Public Perceptions of Digital Human Teachers: A Sentiment and Thematic Analysis of Commentary from Leading Chinese Social Media Platforms

Jialu Cao

College of Education (College of Teacher Education), Zhejiang Normal University
688 Yingbin Avenue, Jinhua City, Zhejiang Province, 321004, China

19548995865@163.com

Abstract. Digital human teachers are a new form of AI-enabled education. Understanding public views is key to quality digital education. This study analyzes sentiment and themes from comments on "digital human teachers" and "virtual teachers" across Weibo, Bilibili, and Xiaohongshu. Results show generally positive attitudes, with concerns about technology, pricing, and appearance. Main critiques are high barriers to use, lack of realism, and low perceived necessity. The study recommends optimizing technological, social, and environmental subsystems and their integration.

Keywords: Digital human teachers; SnowNLP-based sentiment analysis; Latent Dirichlet Allocation Topic Modeling.

1 Introduction

Comprehending public perceptions of digital human teachers is a prerequisite for enhancing digital education quality. Numerous domestic and international policies, such as the "Opinions of the Ministry of Education and Nine Other Departments on Accelerating Educational Digitalization" [9] and the "Guidance for Generative AI in Education and Research," [10] advocate for empowering education with artificial intelligence and exploring new teaching models like intelligent learning companions and digital tutors. As a result, policymakers have prioritized the development and application of digital human teachers. Digital human teachers are AI-powered teaching entities with the look, voice, gestures, and interaction capabilities of human educators, allowing them to deliver educational content and perform instructional activities [6]. As technology progresses, the use of digital human teachers becomes more widespread. However, practical implementation faces obstacles such as limited processing power, ambiguous digital copyrights, the potential weakening of educational functions, the induction of individual learning inertia, and the creation of ethical issues [19]. These challenges have thrown societal disputes about digital human teachers into sharp focus.

Research on digital human instructors has improved understanding of technology, teaching effectiveness, adoption, and learner outcomes, but methods remain mainly

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evaluative and explanatory. For example, Tao Xu et al. use laboratory-controlled studies using multi-factor within-subjects designs to investigate the impact of various design aspects, such as behavioral realism and visual cues, on learning outcomes [18]. Descriptive studies on consumer acceptability and satisfaction are lacking, but essential for solid explanatory and evaluative research. Most literature focuses on developer, teacher, and student perspectives. Yanying Song et al., for example, approach their research from a developer's perspective, offering systems such as an LLM-driven, 3D hyper-realistic interactive digital human to create high-fidelity instructional encounters [14]. Current research on digital human teacher adoption often overlooks public perspectives, staying within techno-utopian frameworks and isolated from socio-technical contexts. Our study takes a public-centered approach, moving past technocentric bias to build an empirical, descriptive foundation for equitable ed-tech research.

Public perception is crucial for developing digital human educators. Social platforms facilitate sentiment analysis via their asynchronous, persistent exchange of user-generated content. They blur the boundaries between traditional interpersonal and mass communication, allowing users to broadcast information to a vast audience while also engaging in interpersonal engagement [3]. Public posts offer authentic, high-volume text for stance analysis, enabling evaluation of affective attitudes, key concerns, and positions on societal phenomena.

2 Research Design

2.1 Research Questions

This study analyzes public discourse on digital human teachers across Weibo, Bilibili, and Xiaohongshu. It examines sentiment, main themes, and user suggestions or critiques, highlighting core opinions and recommended improvements.

2.2 Research Subjects

Social media platforms form the digital ecosystem's technological infrastructure, complicating affective transmission in public events. The spread of online symbols notably amplifies emotional propagation. The interaction ritual chain established by discursive construction, symbolic aggregation, affective sharing, and symbolic reproduction on social media serves tasks such as knowledge distribution, emotional mobilization, and identity construction [20]. Decentralized, diverse communication empowers individuals, while accelerating information flow amplifies public discourse. Concurrently, the shared, accessible, and participatory features of social media have established it as a fresh conduit for scholars to receive academic material [5].

This study utilizes Weibo, Bilibili, and Xiaohongshu—platforms rich in authentic user-generated content—to analyze public perceptions of digital human teachers. A focused corpus was compiled using the context-specific and popular search terms "digital human teacher" and "virtual teacher".

2.3 Data Collection and Processing

Data Sources. Digital human teachers were first implemented in 2022 and widely adopted by 2025. Due to limited public discussion, this study collected user comments from Weibo, Bilibili, and Xiaohongshu using the keywords "digital human teacher" and "virtual teacher," applying flexible dates for a robust dataset.

Data Collection. The study used a Python MediaCrawler with Playwright for data collection, running searches for "digital human teacher" and "virtual teacher."

Data Preprocessing. The raw data offered several hurdles, including compatibility concerns, bias, outliers, redundancy, heterogeneity, and high dimensionality. Preprocessing was performed to guarantee that the data displayed qualities of cleanliness, accuracy, dependability, completeness, and impartiality [15]. Data preprocessing involved a custom stopword list, regex filtering, and whitespace segmentation to tokenize text and extract community-specific sentiment phrases. Cleaning efficacy was validated through a rule-based scan and manual review, yielding 11,248 valid comments.

