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Design principles for AI-powered metaverse language classrooms: A fuzzy Delphi study in higher education

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Abstract

Artificial intelligence (AI) and metaverse technologies are reshaping second language education by enabling immersive, data driven, and collaborative learning. This study identified and prioritized design principles for AI powered metaverse language classrooms in higher education using the Fuzzy Delphi Method (FDM) with a panel of 16 domain experts. The panel evaluated a construct framework spanning pedagogy (heutagogy aligned), technology, assessment, ethics and implementation. Consensus thresholds ($d \leq 0.2$; ≥75% agreement) and defuzzified scores were used to rank items for inclusion in a design guideline. Findings revealed strong expert consensus across all five domains. The highest priorities were Pedagogy (for immersive, authentic tasks) and Assessment & Analytics. Technology and Implementation & Support were also deemed essential but lower in priority. Among heutagogy capabilities, Share was ranked as the most critical element. The study yielded a validated, prioritized set of design principles to guide curriculum designers and instructors in deploying sustainable, learner centred metaverse language learning at scale.

Keywords: Artificial Intelligence, Design Principles, Fuzzy Delphi, Heutagogy, Higher Education, Language Learning, Metaverse.

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1. Introduction

Over the last few years, rapid advances in artificial intelligence (AI) and the metaverse spanning extended reality (XR), intelligent conversational agents, and learning analytics have opened new possibilities for second-language education. Immersive 3D environments can situate learners in authentic sociocultural scenarios; AI-driven agents can provide immediate, dialogic practice with adaptive scaffolding; and learner-facing analytics can strengthen feedback literacy and self-regulation [1, 2]. Despite growing pilots and proofs-of-concept, there remains limited consensus on which pedagogical, technological, assessment, ethical, and implementation principles most reliably translate these affordances into meaningful learning at scale in higher-education language classrooms. This lack of shared guidance risks tool-driven adoption, inequitable access, and misalignment with program outcomes.

At the global level, there is a growing emphasis on inclusive, high-quality, and lifelong learning opportunities, as underscored by UNESCO's Education 2030 framework and the Sustainable Development Goal on quality education (SDG-4). These initiatives advocate for equitable access to education and the development of flexible pathways that equip individuals with the necessary skills to thrive in knowledge societies [3]. Importantly, this vision extends beyond traditional formal schooling to encompass adult education, workplace training, and community learning contexts [4]. In these settings, digital modalities often emerge as the most practical means of engagement. Concurrently, cities and higher education systems around the world are increasingly investing in technology-enhanced models that facilitate continuous upskilling and reskilling, with mobile and online learning recognized as essential tools for fostering participation and adaptability in an ever-evolving educational landscape [5].

Malaysia's higher education strategy is intricately aligned with global commitments to lifelong learning and human-capital development. The Malaysian Education Blueprint 2015--2025 (Higher Education) emphasizes lifelong learning as a fundamental "shift" necessary for fostering a high-income, innovation-driven economy. This strategic focus not only aims to enhance the skills and competencies of the workforce but also to ensure that education remains relevant in an ever-evolving global landscape. By prioritizing lifelong learning, Malaysia seeks to equip its citizens with the tools needed to adapt to changing economic demands, thus promoting sustainable growth and competitiveness on the international stage [6]. Policy initiatives encourage expanded access, industry–university collaboration, and recognition of flexible learning, while institutions are expected to provide the infrastructure, training, and support needed to make technology-enabled provision sustainable. Within this policy environment, mobile and blended modalities have been highlighted as particularly important for adult and part-time learners balancing work and study [7].

Evidence from Malaysian studies further underscores the practicalities of a mobile-first approach. Expert consensus research using the Fuzzy Delphi Method (FDM) has found that smartphones are the most suitable device for lifelong learners, out-ranking tablets and laptops in terms of appropriateness for on-the-move study and sustained engagement [8, 9]. Heutagogical elements explore, create, connect, share, reflect, and collaborate also achieve high consensus, with "share" frequently prioritized because it accelerates knowledge exchange for time-constrained adult learners [10-12]. These findings suggest that any next-generation language-learning design for Malaysian higher education should integrate mobile-friendly experiences and embed heutagogical capabilities to promote autonomy and lifelong learning habits.

