingly.

The grouping element incorporated both the formation of multicultural teams and the development of such groups into collaborative learning environments. These findings are consistent with Bikbulatova et al. (2016), who emphasize that anticipatory curriculum design must build mechanisms for cultural interaction and team-based problem-solving into educational frameworks (Bikbulatova et al., 2016). Moreover, Hariri (2020) highlights that social constructivist learning, when applied in multicultural teams, fosters the shared construction of meaning and promotes deeper learning outcomes (Hariri, 2020). The recursive dynamics of team learning within this model reflect the self-similar and

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scalable nature of fractals, in which small interactions replicate and influence broader educational patterns.

In the domain of educational materials, the study categorized multicultural knowledge, diverse learning resources, and infrastructure (both software and hardware) as critical for supporting intercultural virtual learning. These findings reflect the insights of Ghanbari et al. (2019), who proposed that effective e-learning environments must be backed by accessible, multilingual, and multimodal educational resources tailored to diverse learner needs (Ghanbari et al., 2019). Mostafaei and Hoseini (2021) add that curricular content must be continuously updated to reflect social responsibilities and stakeholder interests, especially in terms of cultural representation and inclusion (Mostafaei & Hoseini, 2021). Furthermore, Corbin and Strauss (2021) suggest that meaningful educational change is contingent upon a grounded understanding of the learner's context, reinforcing the role of diverse materials as mediators between the individual and the curriculum (Corbin & Strauss, 2021).

Finally, in the evaluation element, the study proposed a triadic structure of qualitative, quantitative, and multicultural assessment mechanisms. The need for multidimensional evaluation is supported by Savari and Savari (2022), who observed that students feel more validated when assessment processes reflect their cultural identities and accommodate diverse expressions of learning (Savari & Savari, 2022). Shamsirgaran et al. (2019) argue that assessments in virtual settings must be context-sensitive and formative, offering students continuous feedback and allowing for iterative improvement (Shamsirgaran et al., 2019). Furthermore, Sabouri et al. (2020) confirm that curriculum reform requires shifting from standardized testing toward assessments that recognize cognitive, cultural, and emotional dimensions of learning (Sabouri et al., 2020).

Together, these findings validate the theoretical assertion by Ornstein and Hunkins (2018) that curriculum must be rooted in evolving social, psychological, and philosophical understandings of education (Ornstein & Hunkinks, 2018). The fractal model proposed in this study offers a systemic yet flexible framework for integrating intercultural values and technological responsiveness in virtual education.

While the study offers significant conceptual contributions, it is not without limitations. First, the research was conducted using qualitative methods with a purposive sample of experts, which, while rich in insight, may not be generalizable across all higher education contexts. The reliance on expert interviews, though suitable for theory-building, may also introduce subjectivity and interpretation bias. Furthermore, the model has not yet been piloted or tested in real-world educational settings to evaluate its practical impact on learning outcomes.

Future studies could extend the current findings through mixed-methods or longitudinal research designs. Quantitative validation of the model across different academic institutions and cultural contexts would provide empirical grounding for its broader applicability. Comparative studies across countries, disciplines, or student demographics may also uncover specific variables that affect the model's adaptability and success. Additionally, the role of emerging technologies such as AI, VR, or blockchain in supporting the fractal and intercultural dimensions of the curriculum warrants detailed investigation.

Curriculum designers, educational technologists, and academic policymakers should consider integrating the principles of the fractal model into their virtual program planning. Teacher training programs must include intercultural pedagogy and flexible instructional strategies as core competencies. Furthermore, educational institutions should invest in multilingual and multimedia learning materials, ensure infrastructure readiness, and design culturally responsive evaluation systems. Embracing such a model will allow universities to create inclusive, adaptive, and future-ready learning environments that genuinely reflect the complexity and diversity of global higher education.

Authors' Contributions

Authors equally contributed to this article.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

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