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Designing a Metaverse-Based Curriculum Model for Iranian Secondary Education: A Grounded Theory Study

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ABSTRACT

Purpose: This study aimed to develop a context-sensitive and indigenous model for designing and implementing a metaverse-based curriculum in Iranian secondary education.

Methods and Materials: This qualitative study employed grounded theory based on the systematic approach of Corbin and Strauss. The research field included secondary-school teachers, curriculum planners, educational technology specialists, school principals, and students in Tehran who were familiar with digital technologies and immersive learning environments. Participants were recruited through purposive maximum-variation and snowball sampling, with sampling continuing until theoretical saturation. Saturation was achieved after 28 interviews, followed by three confirmatory interviews, resulting in 31 participants. Data were collected through in-depth semi-structured interviews and analyzed concurrently using open, axial, and selective coding. MAXQDA 2025 was used to organize and manage the qualitative data. Trustworthiness was established through credibility, transferability, dependability, and confirmability procedures, including member checking, peer review, triangulation, an audit trail, and independent coding.

Findings: The analysis indicated that metaverse-based curriculum development is a systemic and context-dependent process rather than a solely technological intervention. The central phenomenon was identified as the design and implementation of a metaverse-based curriculum within the Iranian secondary education system, while the core category emphasized the development of a context-sensitive indigenous curriculum model. Causal conditions reflected the inadequacy of traditional educational approaches and opportunities arising from technological and global developments. Contextual conditions included national policies, technical infrastructure, sociocultural attitudes, and digital competencies. Institutional facilitators and barriers shaped implementation, while the principal strategies involved instructional design, human-resource empowerment, assessment and data analysis, localization and educational equity, and intersectoral collaboration. The model suggested that appropriate implementation could enhance motivation, interaction, higher-order thinking, digital literacy, and experiential learning, whereas inadequate implementation could intensify cognitive load, technological dependence, privacy concerns, and educational inequalities.

Conclusion: Effective integration of the metaverse into Iranian secondary education requires coordinated alignment among curriculum design, teacher competencies, infrastructure, cultural localization, ethical governance, assessment systems, institutional support, and equitable access rather than technology-centered implementation.

Keywords: *Metaverse; Curriculum Design; Secondary Education; Grounded Theory; Immersive Learning; Educational Technology; Iran*

1. Introduction

The rapid expansion of digital technologies has transformed the conceptual boundaries of teaching and learning and has encouraged educational systems to reconsider the nature of curriculum, instructional interaction, learning environments, and the roles of teachers and students. Among emerging technologies, the metaverse has attracted increasing attention because it moves beyond conventional forms of online learning toward persistent, immersive, interactive, and socially constructed digital environments in which learners can participate through virtual representations, manipulate simulated objects, communicate with others, and experience situations that may be difficult, costly, dangerous, or impossible to reproduce in conventional classrooms. In educational contexts, the metaverse may be understood not simply as a technological platform but as an interconnected learning ecosystem combining extended reality, virtual reality, augmented reality, artificial intelligence, digital avatars, simulation, social interaction, and data-driven personalization. Consequently, its educational significance lies in its potential to alter not only where learning takes place but also how curricular objectives are formulated, how content is represented, how students participate in learning activities, how teachers facilitate learning, and how assessment is conducted. Reviews of metaverse-based education have therefore emphasized both its transformative potential and the need for careful attention to pedagogical, technological, ethical, and social challenges associated with its implementation (Meehan et al., 2024; Tlili et al., 2022).

The educational potential of the metaverse is particularly relevant to secondary education, a developmental stage during which learners encounter increasingly complex disciplinary knowledge while simultaneously developing autonomy, problem-solving ability, social identity, digital competence, and higher-order thinking skills. Traditional classroom structures frequently rely on textbooks, teacher-centered explanation, predetermined pacing, and relatively limited opportunities for experiential exploration. Although such approaches continue to play an important role, they may not fully address the learning characteristics of adolescents who increasingly interact with networked, multimedia, and digitally mediated environments. Metaverse-supported learning may provide opportunities to create three-dimensional representations of abstract concepts, reconstruct historical or scientific environments, conduct virtual experiments, facilitate collaborative problem solving, and allow learners to experience curricular content rather than merely receive verbal or textual descriptions of it. Research concerning science education in secondary schools has particularly highlighted the relevance of metaverse environments for visualization, simulation, experimentation, and active learner participation, suggesting that immersive environments may create new possibilities for the teaching of concepts that are difficult to demonstrate within conventional classrooms (Ghasemi et al., 2025; Hafezi et al., 2025).

One of the most frequently discussed educational advantages of immersive technologies is their capacity to facilitate experiential and situated learning. In metaverse environments, learners can participate in scenarios that resemble authentic situations, interact with objects or processes, collaborate with peers, and observe the consequences of their decisions. These characteristics can support a shift from passive reception of information toward learning through exploration, inquiry, experimentation, and reflection. Systematic evidence regarding immersive technologies suggests that such environments can contribute positively to learning performance and intrinsic motivation when instructional activities are appropriately designed, although their effects are strongly influenced by cognitive load, usability, task design, and the degree to which immersion serves meaningful educational purposes rather than functioning as an end in itself (Poupard et al., 2025). Similarly, research examining the broader educational implications of the metaverse has shown that immersive learning can potentially expand access to high-quality educational experiences by enabling students to participate in learning environments and simulations that may otherwise be geographically, economically, or institutionally inaccessible (Almahdi et al., 2025). These findings suggest that the educational value of the metaverse depends less on the novelty of the technology itself than on the quality of the curricular and pedagogical framework within which it is employed.

The development of a metaverse-based curriculum therefore requires reconsideration of conventional curriculum elements. Educational objectives in immersive environments may extend beyond subject-matter acquisition to include digital literacy, creativity, collaborative problem solving, critical thinking, communication, self-regulation, and ethical participation in digital environments. Curriculum content may need to become more interactive, multimodal, dynamic, and adaptable, while teaching methods may shift toward simulation, problem-based learning, project-based

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learning, collaborative inquiry, and experiential learning. Assessment may likewise move beyond static examinations toward continuous observation of learner interactions, performance-based tasks, behavioral analytics, and evidence collected throughout the learning process. Iranian curriculum researchers have increasingly emphasized that the metaverse should be conceptualized in relation to the complete architecture of curriculum rather than treated merely as an additional educational technology. Studies focusing on curriculum elements in metaverse environments have identified the need to reconsider educational goals, content organization, learning activities, teacher and learner roles, assessment processes, and technological requirements as interconnected components of a coherent curricular system (Akbari & Roudi Aliabadi, 2025; Khosravi et al., 2025).

An important dimension of this transformation concerns personalization and adaptive learning. Conventional secondary-school curricula are generally designed for relatively standardized progression, even though students differ substantially in prior knowledge, learning pace, interests, motivation, and cognitive needs. Metaverse environments integrated with artificial intelligence can potentially generate more adaptive learning pathways by monitoring learner performance, identifying patterns of interaction, and adjusting tasks, feedback, or levels of difficulty accordingly. Such environments may permit students to move through learning experiences at differentiated speeds and to receive more individualized instructional support. Research on adaptive learning in metaverse environments has highlighted the potential of artificial intelligence to support personalized learning trajectories and to align instructional experiences more closely with individual learner characteristics (Rezaei et al., 2025). The use of behavioral data generated in virtual and immersive environments may further provide teachers and educational systems with new forms of information about student engagement, decision-making, participation, and learning processes. Studies concerned with learner behavior analysis in virtual reality environments have consequently underscored the importance of valid approaches to interpreting behavioral indicators if such data are to be used meaningfully for educational assessment and decision-making (Mousavi et al., 2024).