Translating these insights into AI-powered metaverse classrooms raises both opportunities and obligations. On the opportunity side, immersive tasks can be designed to foreground pragmatic competence, intercultural communication, and negotiation of meaning; AI agents can deliver rapid, explainable feedback on fluency, accuracy, and discourse moves; and learning dashboards can make progress visible to learners and lecturers alike [13, 14]. On the obligation side, designers must address privacy-by-design, bias mitigation, academic integrity, psychological safety in social VR spaces, and the realities of device, bandwidth, and support inequities that can otherwise widen participation gaps. Without clear, evidence-informed design principles, implementation risks remain high for Malaysian institutions aiming to scale such innovations responsibly and cost-effectively.

This study responds to that gap by eliciting expert consensus on design principles for AI-powered metaverse language classrooms in higher education, using the Fuzzy Delphi Method. Grounded in a conceptual framework that positions learner agency (heutagogy) at the core and treats AI and metaverse technologies as enablers, we structure candidate principles across five domains: Pedagogy, Technology, Assessment & Analytics, Ethics & Safety, and Implementation & Support. A purposive panel of domain experts evaluates these principles on a five-point linguistic scale mapped to triangular fuzzy numbers; consensus thresholds ($d \leq 0.2$ with $\geq 75\%$ agreement) and defuzzified scores are then used to determine inclusion and priority. The outcome is a ranked guideline intended to help curriculum designers and instructors in Malaysia and comparable contexts implement immersive, equitable, and ethically sound language-learning experiences aligned to national policy goals and global sustainability agendas.

In sum, by integrating global imperatives for lifelong, inclusive education with Malaysia's mobile-first realities and institutional priorities, this study aims to move beyond isolated pilots toward a coherent, locally feasible, and internationally relevant set of design principles for AI-metaverse language learning in higher education.

2. Problem Statement

The rapid advancements in Artificial Intelligence (AI) and metaverse technologies are transforming higher education across the globe, presenting opportunities to revolutionize the way language learning is designed, implemented, and experienced [15]. These technologies offer innovative ways to create immersive, socio-culturally authentic environments where learners can engage with language through real-time, embodied interaction [16] receive immediate, adaptive feedback from AI-driven agents [17] and collaborate in virtual spaces that simulate real-world communication contexts [18]. However, despite the immense potential these technologies present, a significant gap remains in how they are integrated into higher education language curricula in a way that ensures their pedagogical effectiveness, ethical responsibility, and equitable access [19].

In particular, the challenge of effectively integrating AI and metaverse technologies into language education is compounded by a lack of systematic frameworks that align technological possibilities with sound pedagogical principles [20]. While numerous pilots and proofs-of-concept in AI and metaverse language learning have been undertaken globally

[21] these efforts often suffer from fragmented approaches that focus on technological innovation at the expense of pedagogical integrity. This gap in research and practice not only limits the effectiveness of these tools but also risks perpetuating digital inequities, with marginalized groups potentially excluded from the benefits these technologies can offer.

At the global level, key educational policy frameworks such as UNESCO's Education 2030 and SDG-4 underscore the need for inclusive, high-quality, lifelong learning opportunities for all [22, 23]. These frameworks call for accessible education that can be personalized to meet the needs of diverse learners. AI and metaverse technologies hold the promise of delivering this personalized, equitable learning by offering immersive environments where learners can practice language skills in context, receive immediate feedback, and engage in collaborative activities that mirror real-world language use [24]. However, the lack of a comprehensive, evidence-based design framework for implementing these technologies risks failing to fully unlock their potential and may lead to tool-driven, technology-centric adoption without a clear pedagogical focus [15].

Further complicating this issue is the ethics and safety concerns related to the use of AI and immersive technologies in education [25]. The use of AI-powered agents and the collection of large datasets for adaptive learning and feedback raise significant concerns around data privacy, bias, algorithmic fairness [26] and psychological safety in immersive, social learning environments [27]. The metaverse itself, with its immersive virtual reality (VR) components, introduces additional challenges regarding safety in online spaces, particularly in maintaining psychological safety and ensuring that social interactions within these environments remain appropriate and respectful [28]. Without clear, foundational design principles that address these ethical and safety considerations, there is a risk that these technologies will exacerbate existing inequalities and introduce new forms of digital harm to learners.

In response to these challenges, this study focuses on developing a validated, prioritized set of design principles for the integration of AI and metaverse technologies into higher education language classrooms [29]. This is especially important in Malaysia, where national educational policies and frameworks are increasingly aligned with global trends. For instance, Malaysia's Education Blueprint 2015-2025 (Higher Education) highlights the importance of lifelong learning, skills development, and the integration of technology into education [30]. Despite these policy commitments, the successful, large-scale implementation of AI and metaverse tools in Malaysian higher education remains limited [31]. A significant challenge lies in the implementation gap, where institutions are often unsure of how to integrate these technologies meaningfully into curricula in a way that is pedagogically grounded, scalable, and sustainable [32].

The lack of consensus on how AI and metaverse tools can be integrated into language learning at scale is a major barrier to their widespread adoption [33]. While the potential of AI to deliver personalized learning experiences is widely recognized, the practical application of these tools in language classrooms remains uncertain [34]. Pedagogical fragmentation is a significant issue, where technology-driven solutions are implemented without a clear connection to learning outcomes or student engagement [35]. For example, immersive tasks in the metaverse may offer engaging environments but fail to align with language learning objectives that require real communication practice, pragmatic competence, or meaning negotiation. Similarly, AI feedback systems may provide instant responses to learner inputs, but if the feedback is not adequately explainable or actionable, learners may not benefit from the reflective processes needed to improve their skills [36].

Moreover, the ethical vacuum in the design of AI and metaverse language classrooms is a critical concern [37-39]. AI systems, including conversational agents and learning analytics, rely heavily on large datasets, often derived from user behavior or biometric information. While this data can provide valuable insights for personalized learning, it also raises significant concerns regarding data privacy and the security of learners' personal information [40, 41]. Furthermore, AI systems are vulnerable to biases present in the training data, potentially leading to unfair or discriminatory experiences for certain groups of learners. In the context of language learning, such biases could result in unequal treatment of learners from different linguistic, cultural, or ethnic backgrounds.

Equally important are the psychological safety concerns associated with the metaverse. Social virtual environments present new challenges regarding harassment, discrimination, and cyberbullying [42, 43] which can have detrimental effects on learners' mental well-being. As AI-powered metaverse classrooms become more interactive and social, ensuring the psychological safety of learners will become an increasingly important ethical consideration [44]. Without clear protocols for safe interaction, both AI agents and human learners may engage in harmful behaviours that undermine the positive potential of these technologies [45, 46].

The third critical gap is in implementation and scalability. While institutions may experiment with AI and metaverse tools in small-scale projects [47] a systemic approach to their widespread adoption is often lacking [48, 49]. This includes the infrastructure needed to support these technologies, the educator training required to effectively use them, and the equity considerations [50] for students who may have limited access to high-bandwidth internet or the necessary devices [51]. Without explicit design principles that address equity, access, and institutional readiness, the widespread adoption of AI and metaverse tools risks creating further digital divides [47, 52].

This study, therefore, aims to fill these gaps by developing a comprehensive set of design principles for the integration of AI and metaverse technologies into language education in higher education settings. Using the Fuzzy Delphi Method (FDM), this study will gather expert consensus on the most critical design principle [53] across five key domains: Pedagogy, Technology, Assessment & Analytics, Ethics & Safety, and Implementation & Support [54, 55]. These principles will be designed to ensure that AI and metaverse tools are pedagogically grounded, ethically sound, and equitable, thus enabling their sustainable adoption at scale.

Ultimately, this study seeks to contribute to the global conversation on how emerging technologies can be used to transform language education in a way that is inclusive, effective, and aligned with global educational priorities, particularly the Sustainable Development Goals. By developing clear, validated design principles, this study aims to provide curriculum designers, instructors, and institutions with a practical, evidence-based roadmap. With this framework in place, the potential for AI-powered metaverse language classrooms to improve language acquisition, learner autonomy, and global learning outcomes can be realized.

3. Purpose of Review

A study was conducted to get an expert consensus in developing m-learning content based on heutagogy approaches to lifelong education. Therefore, this study will fulfil the following objectives

1. Synthesise a candidate framework of design principles for AI-powered metaverse language classrooms in higher education.
2. Elicit and quantify expert consensus on the relevance and priority of each principle via Fuzzy Delphi.
3. Produce a ranked guideline to support implementation and evaluation.