The changing nature of curriculum in immersive environments also transforms the role of the teacher. In conventional instruction, teachers are often the primary organizers and transmitters of curriculum content; however, metaverse-supported learning requires teachers to perform more complex roles as learning designers, facilitators, moderators, technological guides, evaluators, and guardians of students' ethical and psychological safety. Teachers must be able to determine when an immersive activity provides genuine pedagogical value, select or design appropriate virtual experiences, manage interaction within digital environments, support learners experiencing cognitive or technical difficulties, and integrate virtual experiences with broader curricular goals. Iranian scholarship on metaverse-based education has emphasized that the teacher remains central rather than becoming obsolete, but that the competencies required of teachers change substantially in immersive learning settings (Ahmadi, 2024). International work on extended-reality-specific teacher competencies similarly indicates that existing digital competence frameworks need to be expanded to include capacities related to immersive learning design, management of virtual environments, embodied interaction, safety, accessibility, and the pedagogically meaningful use of XR technologies (Niels & Schröder, 2025). Teacher preparation and continuing professional development are therefore fundamental prerequisites for any sustainable metaverse-based curriculum.

At the same time, the educational adoption of the metaverse cannot be separated from issues of access, equity, and inclusion. Immersive education often requires reliable high-speed connectivity, appropriate computing devices, virtual reality headsets or related hardware, technical support, and accessible digital content. Unequal access to these resources can create new forms of educational disadvantage or intensify existing inequalities between regions, schools, socioeconomic groups, and learners with different physical or educational needs. Although metaverse environments have the potential to expand access to rich educational experiences, this potential can only be realized when inclusion is explicitly incorporated into curriculum design and implementation. Recent research examining the relationship between the metaverse and educational equity has emphasized that immersive technologies can contribute to the development of STEM competencies and broaden access to learning opportunities, but only if infrastructural, accessibility, and socioeconomic barriers are systematically addressed (Khadivi, 2026). A multilayer model of the metaverse classroom has similarly emphasized the importance of designing immersive education as an inclusive ecosystem in which technological, pedagogical,

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social, and accessibility dimensions operate together rather than independently (Nouraee Yeganeh et al., 2025).

These concerns are particularly important in the Iranian educational context. Iranian schools differ considerably in access to digital infrastructure, technological equipment, trained personnel, and organizational support. The introduction of immersive technologies into secondary education therefore cannot be approached through simple transfer of models developed in technologically advanced educational systems. Structural barriers such as inadequate infrastructure, financial limitations, shortages of appropriate hardware, inconsistencies in technological readiness, centralized administrative structures, and weaknesses in professional training may substantially influence implementation. Recent analysis of structural barriers to metaverse implementation in Iranian schools has demonstrated that successful adoption depends on institutional readiness and coordinated planning rather than merely the availability of individual technological tools (Karimi et al., 2026). Feasibility studies of the application of the metaverse in education have similarly indicated that technological, pedagogical, organizational, and human factors must be evaluated together before large-scale implementation can be considered realistic (Talebi-Anas & Razghi Sharsavar, 2026). Thus, a curriculum model intended for Iranian secondary education must be grounded in the actual capacities and limitations of the educational system.

In addition to structural constraints, cultural compatibility constitutes a central issue in designing metaverse-based curricula. Curriculum is not culturally neutral; educational objectives, representations of knowledge, acceptable forms of interaction, teacher–student relationships, ethical norms, and expectations concerning schooling are embedded within particular social and cultural contexts. Virtual worlds developed in global technology markets may embody assumptions, symbols, interactional norms, or forms of representation that do not necessarily correspond to the cultural, religious, linguistic, and educational expectations of Iranian schools. Localization therefore involves considerably more than translating interfaces or instructional text into Persian. It requires ensuring that learning scenarios, avatars, communication structures, values, visual representations, and pedagogical activities are compatible with the cultural and ethical expectations of learners, families, teachers, and educational authorities. Research specifically addressing localization of metaverse curricula in Iranian schools has identified cultural and educational barriers as major determinants of acceptance and has emphasized the necessity of culturally responsive curriculum development (Safari, 2025). Accordingly, the construction of an indigenous model requires balancing the global affordances of emerging technologies with the local values, expectations, and institutional characteristics of Iranian education.

The establishment of national standards and governance mechanisms is another essential dimension of metaverse-based curriculum development. Immersive environments raise questions regarding the quality and validity of educational content, student data protection, privacy, identity management, appropriate forms of interaction, intellectual property, platform security, assessment credibility, and the boundaries of commercial involvement in education. These issues become particularly significant when the users are adolescents. Without clear standards, schools may adopt incompatible platforms, teachers may rely on content of uneven educational quality, and students may be exposed to risks that existing school regulations were not designed to address. Research on technological learning models for Iranian schools has emphasized the need for systematic alignment among infrastructure, pedagogy, institutional support, and emerging technological capabilities (Forouzanmehr et al., 2025). Likewise, investigations into the dimensions of metaverse implementation in Iranian educational settings indicate that curriculum design must be supported by coherent policy structures if the technology is to move beyond isolated experimentation (Ghasemi et al., 2025; Hafezi et al., 2025). A sustainable model must consequently connect classroom-level instructional design with broader organizational and policy-level arrangements.

Another challenge concerns the cognitive consequences of immersive learning. The richness and interactivity of three-dimensional environments can increase engagement, but they can also expose learners to large amounts of simultaneous visual, auditory, spatial, and interactive information. Poorly designed environments may therefore increase extraneous cognitive load, distract learners from instructional goals, and produce fatigue or disorientation. Evidence from research on immersive educational technologies indicates that learning outcomes vary according to the relationship between immersion, task complexity, cognitive load, and learner motivation (Poupard et al., 2025). The metaverse should thus not be assumed to improve learning simply because it offers a more technologically advanced environment. Effective curriculum design requires careful control of sensory complexity, sequencing of learning activities, scaffolding, duration of immersion, and the alignment of interactive features with intended learning outcomes. This issue is especially important for adolescents, whose self-regulation and attentional control may still be developing and who may differ considerably in prior experience with immersive technologies.

Ethical concerns similarly complicate the educational use of the metaverse. Immersive platforms can generate extensive data regarding users' movements, interactions, preferences, responses, and behavioral patterns. While these data can support personalized learning and formative assessment, they can also create risks involving privacy, surveillance, profiling, and inappropriate use of student information. In addition, interaction through avatars may raise questions about identity, interpersonal conduct, harassment, psychological safety, and boundaries between educational and recreational digital environments. Critical reviews of metaverse education have cautioned that its benefits coexist with significant concerns related to privacy, security, addiction, accessibility, social isolation, and ethical governance (Meehan et al., 2024; Tlili et al., 2022). Consequently, ethical safeguards must be treated as an integral component of curriculum design rather than as a secondary technical issue. Curriculum designers must consider what data should be collected, who should have access to them, how student identities should be protected, how acceptable behavior should be regulated, and how virtual learning experiences can remain developmentally appropriate.

Despite these challenges, recent Iranian scholarship demonstrates growing interest in developing educational models suited to emerging immersive technologies. Researchers have examined curriculum components, implementation requirements, science education applications, teacher roles, technological learning models, localization needs, learner analytics, and structural barriers (Akbari & Roudi Aliabadi, 2025; Forouzanmehr et al., 2025; Ghasemi et al., 2025; Khosravi et al., 2025). These studies represent important steps toward understanding the educational implications of the metaverse. However, much of the existing work addresses particular dimensions of the phenomenon separately. Some studies emphasize technology and infrastructure, others focus on instructional applications, and others examine particular curriculum elements or subject areas. As a result, there remains a need for a comprehensive model capable of explaining how causal conditions, contextual characteristics, institutional facilitators and barriers, instructional strategies, human resource requirements, localization, equity, assessment, and educational consequences interact within the specific context of Iranian secondary education.

This gap is significant because curriculum design is fundamentally systemic. A metaverse-based curriculum cannot function effectively if technologically sophisticated learning scenarios are developed without teacher preparation, if personalized assessment is introduced without ethical data governance, or if high-quality virtual content is created while significant groups of students lack adequate technological access. Similarly, localization cannot be treated independently of pedagogical design, and infrastructure cannot be separated from national policy and institutional support. Research on multilayer immersive classroom models has emphasized that effective metaverse education requires coordination across technological, pedagogical, social, and organizational layers (Nouraee Yeganeh et al., 2025). Evidence regarding quality educational access further suggests that the benefits of immersive environments depend on how these interconnected layers are organized and made available to learners (Almahdi et al., 2025). What is therefore required is not simply a list of curriculum components, but an explanatory model showing how the different conditions and processes surrounding metaverse-based curriculum development relate to one another.

The exploratory nature of this problem makes qualitative theory-building particularly valuable. Because the educational metaverse remains an emerging phenomenon and its implementation within Iranian secondary education is still developing, predetermined models may fail to capture context-specific concerns raised by teachers, curriculum specialists, school administrators, educational technology experts, and students. Generating a model from the experiences and interpretations of these stakeholders allows categories and relationships to emerge from the educational context itself. Systematic qualitative coding provides a means of moving from participants' detailed accounts toward higher-order concepts and integrated theoretical explanation, while preserving sensitivity to context and variation within the data (Saldaña, 2025). Such an approach is especially appropriate when the purpose is to develop an indigenous curriculum framework rather than merely test the applicability of an imported model.

Recent Iranian studies have also begun to indicate the need for such integrative work. Investigations of technological learning in schools have proposed the

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importance of aligning emerging technology with curriculum and organizational structures (Forouzanmehr et al., 2025); studies of metaverse curriculum elements have highlighted interconnected curricular dimensions (Akbari & Roudi Aliabadi, 2025; Khosravi et al., 2025); analyses of localization have demonstrated the centrality of culture and educational context (Safari, 2025); and structural analyses have documented the barriers that may impede implementation at the school-system level (Karimi et al., 2026). At the same time, feasibility research suggests that adoption must be approached realistically in relation to available resources and institutional readiness (Talebi-Anas & Razghi Sharsavar, 2026), while emerging international research emphasizes the importance of teacher competence, inclusion, cognitive design, personalization, and educational equity (Khadivi, 2026; Niels & Schröder, 2025; Rezaei et al., 2025). Taken together, these findings indicate that metaverse-based curriculum development must be conceptualized as a multidimensional educational transformation involving technology, pedagogy, culture, human resources, governance, equity, and ethics.

The need for a comprehensive model is further reinforced by the distinctive characteristics of secondary education. Secondary schools operate at the intersection of centralized curriculum requirements, disciplinary specialization, adolescent developmental needs, high-stakes assessment, teacher subject expertise, family expectations, and preparation for higher education or employment. Introducing the metaverse into this environment affects not only teaching methods but also the relationships among curriculum objectives, subject content, student agency, assessment practices, school organization, and educational equality. Without a coherent framework, implementation may remain fragmented, technology-driven, and dependent on isolated initiatives. Conversely, a context-sensitive curriculum model could provide a conceptual foundation for policymakers, curriculum planners, school administrators, teachers, and educational technology developers to coordinate decisions regarding educational goals, infrastructure, content, instructional strategies, assessment, teacher development, localization, and ethical safeguards. Such a model may also help ensure that metaverse adoption is driven by educational needs rather than technological enthusiasm and that innovation remains aligned with the cultural and institutional realities of Iranian schools.

Accordingly, the aim of the present study was to develop a context-sensitive, indigenous model for designing a metaverse-based curriculum in Iranian secondary education through a qualitative grounded theory approach.

2. Methods and Materials

2.1. Study Design and Participants

This study employed a qualitative research design based specifically on grounded theory, following the systematic approach proposed by Corbin and Strauss (2015). Grounded theory was selected because of the exploratory and theory-generating nature of the research problem. Despite the growing scholarly attention devoted to immersive technologies, virtual reality, and the metaverse in education, there remains a lack of a comprehensive, coherent, and context-sensitive model for designing a metaverse-based curriculum for Iranian secondary education. Accordingly, rather than testing a predetermined theoretical framework, the study sought to generate a conceptual model inductively from participants' experiences, perceptions, and professional knowledge. This approach made it possible to identify the conditions, processes, interactions, strategies, and consequences associated with the design and implementation of a metaverse-based curriculum while taking into account the cultural, educational, technological, and social characteristics of the Iranian educational context. Consistent with grounded theory methodology, data collection and analysis proceeded concurrently, and emerging concepts continuously informed subsequent sampling, questioning, and analytical decisions.

The research field comprised individuals directly or professionally associated with secondary education and educational technology in Tehran, including upper-secondary teachers, curriculum planners, educational technology specialists, school principals, and students enrolled in Grades 10 to 12. Eligibility was primarily based on participants' ability to provide informed and experience-based perspectives regarding curriculum design, digital learning, virtual environments, or emerging technologies such as virtual reality and the metaverse. Participants were selected through purposive sampling with maximum variation in order to capture diverse viewpoints across professional roles, academic backgrounds, teaching disciplines, managerial experiences, and student grade levels. Snowball sampling was also employed to identify and recruit additional key informants whose expertise was considered particularly relevant to the emerging categories. In accordance with grounded theory principles, the sample size was not determined in advance. Instead, sampling continued until theoretical saturation was achieved, defined as the point at which additional interviews no longer generated substantively new properties, dimensions, concepts, or relationships relevant to the developing categories.

Theoretical saturation was reached after 28 interviews, at which point the emerging categories had become sufficiently developed and additional data produced substantial repetition rather than new conceptual insights. Nevertheless, three supplementary interviews were conducted to verify the stability and completeness of the emerging theoretical structure. These additional interviews did not yield new categories or modify the conceptual relationships already identified. The final sample therefore consisted of 31 participants. This group included 12 secondary-school teachers representing different subject areas, including experimental sciences, mathematics, Persian literature, and English language; eight curriculum planners and educational technology specialists holding doctoral degrees and having published at least one scholarly work related to emerging educational technologies; four school principals with managerial experience in smart or technology-enhanced schools; and seven students from Grades 10 to 12. The inclusion of participants from different stakeholder groups was intended to provide a multidimensional understanding of metaverse-based curriculum design and to ensure that the emerging model reflected pedagogical, technological, managerial, curricular, and learner-centered perspectives rather than the assumptions of a single professional group.

2.2. Instruments

The primary data collection instrument was the in-depth semi-structured interview. This method was selected because it combines a degree of thematic consistency across participants with sufficient flexibility to investigate unexpected ideas, experiences, concerns, and interpretations as they emerge during the interview process. Semi-structured interviewing was particularly appropriate for grounded theory because it enabled the researchers to begin with broad sensitizing questions while progressively refining the interview focus in response to concepts generated during concurrent data analysis. The interview format therefore included both predetermined open-ended questions and exploratory probes that allowed participants to elaborate on their responses, provide examples, clarify meanings, and discuss contextual factors affecting the feasibility of metaverse-based education. The interviewer maintained the general direction of the discussion while avoiding rigid adherence to a fixed sequence of questions, thereby allowing relevant concepts to emerge from participants' accounts (Brinkmann & Kvale, 2018).