4. Conceptual Framework: Heutagogy-Aligned AI–Metaverse Language Learning

This study is grounded in an integrated conceptual framework that synthesizes three core theoretical and technological pillars to guide the design of next-generation language learning environments:

1. Heutagogy (Self-Determined Learning): Positions learner agency as the ultimate goal, focusing on developing learner capabilities such as exploration, creation, connection, sharing, reflection, and collaboration.
2. Metaverse Affordances: Leverages the unique capabilities of immersive environments, including presence (the feeling of "being there"), embodiment (learning through a virtual avatar), and authentic simulation (socio-cultural contexts for language use).
3. Artificial Intelligence (AI): Utilizes AI capabilities such as LLM-based conversational agents, learning analytics, and adaptive scaffolding to provide personalized, immediate, and explainable support.

The framework strategically positions learner agency at the core, treating AI and metaverse technologies not as ends in themselves, but as enablers that expand learners' capacity to explore, practice, and demonstrate target-language competence in authentic and meaningful ways.

4.1. Theory of Change (Logic Model)

The operationalization of this framework is best understood through a Theory of Change logic model, which maps the pathway from inputs to long-term outcomes:

- Inputs: The essential resources required, including XR platforms, AI conversational agents, learning analytics dashboards, content, trained educators, and ethical/privacy safeguards.
- Processes: The key learning activities enabled by the framework, such as immersive tasks, AI-mediated feedback, collaborative avatar-based interaction, reflective journaling, and e-portfolio curation.
- Proximal Outcomes**:** The immediate, measurable results of these processes, including increased learner autonomy, improved language fluency/accuracy, pragmatic competence, enhanced feedback literacy, and a strong sense of engagement and presence.
- Distal Outcomes: The long-term, overarching goals, such as sustained self-directed learning habits, successful transfer of language skills to real-world contexts, equitable participation, and program-level achievements aligned with lifelong learning agendas.