An initial interview guide was developed on the basis of the conceptual literature on curriculum design, educational technology, immersive learning environments, virtual reality, and metaverse-supported education. The preliminary guide was organized around seven broad sensitizing domains: educational objectives, curriculum content, teaching and learning methods, assessment, technological and organizational infrastructure, educational inclusion and equity, and the changing role and competencies of teachers. These domains were used only as an initial orientation for entering the field and were not treated as fixed analytical categories. In keeping with grounded theory logic, the interview guide evolved during data collection as new concepts and relationships became visible through constant comparison. Examples of the guiding questions included: "What do you consider to be the most important educational goals of a metaverse-based curriculum at the secondary-school level?"; "What characteristics should curriculum content have when it is presented in a metaverse environment?"; "How would teachers' instructional methods in a metaverse classroom differ from conventional teaching approaches?"; "How should student learning be assessed in a metaverse-based curriculum?"; "What barriers may prevent equal student access to metaverse-based learning in Iran?"; and "What is the role of the teacher in a metaverse classroom, and what competencies would teachers need to perform that role effectively?" Follow-up questions such as "Can you explain this further?", "What conditions would make this possible?", "What challenges might arise?", and "Can you provide an example from your experience?" were used to deepen the interviews and clarify the properties and dimensions of emerging concepts.

All interviews were conducted after obtaining participants' informed consent. With prior permission, the interviews were audio-recorded to ensure accurate preservation of participants' statements and were subsequently transcribed verbatim. Interview transcripts were repeatedly reviewed alongside field notes and analytical memos generated during the data collection process. Data collection was closely integrated with analysis, meaning that insights obtained from earlier interviews shaped the focus of subsequent interviews and assisted in identifying participants who could elaborate on insufficiently developed categories. This iterative movement

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between data collection, coding, comparison, and further sampling was continued until theoretical saturation was established. MAXQDA 2025 qualitative data analysis software was used to organize interview transcripts, manage codes and categories, retrieve coded segments, document analytical memos, and facilitate the systematic comparison of data across participants. The software functioned as an organizational and data-management environment, whereas all conceptual decisions, interpretations, category development, and theoretical integration were undertaken by the researchers.

To strengthen the trustworthiness of the qualitative inquiry, the criteria of credibility, transferability, dependability, and confirmability proposed by Lincoln and Guba (1985) were considered throughout the research process. Credibility was enhanced through prolonged engagement with the data, iterative interviewing, member checking, peer review of emerging interpretations, and comparison of perspectives obtained from different stakeholder groups. Selected participants were provided with summaries of key interpretations to determine whether the researchers' understanding appropriately reflected their experiences and perspectives. Peer debriefing was also used to critically examine preliminary codes, conceptual boundaries, and relationships among categories. Maximum-variation sampling and the inclusion of teachers, specialists, principals, and students further strengthened credibility by allowing emerging concepts to be examined from different positions within the educational system. Transferability was supported through detailed descriptions of the research context, participant characteristics, sampling logic, interview procedures, and analytical process, enabling readers to judge the potential relevance of the findings to other educational settings. Dependability and confirmability were reinforced by maintaining an audit trail containing interview recordings, verbatim transcripts, coding files, category-development records, analytical memos, methodological decisions, and successive versions of the emerging theoretical model. As an additional check on coding consistency, two independent coders examined three randomly selected interviews. Intercoder agreement was assessed using Cohen's kappa and yielded a coefficient of 0.86, indicating a high level of agreement in the application and interpretation of the coding framework.

2.3. Data Analysis

Data analysis was conducted concurrently with data collection and followed the open, axial, and selective coding procedures associated with the systematic grounded theory approach of Corbin and Strauss (2015). The analytical process was iterative rather than strictly linear, with the researchers repeatedly moving between raw interview data, initial codes, categories, theoretical comparisons, analytical memos, and emerging relationships. Constant comparison served as a central analytical technique throughout the study. Each new segment of data was compared with previously coded segments, codes were compared with other codes, and emerging categories were compared across participants and stakeholder groups. This continuous comparative process enabled the researchers to identify conceptual similarities and differences, refine category boundaries, determine the properties and dimensions of categories, and progressively increase the level of abstraction of the analysis.

During open coding, each interview transcript was read carefully and examined line by line. Analytical questions were continually posed to the data, including what was occurring in a particular statement, what experience or process the participant was describing, under what conditions the phenomenon occurred, what actions were taken, and what consequences followed. Meaningful segments were assigned conceptual labels. Some codes were formulated as in vivo codes that preserved participants' own expressions, whereas others were researcher-generated codes representing a more abstract interpretation of the underlying meaning. Coding remained deliberately open during the early stages so that the analysis would not be prematurely constrained by the seven sensitizing domains contained in the initial interview guide. Across approximately 310 pages of transcribed interview material, more than 250 preliminary concepts were initially identified. Through repeated comparison, elimination of redundant codes, merging of conceptually overlapping labels, and refinement of conceptual definitions, these were progressively reduced to 48 final concepts organized within 18 initial categories. Analytical memos were written throughout this stage to document conceptual insights, questions, comparisons, potential relationships, and decisions concerning category development.

Axial coding was then used to reassemble the data by identifying systematic relationships among the categories and subcategories developed during open coding. Particular attention was given to the conditions giving rise to the phenomenon, the contextual characteristics within which it occurred, intervening conditions that facilitated or constrained its development, the actions and interactional strategies adopted by relevant actors, and the consequences resulting from those strategies. The categories were therefore organized through the paradigm model proposed by Corbin and Strauss (2015), incorporating causal conditions, the central phenomenon, contextual conditions, intervening conditions, strategies or interactions, and consequences. Through repeated comparison of participants' accounts and examination of relationships among categories, "the design and implementation of a metaverse-based curriculum within the Iranian secondary education system" emerged as the central phenomenon around which the other categories could be meaningfully organized. Relationships were continually tested against the interview data to ensure that the developing paradigm reflected participants' accounts rather than an externally imposed theoretical structure.

During selective coding, the researchers integrated and refined the categories around a central category capable of explaining the overall process identified through the study. The central category was conceptualized as "designing a context-sensitive indigenous model of a metaverse-based curriculum." This category provided the highest level of theoretical integration because it connected the pedagogical, technological, organizational, cultural, equity-related, and professional dimensions identified across the interviews. A storyline was subsequently developed to explain how causal and contextual conditions contributed to the emergence of the need for metaverse-based curriculum design, how intervening factors influenced its feasibility, what strategies were required for its implementation, and what educational consequences could potentially result from those strategies. Throughout selective coding, categories that were insufficiently developed were revisited through the original transcripts and analytical memos, while relationships were refined until the theoretical structure demonstrated conceptual coherence and explanatory completeness. The final model was therefore generated through systematic integration of the empirical categories rather than through the direct application of a predetermined curriculum or technology model. The analysis concluded when the relationships among the central category, major categories, and their subcategories were theoretically saturated and further comparison did not result in meaningful modification of the emerging grounded theory.

3. Findings and Results

The open-coding analysis resulted in a large set of initial codes derived directly from the participants' accounts. Through line-by-line examination of the interview transcripts, more than 250 preliminary concepts were identified. These concepts were subsequently compared, refined, merged where conceptual overlap existed, and reduced to 48 final concepts. The analysis showed that participants addressed multiple dimensions of metaverse-based curriculum design, including the need to transform conventional teaching, the educational affordances of immersive environments, infrastructure and accessibility, cultural acceptance, teacher preparedness, localization, cognitive challenges, and national policy requirements. Table 1 presents selected examples of open codes extracted from participants' statements and the corresponding final concepts developed during the open-coding process.

Table 1

Examples of Final Concepts and Corresponding Open Codes

Row	Open Code (Initial Label)	Final Concept
1	"Traditional classrooms no longer meet the needs of today's students."	Need to transform traditional teaching methods
2	"Students have grown up with virtual environments, so this kind of space is attractive to them."	Attractiveness of the metaverse for adolescents
3	"Students should learn how to think, not what to think."	Need to develop twenty-first-century skills
4	"What is presented in textbooks is different from what students encounter in the real world."	Gap between traditional curriculum content and learners' needs

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5	“Other countries are already using this technology, and we have fallen behind.”	Successful international experiences in applying the metaverse
6	“COVID-19 showed that distance education is possible, but it needs to be interactive.”	Educational pressures arising from the COVID-19 pandemic
7	“The Ministry of Education still does not have standards for virtual content.”	Absence of national standards
8	“In some rural areas, students do not even have adequate internet access, let alone headsets.”	Digital divide across geographical regions
9	“Some parents are worried that their children may get lost in virtual environments.”	Cultural resistance among parents
10	“We teachers ourselves do not know how to work with these technologies.”	Insufficient teacher training
11	“If the content is in Persian and based on our own culture, it will work better.”	Localization of curriculum content
12	“When students are in the metaverse, they may not be able to maintain sufficient concentration on the lesson.”	Cognitive disorientation in three-dimensional environments

The examples in Table 1 illustrate that the participants’ experiences extended beyond the technological characteristics of the metaverse and encompassed broader curricular, pedagogical, cultural, infrastructural, and professional concerns. Several open codes emphasized dissatisfaction with conventional instructional arrangements and the perceived mismatch between traditional curriculum content and the learning characteristics of contemporary adolescents. At the same time, participants described immersive and interactive environments as potentially attractive and educationally valuable for secondary-school students, particularly because such environments could provide more experiential and authentic forms of learning. References to twenty-first-century competencies, successful international experiences, and lessons learned from emergency remote education during the COVID-19 pandemic further indicated that the perceived need for a metaverse-based curriculum was closely connected with broader changes in education and digital society.

Other codes demonstrated that the adoption of the metaverse could not be understood solely as an instructional innovation. Participants repeatedly referred to the absence of national standards, unequal access to high-quality internet and immersive hardware, inadequate professional preparation among teachers, and cultural resistance among families. The need to develop Persian-language and culturally appropriate content also emerged as an important consideration in adapting metaverse environments to the Iranian educational context. In addition, participants identified cognitive challenges associated with three-dimensional immersive environments, particularly the possibility of distraction, cognitive overload, and difficulty maintaining attention. These codes provided the conceptual foundation for grouping the 48 final concepts into broader categories during the subsequent stage of open coding.

The 48 final concepts were next grouped according to their semantic and thematic similarities. This categorization was conducted through constant comparison by examining common properties among concepts and determining whether conceptually related items could be organized under more abstract explanatory labels. Through this process, 18 initial categories were identified. These categories represented the major domains emerging from participants’ accounts regarding the conditions, requirements, strategies, and anticipated consequences of designing and implementing a metaverse-based curriculum in Iranian secondary education. Table 2 presents the 18 initial categories, examples of their constituent concepts, and the number of codes associated with each category.

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Table 2

Initial Categories Derived from Open Coding

Row	Initial Category	Constituent Concepts (Examples)	Number of Codes
1	Need for Transformation in the Educational System	Need to transform traditional teaching methods; gap between curriculum content and learners' needs; need to develop twenty-first-century skills	34
2	Metaverse Affordances for Learning	Attractiveness of the metaverse for adolescents; simulation of real-life situations; multisensory interaction; experiential learning	28
3	Requirements Arising from Global Developments	Successful international experiences in applying the metaverse; pressures arising from the COVID-19 pandemic; need for interactive distance learning	22
4	National Policies and Standards	National policies concerning educational technologies; presence or absence of national standards for metaverse-based content	19
5	Access to Technical Infrastructure	Access to high-speed internet; availability of virtual-reality hardware; digital divide across regions	25
6	Culture and Social Attitudes	School-centered culture versus virtual learning; positive or negative stakeholder attitudes toward the metaverse; parental cultural resistance	31
7	Digital Competencies	Teachers' digital literacy; students' digital literacy; technological readiness	27
8	Institutional Facilitators	Financial and policy support; intersectoral cooperation; teacher empowerment programs	23
9	Institutional Barriers	Insufficient funding and equipment; absence of national standards; inadequate teacher training	36
10	Cultural and Value-Based Barriers	Cultural resistance among parents and teachers; security and ethical concerns; potential conflict with collectivist values	29
11	Instructional Design	Challenge-based and narrative scenario design; personalization of learning pathways; balancing immersion and cognitive load	42
12	Human Resource Empowerment	Teacher empowerment through professional development; development of technical and ethical competencies	33
13	Assessment and Data Analysis	Multidimensional assessment based on behavioral data; formative and real-time assessment	38
14	Localization and Equity	Localization of content based on cultural and religious values; development of safe and inclusive spaces; equity in access to technology	26
15	Participation and Intersectoral Collaboration	Creation of collaborative networks; stakeholder participation in model design	18
16	Positive Learning Outcomes	Increased motivation, interaction, and active participation; development of critical thinking and collaboration; reduction of educational quality gaps	35
17	Implementation and Cognitive Challenges	Increased cognitive load and immersion-related fatigue; cognitive disorientation in three-dimensional environments; weaknesses in learner self-regulation	28
18	Ethical and Sustainability Considerations	Ethical and privacy concerns; energy consumption and the carbon footprint of metaverse technologies	21

As shown in Table 2, instructional design was the most frequently represented category, with 42 codes. This category included concepts related to the design of narrative and challenge-based learning scenarios, personalization of learning pathways, experiential activities, and the need to balance immersive engagement with students' cognitive capacities. The high frequency of this category indicates that participants placed substantial emphasis on the pedagogical architecture of metaverse-based learning rather than viewing the metaverse merely as a technological platform. Assessment and data analysis was the second most frequent category, with 38 codes, reflecting participants' emphasis on multidimensional, continuous, process-oriented, and real-time approaches to assessment. Institutional barriers, with 36 codes, and positive learning outcomes, with 35 codes, were also strongly represented. These findings demonstrate that participants simultaneously recognized considerable educational potential and substantial implementation constraints.

The remaining categories showed that implementation of a metaverse-based curriculum was perceived as contingent on a complex set of contextual and institutional conditions. The need for transformation in the educational system contained 34 codes, while human resource empowerment contained 33 codes and culture and social attitudes contained 31 codes. These categories reflected concerns regarding the inadequacy of traditional methods, the importance of developing teachers' technological and pedagogical competencies, and the influence of stakeholder attitudes on the acceptance of immersive learning. Cultural and value-based barriers were represented by 29 codes, while both metaverse affordances for learning and implementation and cognitive challenges contained 28 codes. Digital competencies accounted for 27 codes, localization and equity for 26 codes, and access to technical infrastructure for 25 codes. Together, these categories demonstrate that successful curriculum design depends not only on instructional quality but also on digital readiness, equitable access, cultural compatibility, and institutional preparedness.