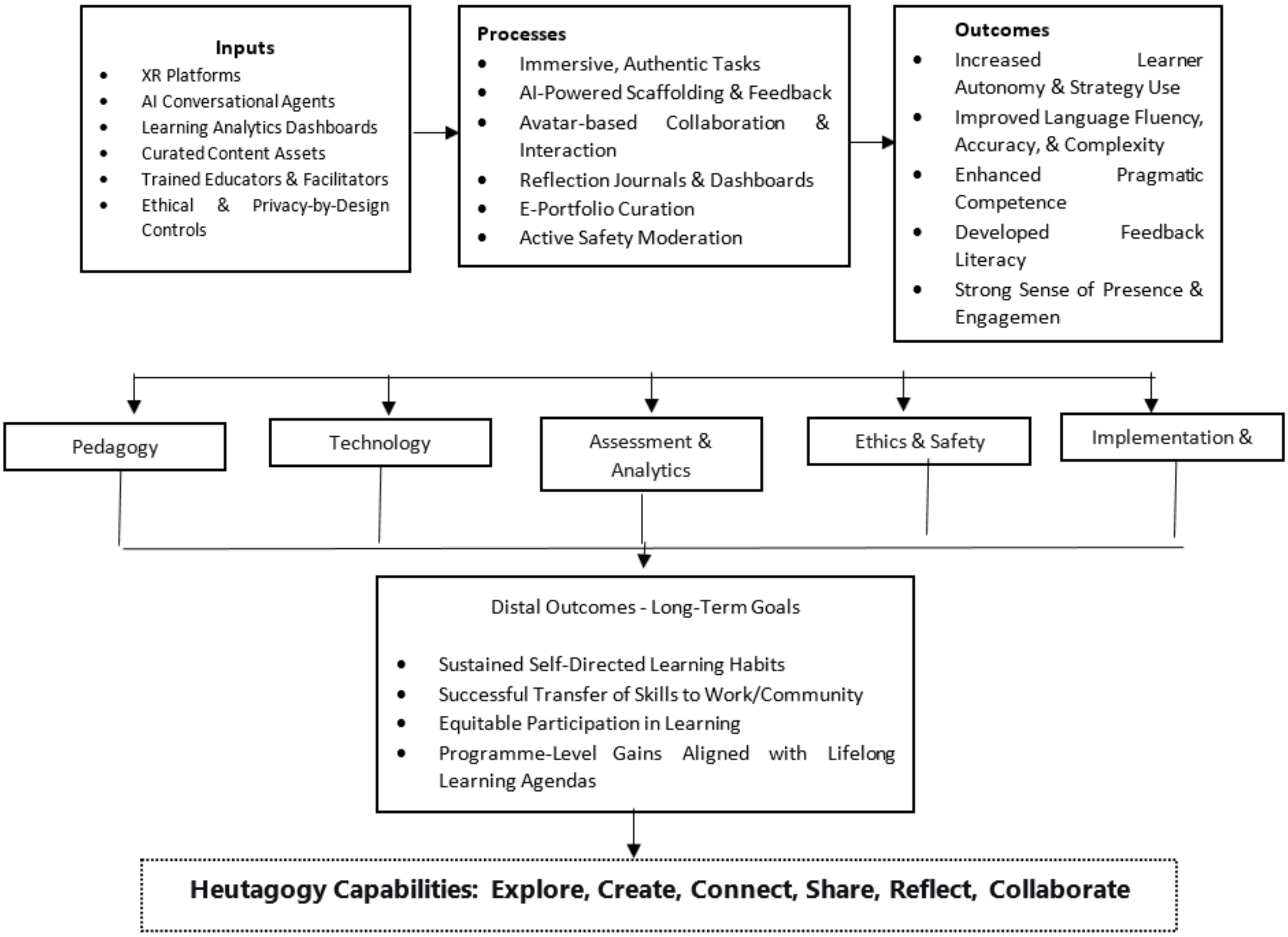

Figure 1.
Conceptual Model for Heutagogy-Aligned AI-Metaverse Language Learning.

The framework is made actionable through five interconnected design domains. Each domain contains specific principles and is explicitly linked to the development of one or more of the six heutagogy capabilities (Explore, Create, Connect, Share, Reflect, Collaborate).

Table 1.
The Five Design Domains & Six Heutagogy Capabilities.

Design Domain	Key Focus	Principles (for validation)	Heutagogy Links
A. Pedagogy	Learner-centred, authentic tasks	P1: Tasks simulate real situations requiring negotiation of meaning. P3: Learners receive scaffolds to plan and evaluate strategies.	Explore, Create, Reflect, Collaborate
B. Technology	XR Usability & AI Fidelity	T2: AI agents provide context-aware, multilingual dialogue. T5: Equivalent paths for learners without VR headsets.	Explore, Connect, Share
C. Assessment & Analytics	Formative, authentic, explainable	A1: Feedback delivered within seconds after a task. A3: Dashboards display explainable indicators.	Reflect, Share, Create
D. Ethics & Safety	Privacy-by-design, fairness, wellbeing	E1: Learners can opt out of data collection without penalty. E3: Social-VR spaces include moderation and reporting.	Connect, Share, Reflect
E. Implementation & Support	Capacity, equity, sustainability	I1: Low-bandwidth/offline options are available. I3: Lecturers receive structured training.	Share, Explore, Collaborate

4.1.1. Propositions for Validation

The framework generates testable propositions that were validated through the Fuzzy Delphi method:

- H1 (Pedagogy → Outcomes): Authentic, heutagogy-aligned tasks increase language performance and autonomy.
- H2 (Technology → Processes): High XR usability and AI fidelity increase presence and practice time.
- H3 (Assessment → Proximal): Explainable feedback and analytics strengthen feedback literacy and self-regulation.
- H4 (Ethics → Adoption): Strong privacy and safety mechanisms increase trust and sustained use.
- H5 (Implementation → Equity): Access supports and staff development reduce participation disparities.

5. Methodology

This study adopts a quantitative Fuzzy Delphi design to obtain expert consensus for developing design principles of AI-powered metaverse language classrooms in higher education.

5.1. Fuzzy Delphi technique

The technique integrates fuzzy set theory with the classical Delphi approach. Experts rate each item on a five-point linguistic scale that is mapped to triangular fuzzy numbers. Aggregated fuzzy numbers are used to evaluate consensus and priority.

Table 2.
5-point Fuzzy Scale.

Linguistic variable	Triangular fuzzy number
Strongly Disagree	(0.00, 0.10, 0.20)
Disagree	(0.10, 0.20, 0.40)
Uncertain	(0.20, 0.40, 0.60)
Agree	(0.40, 0.60, 0.80)
Strongly Agree	(0.60, 0.80, 1.00)

Table 3.
Fuzzy Delphi Technique.

Steps in Fuzzy Delphi Technique	Purpose
Step 1: Determining the experts	Identify domain experts and invite them via workshop/meeting/email to rate the proposed items.
Step 2: Selecting linguistic scales	Use a 5-point linguistic scale and map to triangular fuzzy numbers.
Step 3: Getting the average value	Compute each item's aggregated fuzzy triplet (n1, n2, n3).
Step 4: Determining the value of d (threshold) and 75% consensus	Calculate the pairwise distance d between experts' fuzzy numbers. Items achieve consensus when d ≤ 0.2 for ≥ 75% of experts; otherwise, proceed to a second round or discard the item.
Step 5: Fuzzy evaluation process	Sum the triangular fuzzy numbers to obtain the overall fuzzy evaluation for each item/construct.
Step 6: Defuzzification process	Convert fuzzy numbers to a scalar using $n_{max} = (n_1 + n_2 + n_3)/3$ and rank items from highest to lowest.

5.2. Participants

A purposive panel of 16 experts participated: applied linguistics (4), educational technology (4), metaverse (3), AI in education (3), assessment & analytics (1), and ethic (1). Inclusion criteria: doctoral qualification or equivalent portfolio; ≥5 years' relevant experience; and recent contributions to AI, metaverse, or assessment in higher education. Adler and Ziglio [56] pointed out that 10–20 people are enough if the expert consensus and uniformity are high.

Table 4.
Numbers of experts in Fuzzy Delphi approach (n = 16).

Experts in field	Quantity
Applied Linguistics	4
Educational Technology	4
Metaverse	3
AI in Education	3
Assessment & Learning	1
Ethic	1
Total	16

5.3. Instrument of Study

A structured questionnaire captured (a) demographics/expertise and (b) ratings of candidate design principles organised under five domains: Pedagogy, Technology, Assessment & Analytics, Ethics & Safety, and Implementation &

Support. Items were adapted from current literature on metaverse language learning, AI, heutagogy, and ethical AI. Experts could suggest new items.

5.4. Procedure

Round 1 administered the instrument via email and individual sessions. Fuzzy aggregation and threshold analysis were performed to determine consensus. Borderline items and newly suggested items were prepared for potential Round 2; however, consensus in Round 1 was sufficient for the majority of items.

5.5. Data Analysis

1. Map linguistic responses to triangular fuzzy numbers (Table 1).
2. Aggregate to obtain (n_1,n_2,n_3) per item.
3. Compute the threshold distance *d* between experts' fuzzy numbers; consensus is achieved when $d \leq 0.2$ for $\geq 75\%$ of experts.
4. Calculate overall fuzzy evaluation by summing fuzzy numbers. 5) Defuzzify each item using $n_{max} = (n_1 + n_2 + n_3)/3$ and rank items.

6. Findings

6.1. Consensus on Design Domains for AI–Metaverse Language Classrooms

The expert panel achieved a strong consensus on all five proposed design domains. As detailed in Table 4, all domains exceeded the 75% agreement threshold, with Pedagogy, Assessment & Analytics, and Ethics & Safety achieving a perfect 100% consensus among the 16 experts. Technology and Implementation & Support also achieved a high consensus of 94%.

The defuzzification process, which converts the fuzzy evaluations into a single crisp value for ranking, revealed a clear priority order among the domains. The Pedagogy domain (defuzzified average = 0.83) was ranked as the highest priority, followed closely by Assessment & Analytics (0.82). Ethics & Safety (0.81) was ranked third, while Technology (0.79) and Implementation & Support (0.77) were deemed essential but of slightly lower immediate priority.

Table 5.
Threshold value (d) per expert, percentage per item, Fuzzy Evaluation, average Defuzzification, and Rank for design domains.