During the next analytical stage, the initial categories were reorganized according to the grounded theory paradigm model. The central phenomenon was identified as "designing and implementing a metaverse-based curriculum in the Iranian secondary education system." The causal conditions were organized into two broad groups. The first concerned the inadequacy of conventional educational approaches and the internal need for educational transformation, including the necessity of reforming traditional teaching methods, developing twenty-first-century competencies, and reducing the gap between conventional curriculum content and learners' emerging needs. The second group concerned opportunities and requirements arising from technological and global developments, including the educational affordances of the metaverse, successful international experiences, the consequences of the COVID-19 pandemic for digital education, and broader pressures generated by technological transformation. Contextual conditions consisted of national policies and standards, access to technological infrastructure, social and cultural attitudes, and the digital competencies of teachers and students.

Intervening conditions were divided into facilitating and constraining factors. Facilitating factors included financial and policy support, intersectoral collaboration, teacher development programs, localization of educational content, and the establishment of successful pilot initiatives. In contrast, institutional and cultural constraints included inadequate funding and equipment, resistance among parents and teachers, absence of national standards, insufficient teacher preparation, and security and ethical concerns. The principal action and interaction strategies consisted of five categories: instructional design, human resource empowerment, assessment and data analysis, localization and equity, and participation and intersectoral collaboration. These strategies collectively represented the practical mechanisms through which the metaverse-based curriculum could be designed, adapted, implemented, and sustained within the Iranian secondary education context.

The consequences emerging from the paradigm model were organized into positive educational outcomes and potential challenges. Positive outcomes included increased learner motivation, interaction, and active participation; development of critical thinking and collaborative competencies; enhanced digital literacy; improved understanding of abstract concepts through immersive simulation; and the potential reduction of disparities in educational quality. Conversely, participants identified several possible adverse or unintended consequences, including increased cognitive load, immersion-related fatigue, excessive dependence on technology, privacy and ethical concerns, and the possibility that unequal access to infrastructure could reproduce or intensify existing educational inequalities. The selective integration of these categories ultimately centered on the core category of "designing a context-sensitive indigenous model of a metaverse-based curriculum," through which the relationships among causal conditions, contextual factors, intervening conditions, strategies, and consequences were theoretically integrated.

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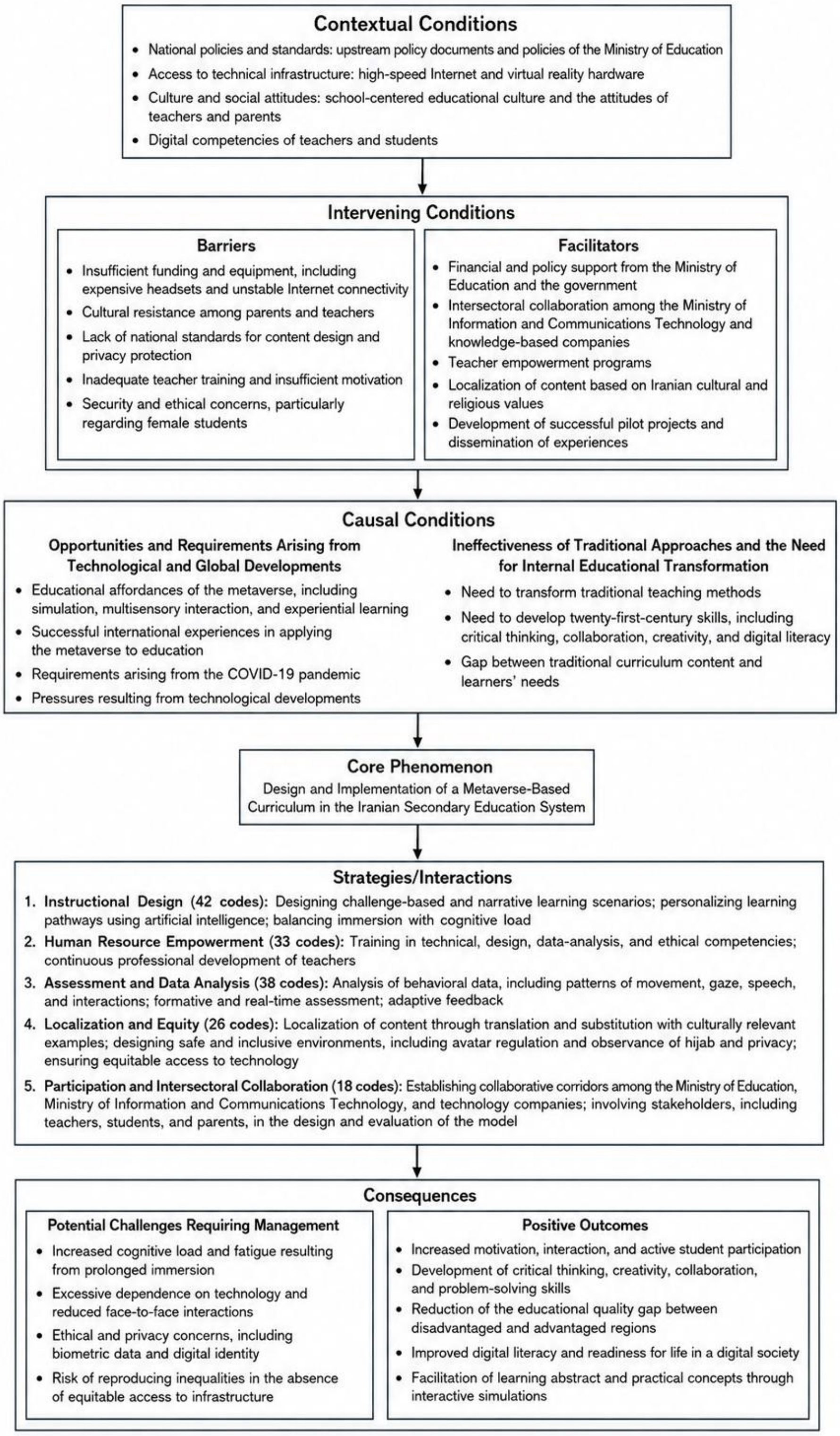
Figure 1

Paradigm Model for Designing and Implementing a Context-Sensitive Metaverse-Based Curriculum in Iranian Secondary Education



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4. Discussion and Conclusion

The present study aimed to develop a context-sensitive indigenous model for designing a metaverse-based curriculum in Iranian secondary education through a qualitative grounded theory approach. The findings showed that the development and implementation of such a curriculum is a multidimensional process shaped by causal conditions, contextual conditions, intervening conditions, strategic actions, and educational consequences. Open coding resulted in 18 initial categories, among which instructional design, assessment and data analysis, institutional barriers, positive learning outcomes, the need for transformation in the educational system, human resource empowerment, and culture and social attitudes were particularly prominent. At the axial level, these categories were integrated around the central phenomenon of designing and implementing a metaverse-based curriculum in the Iranian secondary education system, while selective coding led to the core category of designing a context-sensitive indigenous metaverse-based curriculum. The findings therefore indicate that successful metaverse integration cannot be reduced to the adoption of immersive technologies; rather, it requires systemic alignment among pedagogy, curriculum, infrastructure, teacher capabilities, cultural values, assessment systems, governance, and educational equity.

One of the principal findings concerned the causal conditions underlying the need for a metaverse-based curriculum. Participants emphasized the inadequacy of some conventional teaching approaches, the mismatch between traditional curriculum content and contemporary learner needs, and the increasing importance of twenty-first-century skills. These findings suggest that interest in the metaverse emerges partly from broader dissatisfaction with forms of schooling that provide limited opportunities for experiential learning, active participation, simulation, collaboration, and personalized learning. This result is consistent with studies that have conceptualized metaverse-based education as a potential response to changing learner characteristics and the limitations of conventional classroom structures. Akbari and Roudi Aliabadi similarly emphasized the need to reconsider major curriculum elements when education moves into immersive environments (Akbari & Roudi Aliabadi, 2025). Khosravi et al. also showed that curriculum design in metaverse environments requires the reconstruction of goals, content, teaching-learning activities, and assessment rather than the simple transfer of conventional curricula into virtual spaces (Khosravi et al., 2025). Thus, the present findings support the view that metaverse-based curriculum development should begin with educational transformation rather than technological substitution.