Expert	Pedagogy	Technology	Assessment & Analytics	Ethics & Safety	Implementation & Support
1	0.06	0.08	0.07	0.05	0.09
2	0.04	0.07	0.05	0.06	0.08
3	0.05	0.09	0.06	0.08	0.10
4	0.07	0.11	0.08	0.07	0.12
5	0.03	0.10	0.04	0.05	0.09
6	0.08	0.12	0.09	0.06	0.13
7	0.09	0.06	0.07	0.08	0.10
8	0.05	0.05	0.06	0.09	0.08
9	0.10	0.14	0.07	0.06	0.22
10	0.07	0.09	0.08	0.07	0.11
11	0.06	0.10	0.06	0.05	0.12
12	0.04	0.23	0.05	0.06	0.09
13	0.05	0.13	0.04	0.07	0.10
14	0.08	0.15	0.06	0.08	0.12
15	0.07	0.16	0.08	0.09	0.14
16	0.06	0.18	0.05	0.07	0.15
% of experts with $d \leq 0.2$	100%	94%	100%	100%	94%
Total percentage $d \leq 0.2$ (all cells)	98%				
Defuzzification (Fuzzy Evaluation)	39.84	37.92	39.36	38.88	36.96
Defuzzification (Average Response)	0.83	0.79	0.82	0.81	0.77
Ranking	1	4	2	3	5

Note: Consensus criterion $d \leq 0.2$ with $\geq 75\%$ agreement. Higher average defuzzification indicates higher priority.

6.2. Consensus on Heutagogy Elements within AI–Metaverse Tasks

A similar analysis was conducted for the six heutagogical capabilities. As shown in Table 5, all six elements met the consensus threshold. The capability to Share was ranked as the most critical element (defuzzified average = 0.84), followed by Explore (0.82) and Create (0.81). Collaborate (0.80), Reflect (0.78), and Connect (0.76) were also validated as important, though of lower priority.

It is noteworthy that while connect had the lowest ranking and a consensus of 88% (slightly above the threshold), this likely reflects expert concerns about the practical challenges of social connectivity in virtual environments, such as safety and moderation, rather than a dismissal of its importance.

Table 6.
Threshold value (d) per expert, percentage per item, Fuzzy Evaluation, average Defuzzification, and Rank for heutagogy elements.

Expert	Explore	Create	Collaborate	Share	Reflect	Connect
1	0.06	0.07	0.09	0.05	0.08	0.12
2	0.05	0.06	0.07	0.06	0.09	0.11
3	0.08	0.09	0.10	0.07	0.10	0.13
4	0.07	0.08	0.11	0.06	0.12	0.14
5	0.09	0.07	0.23	0.08	0.11	0.15
6	0.06	0.05	0.09	0.07	0.10	0.12
7	0.05	0.06	0.08	0.05	0.09	0.10
8	0.07	0.08	0.11	0.06	0.12	0.22
9	0.06	0.07	0.09	0.05	0.08	0.12
10	0.05	0.06	0.08	0.05	0.09	0.11
11	0.06	0.07	0.10	0.06	0.10	0.13
12	0.05	0.05	0.08	0.05	0.09	0.12
13	0.08	0.09	0.11	0.07	0.12	0.21
14	0.07	0.08	0.10	0.06	0.21	0.14
15	0.06	0.07	0.09	0.05	0.10	0.12
16	0.05	0.06	0.08	0.05	0.09	0.11
% of experts with d ≤ 0.2	100%	100%	94%	100%	94%	88%
Total percentage d ≤ 0.2 (all cells)	96%					
Defuzzification (Fuzzy Evaluation)	39.36	38.88	38.40	40.32	37.44	36.48
Defuzzification (Average Response)	0.82	0.81	0.80	0.84	0.78	0.76
Ranking	2	3	4	1	5	6

7. Discussing the Findings

The strong expert consensus achieved across all five domains and six heutagogical elements robustly validates the proposed conceptual framework. This consensus unequivocally confirms that the successful integration of AI and metaverse technologies into higher education language learning is not merely a technological challenge but a complex, multi-faceted endeavour requiring a holistic and principled design approach. The prioritization of domains provides a critical roadmap for stakeholders, moving beyond speculative enthusiasm to a grounded strategy for implementation.