The second group of causal conditions was associated with the educational affordances of the metaverse and broader global technological developments. Participants described immersive environments as potentially capable of increasing interaction, creating realistic simulations, supporting multisensory experiences, and facilitating experiential learning. These perceptions are strongly supported by previous research. Ghasemi et al. identified simulation, visualization, interaction, and active engagement as important dimensions of the metaverse in secondary-school science education (Ghasemi et al., 2025). Hafezi et al. likewise reported that the implementation of metaverse technologies in science education can provide opportunities to represent complex and abstract phenomena in more tangible and interactive forms (Hafezi et al., 2025). International evidence also supports this interpretation. Poupard et al. found that immersive technologies can improve learning performance and intrinsic motivation when instructional design appropriately manages cognitive demands (Poupard et al., 2025). Tlili et al. similarly concluded that the metaverse can offer significant educational opportunities through immersion, interaction, simulation, and social presence, while also cautioning that these benefits depend on appropriate pedagogical and ethical design (Tlili et al., 2022). The present study therefore reinforces the argument that the educational value of the metaverse lies not merely in immersion itself but in its capacity to create qualitatively different forms of learning experience.

The findings further demonstrated that contextual conditions play a decisive role in determining whether metaverse-based curriculum implementation is feasible. Four major contextual dimensions emerged: national policies and standards, access to technical infrastructure, culture and social attitudes, and the digital competencies of teachers and students. This result highlights the context-dependent character of educational innovation. A curriculum may be pedagogically well designed but remain impractical if schools lack sufficient internet connectivity, appropriate hardware, technical support, or institutional standards. Karimi et al. similarly identified structural limitations, technological deficiencies, and institutional weaknesses as major barriers to the implementation of the metaverse in

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Iranian schools (Karimi et al., 2026). Talebi-Anas and Razghi Sharsavar also emphasized that the feasibility of educational metaverse implementation depends on the simultaneous readiness of technological, organizational, human, and pedagogical infrastructures (Talebi-Anas & Razghi Sharsavar, 2026). The current findings therefore suggest that metaverse curriculum design should be embedded within a broader readiness framework rather than being treated as an isolated classroom-level intervention.

The importance of digital competencies also emerged clearly from the interviews. Participants emphasized that insufficient digital literacy among teachers and, in some cases, students can reduce the effectiveness of immersive learning environments. This finding accords with Ahmadi's analysis of the changing teacher role in metaverse-based education, which emphasizes that teachers need new technological, pedagogical, managerial, and ethical competencies in order to function effectively in immersive environments (Ahmadi, 2024). Niels and Schröder likewise argued that conventional digital competence frameworks are insufficient for immersive education and should be extended to include XR-specific competencies such as virtual environment management, embodied interaction, immersive instructional design, and learner safety (Niels & Schröder, 2025). Consequently, the present findings indicate that teacher preparedness should not be conceptualized as a secondary implementation issue. Instead, it represents a central condition for transforming metaverse technology into meaningful educational practice.

Another important finding concerned culture and social attitudes. Participants reported parental resistance, concerns about excessive virtual engagement, and uncertainty regarding the cultural compatibility of immersive environments. These concerns were complemented by a strong emphasis on localization, including the need for Persian-language content and alignment with Iranian cultural and educational values. This finding is directly consistent with Safari, who identified cultural and educational barriers as important determinants of metaverse acceptance in Iranian schools and emphasized the necessity of localizing content and learning environments (Safari, 2025). The result also extends existing studies by showing that localization should not be understood solely as translation or surface-level cultural adaptation. Rather, it should encompass the design of learning scenarios, interaction norms, representations, ethical boundaries, and educational expectations that correspond to the social and cultural context of Iranian secondary education. In this sense, the core category identified in the present study—designing a context-sensitive indigenous metaverse-based curriculum—captures a central requirement that is sometimes underemphasized in technology-centered models.

The intervening conditions identified in the study included both facilitators and barriers. Financial and policy support, intersectoral collaboration, teacher development programs, localization, and successful pilot projects functioned as facilitating conditions, whereas inadequate funding and equipment, insufficient teacher preparation, parental and teacher resistance, lack of national standards, and ethical and security concerns operated as barriers. These findings indicate that the same educational technology may produce very different outcomes depending on the institutional environment in which it is introduced. Forouzanmehr et al. similarly proposed that the successful development of technological learning models for Iranian schools requires coordinated attention to policy support, infrastructure, professional development, and institutional organization (Forouzanmehr et al., 2025). Meehan et al. also emphasized that educational metaverse adoption is simultaneously enabled and constrained by technological accessibility, organizational readiness, privacy, security, and pedagogical quality (Meehan et al., 2024). Thus, the present results support a systemic interpretation in which implementation is influenced by the interaction between enabling and constraining forces rather than by technological capability alone.

Among the strategic categories, instructional design had the highest frequency of codes, making it one of the most prominent findings of the study. Participants stressed challenge-based and narrative learning scenarios, personalized learning pathways, experiential activities, and the importance of balancing immersion with cognitive load. This finding has considerable theoretical significance because it shows that stakeholders did not regard the metaverse simply as a delivery medium. Instead, they viewed the pedagogical design of experiences as the main mechanism through which the technology acquires educational value. Poupard et al. showed that immersive technologies can generate improved learning outcomes only when cognitive load and task design are appropriately managed (Poupard et al., 2025). Similarly, Tlili et al. cautioned against assuming an automatic relationship between immersion and educational effectiveness, noting that pedagogical design remains a determining factor (Tlili et al., 2022). The current findings therefore suggest that metaverse-based curriculum designers should prioritize learning architecture, sequencing, scaffolding, meaningful interaction, and instructional coherence over technological novelty.

Personalization also emerged as an important feature of instructional design. Participants supported differentiated learning pathways and responsiveness to individual student characteristics. This finding is aligned with Rezaei et al., who showed that artificial intelligence can be integrated into metaverse environments to create adaptive learning pathways based on learner characteristics, performance, and interaction patterns (Rezaei et al., 2025). Such personalization may be particularly valuable in secondary education, where learners differ considerably in prior knowledge, learning pace, interests, and self-regulatory skills. However, the present findings also suggest that personalization should be balanced with common curricular objectives and equity considerations. Personalized learning cannot be allowed to become a mechanism through which students receive fundamentally unequal educational opportunities or become isolated from collaborative learning processes.

Assessment and data analysis constituted another major strategic category and had one of the highest frequencies in the open-coding results. Participants emphasized multidimensional assessment, process-oriented evaluation, behavioral data analysis, and real-time feedback. This finding reflects an important shift from conventional assessment toward continuous evidence generation within immersive environments. Mousavi et al. demonstrated the importance of systematically analyzing learner behavior in virtual reality environments and emphasized the potential of behavioral indicators to support educational measurement (Mousavi et al., 2024). Metaverse environments can potentially capture interaction patterns, task completion, collaboration, movement, decision-making, and engagement in ways that conventional paper-and-pencil assessment cannot. Nevertheless, the present study also revealed that data-rich assessment creates ethical and privacy concerns, indicating that assessment innovation should be accompanied by clear standards regarding data ownership, interpretation, storage, and appropriate use.

Human resource empowerment was also identified as a major strategy. Participants repeatedly stressed professional development, technical training, pedagogical preparation, and ethical competence. This finding is consistent with both Iranian and international research suggesting that teachers are not displaced by immersive technologies but instead acquire more complex responsibilities. Ahmadi emphasized that teachers in metaverse-based education must function as facilitators, designers, managers, and guides rather than merely transmitters of knowledge (Ahmadi, 2024). Niels and Schröder similarly identified specialized competencies required for immersive education that extend beyond general digital literacy (Niels & Schröder, 2025). Therefore, the present study suggests that teacher development should be embedded within curriculum implementation from the outset. Providing technology without developing teachers' capacity to design meaningful immersive experiences would likely produce superficial or ineffective use.

Localization and equity emerged together as another strategic category, indicating that participants perceived cultural relevance and fair access as interconnected rather than separate concerns. The findings showed that a metaverse-based curriculum should be culturally appropriate while also ensuring that students across different socioeconomic and geographical settings can participate. Almahdi et al. found that the metaverse can potentially improve access to high-quality educational experiences, particularly by overcoming some spatial limitations of conventional education (Almahdi et al., 2025). Khadivi, however, emphasized that the contribution of immersive technologies to educational equity depends heavily on addressing unequal access to infrastructure and digital resources (Khadivi, 2026). Nouraee Yeganeh et al. likewise proposed a multilayer metaverse classroom model in which inclusion, technological accessibility, pedagogy, and interaction are integrated within a unified framework (Nouraee Yeganeh et al., 2025). These studies support the present finding that equity should be designed into metaverse curricula rather than addressed after implementation. Without such planning, immersive education could reproduce or even intensify existing inequalities.

Participation and intersectoral collaboration represented the fifth major strategy. Although it had fewer codes than instructional design or assessment, its position within the paradigm model suggests that it has a cross-cutting function. Participants indicated that schools, policymakers, curriculum specialists, technology developers, families, teachers, and students should participate in the design and implementation process. This result is consistent with the systemic nature of the emerging model. Forouzanmehr et al. emphasized coordinated relationships among technological, educational, and organizational actors in developing models for emerging technology use in Iranian schools

(Forouzanmehr et al., 2025). Similarly, Nouraee Yeganeh et al. conceptualized immersive education as a multilayer environment in which different components and actors must operate in coordination (Nouraee Yeganeh et al., 2025). The current findings therefore indicate that fragmented decision-making is unlikely to support sustainable implementation and that participatory governance is necessary for legitimacy, adaptability, and practical feasibility.

The positive consequences identified in the study included greater motivation and interaction, development of critical thinking and collaboration, improved digital literacy, facilitation of abstract concept learning, and potential reduction of educational quality gaps. These outcomes are consistent with evidence from previous research. Poupard et al. reported that immersive educational environments can enhance motivation and, under appropriate conditions, improve learning performance (Poupard et al., 2025). Almahdi et al. similarly found evidence that metaverse-supported education may contribute to improved access to quality learning experiences (Almahdi et al., 2025). Ghasemi et al. highlighted the potential of immersive environments to support active and experiential science learning in secondary schools (Ghasemi et al., 2025). These studies provide support for the participants' expectation that the metaverse can strengthen engagement and facilitate learning through simulation and active participation.

At the same time, the findings showed that these positive consequences coexist with possible negative outcomes, including cognitive overload, immersion-related fatigue, excessive dependence on technology, privacy concerns, and the risk of reproducing inequality. These results strongly align with earlier reviews emphasizing the dual nature of immersive education. Tlili et al. characterized the metaverse as a technology that may function either as an educational opportunity or as a source of new risks depending on how it is designed and governed (Tlili et al., 2022). Meehan et al. similarly emphasized concerns related to privacy, accessibility, wellbeing, technological dependence, and implementation complexity (Meehan et al., 2024). Poupard et al. further demonstrated that increased immersion does not necessarily produce better learning and may increase cognitive burden when instructional environments contain excessive or poorly organized information (Poupard et al., 2025). Accordingly, the present study reinforces the need for a balanced perspective that neither idealizes nor rejects the metaverse but evaluates its educational value in relation to pedagogical design, learner wellbeing, equity, and ethical safeguards.

Overall, the grounded theory model developed in this study suggests that metaverse-based curriculum design in Iranian secondary education should be understood as a systemic process rather than a technological intervention. The central category of designing a context-sensitive indigenous metaverse-based curriculum integrates the major findings of the study by emphasizing that educational objectives, instructional design, teacher competencies, assessment, infrastructure, culture, equity, policy, and ethics must be considered together. This interpretation is consistent with the broader literature suggesting that the metaverse becomes educationally meaningful only when technological capabilities are integrated with coherent pedagogical and institutional structures (Akbari & Roudi Aliabadi, 2025; Khosravi et al., 2025; Talebi-Anas & Razghi Sharsavar, 2026). The model developed here extends these studies by organizing the relevant dimensions within a paradigm structure that explains how causal conditions, contextual factors, intervening conditions, strategies, and consequences relate to one another in the specific context of Iranian secondary education. The findings also demonstrate the value of systematic qualitative coding for developing context-sensitive theoretical explanations from stakeholder experiences (Saldaña, 2025).

The present study has several limitations. First, the participants were recruited from Tehran, and the educational, infrastructural, socioeconomic, and cultural conditions of schools in other provinces may differ substantially. Second, although maximum-variation sampling was used to include teachers, curriculum and educational technology specialists, school principals, and students, the perspectives of parents, national policymakers, technology developers, and school counselors were not directly examined. Third, the study focused on participants' perceptions, professional experiences, and expectations regarding metaverse-based education rather than observing the long-term implementation of a fully operational metaverse curriculum in actual secondary-school settings. Finally, because grounded theory seeks conceptual depth and theoretical development rather than statistical generalization, the proposed model should be interpreted as a contextually grounded explanatory framework whose applicability may vary across educational settings.

Future research should examine the proposed model in different provinces and among schools with varying levels of technological readiness in order to assess the stability and contextual variability of its categories. Additional qualitative studies could incorporate parents, policymakers, instructional designers, technology providers, and students with special educational needs to broaden the stakeholder perspective. Researchers may also conduct longitudinal implementation studies in which selected components of the proposed curriculum are introduced in real school environments and refined through repeated cycles of observation and stakeholder feedback. Future work should additionally investigate specific issues such as cognitive load, student self-regulation, privacy, digital identity, cultural adaptation, accessibility, and teacher professional development in greater depth, while comparative studies across different national educational systems could clarify which elements of metaverse curriculum design are context-specific and which may have broader applicability.

From a practical perspective, educational authorities should avoid introducing metaverse technologies into schools as isolated technological projects. Implementation should begin with small-scale pilot programs accompanied by clear instructional objectives, teacher preparation, technical support, and systematic evaluation. Curriculum planners should develop culturally appropriate and age-appropriate immersive content while ensuring that virtual activities remain aligned with national curriculum goals. Teacher professional development should include immersive instructional design, classroom management in virtual environments, assessment of learner behavior, digital ethics, privacy, and strategies for controlling cognitive load. Policymakers should also establish minimum standards for infrastructure, content quality, data protection, student safety, and accessibility before large-scale adoption. Particular attention should be given to schools and regions with limited technological resources so that implementation does not widen existing educational inequalities, and collaboration among schools, universities, technology organizations, families, and educational authorities should be institutionalized throughout the design and implementation process.

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

The authors report no conflict of interest.

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Ethical Considerations

All procedures performed in studies involving human participants were under the ethical standards of the institutional and, or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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