7.1. The Primacy of Pedagogy and Assessment-Led Design

The highest priority accorded to the Pedagogy and Assessment & Analytics domains sends a powerful, unequivocal message: in the triad of pedagogy, technology, and content, pedagogical imperatives must be the primary driver [57, 58]. Experts assert that the ultimate value of these advanced tools lies not in their novelty but in their capacity to foster deep, self-determined language acquisition. The call for "immersive, authentic tasks" (Pedagogy) directly addresses the problem of pedagogical fragmentation identified in the problem statement, where tool-centric adoption often results in experiences that are visually impressive yet pedagogically shallow [59, 60]. This finding aligns with the constructivist and situated learning theories [61, 62] which posit that knowledge is constructed through authentic, socially-mediated activities. The metaverse's potential is realized only when tasks necessitate genuine negotiation of meaning and pragmatic competence development, moving beyond scripted interactions [63].

Closely ranked, the prioritization of Assessment & Analytics underscores a paradigm shift from summative judgment to formative, process-oriented support [64]. The demand for "timely, explainable feedback" highlights the transformative role of AI not as a replacement for instructors, but as a catalyst for developing learner metacognition and feedback literacy [65]. AI-driven analytics can make the learning process visible and manageable for the learner, thereby directly enhancing autonomy, a core tenet of heutagogy [10, 66]. This pairing suggests that the most powerful application of AI is to create a responsive loop where immersive practice is immediately followed by intelligible feedback, closing the gap between performance and understanding.

7.2. Ethics and Safety as Foundational Prerequisites, not Afterthoughts

The high consensus and ranking of the Ethics & Safety domain reflect a mature and critical understanding among experts that innovation must be responsibly bounded. This directly mitigates the ethical and safety vacuum outlined in the problem statement [67, 68]. Principles of data minimization, algorithmic bias mitigation, and psychological safety are not secondary concerns but foundational prerequisites for building trust and ensuring the well-being of all participants [69]. In data-rich immersive environments, the risks of surveillance, bias, and harassment are amplified [70]. Therefore, a privacy-by-design approach and robust community governance are non-negotiable for sustainable adoption. Without these safeguards, the potential for harm could irrevocably erode institutional and learner trust before these technologies reach maturity, a concern echoed in critical studies of educational technology [71].

7.3. Technology and Implementation as Essential Enablers

The slightly lower prioritization of Technology and Implementation & Support should not be misinterpreted as a dismissal of their importance. Instead, it positions them correctly as essential enablers [72, 73]. Robust XR usability, high

AI fidelity, equitable access schemes, and comprehensive educator training constitute the necessary infrastructure that must be operationalized to realize the higher-order pedagogical and ethical goals. This finding underscores the reality of the implementation chasm, particularly in mobile-first and resource-constrained contexts like Malaysia. It affirms the need for device-agnostic design and low-bandwidth alternatives to prevent a new digital divide [74]. Furthermore, the need for "structured training" for lecturers is critical, as their role evolves from knowledge deliverers to designers of complex immersive experiences and facilitators of AI-mediated learning [75-77]. This aligns with TPACK models that emphasize the importance of teacher readiness for technology integration [78].

7.4. The Centrality of Social Constructivism and Heutagogy

Delving into the pedagogical core, the prioritization of Share as the foremost heutagogical capability is particularly significant. It validates the social constructivist nature of language learning, emphasizing that competence is developed through interaction and knowledge exchange [79-81]. For adult and lifelong learners, a key demographic in this study, efficient sharing mechanisms accelerate learning and foster community for those balancing study, work, and family [82]. This result strongly supports earlier Malaysian Fuzzy Delphi findings on m-learning, creating a coherent narrative for the region's mobile-first, lifelong learning strategy.

The strong showing of Explore and Create further reinforces that AI-powered metaverse environments should be designed as sandboxes for linguistic experimentation and meaning-making [83]. AI scaffolding can lower the affective filter for experimentation, allowing learners to take risks and creatively use the target language in a safe environment, thereby fostering true autonomy and self-directed learning capabilities [84].

8. Conclusion

In conclusion, this study has successfully addressed a critical gap by establishing a validated, prioritized set of design principles for AI-powered metaverse language classrooms. The expert consensus provides a clear mandate: the path forward must be pedagogy-led, assessment-informed, and ethically-grounded, with technology and implementation acting as crucial supporting pillars. By adhering to these principles, educators and institutions can navigate the complexities of this new landscape and harness the profound potential of AI and the metaverse to create next-generation language learning experiences *that are not only immersive and intelligent but also inclusive, empowering, and authentically human*.

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