2.4 Methodology and Procedures

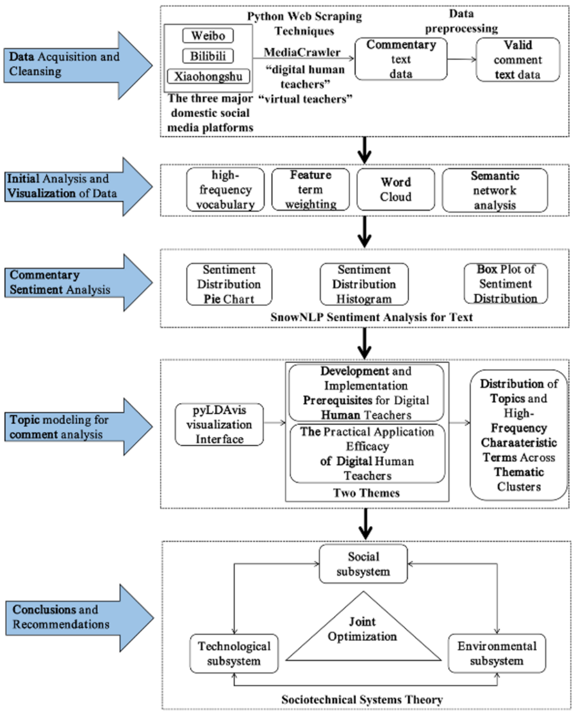

Fig. 1. Research Technical Roadmap.

This study analyzes social media discourse on "digital human teachers" and "virtual teachers" from Weibo, Bilibili, and Xiaohongshu. A five-step methodology includes data crawling/cleaning, textual feature analysis, sentiment assessment, LDA topic modeling, and synthesis of findings, visualized in Figure 1.

3 Results and Analysis

3.1 Initial Data Analysis and Visualization

This study uses preprocessed review text data for analysis, with exploratory mining of its linguistic aspects.

High-Frequency Terms and Weight Distribution Analysis. A bespoke stopword list was used to implement English word tokenization, along with regex-based non-alphabetic letter removal and whitespace segmentation.The "Top 30 keywords" were extracted from the review texts, with results presented in **Table 1**; feature term weights were calculated using the TF-IDF algorithm, as shown in Formula (1). In this formula, TF represents term frequency—the occurrence of a feature phrase inside a text that indicates its local importance. IDF stands for inverse document frequency, which examines a term's ability to discriminate between document classes [11]. The computed feature terms and their corresponding weights, derived via the TF-IDF algorithm, are shown in **Table 2**.

Table 1. Top 30 Keywords and Their Frequency Distribution.

Number	Keywords	Percentage Composition (%)	Number	Keywords	Percentage Composition (%)	Number	Keywords	Percentage Composition (%)
1	ai	2.12	11	Such	0.36	21	Comprehend	0.29
2	Teacher	1.01	12	Infeasible	0.34	22	Directly	0.28
3	A single	0.72	13	Problem	0.33	23	Observe	0.28
4	Digitization	0.65	14	Already	0.33	24	Consider	0.26
5	Video	0.63	15	Technology	0.32	25	Somewhat	0.25
6	Indeed	0.59	16	In a single pass	0.31	26	Elements	0.25
7	Not present	0.58	17	does not	0.31	27	learn	0.24
8	Perceptual experience	0.49	18	requires	0.31	28	Aspire	0.24
9	Currently	0.49	19	model;	0.30	29	Persevere	0.24
10	Generate	0.42	20	supports	0.29	30	Subsequently	0.23

$$f(a) = TF(a) \cdot IDF(a) = TF(a) \cdot \log\frac{N}{n(a)+1} \quad (1)$$

Table 2. Feature terms and their weights.

Number	Term	Weight	Number	Term	Weight	Number	Term	Weight
1	ai	0.028229	11	Cannot	0.007769	21	incapable	0.006235
2	Teacher	0.020797	12	Impressive	0.007423	22	technical expertise	0.006211
3	Genuine	0.011710	13	Proceed	0.007415	23	generate	0.006084
4	Numerical Data	0.011448	14	Momentarily	0.007186	24	necessitate	0.005887
5	Video Media	0.011162	15	Software	0.006810	25	possess knowledge	0.005860
6	Singularity	0.011150	16	Already	0.006764	26	model	0.005811
7	Perceptual	0.010877	17	Support	0.006732	27	voice	0.005786
8	Non-existent	0.009514	18	Learning	0.006491	28	visualize	0.005780
9	Current	0.008562	19	This type of	0.006476	29	direct	0.005632
10	Pleasant	0.008523	20	Somewhat	0.006382	30	issue	0.005514

The WordCloud library was employed to generate a keyword visualization, the results of which are presented in **Figure 2**. Synthesizing the aforementioned analytical outcomes, public discourse concerning digital human educators reveals two polarized semantic clusters: one comprising keywords indicative of a positive stance, such as "ai," "teacher," "technology," "good," "great," "better," "support," and "model"; the other encompasses terms reflecting skepticism or negative perceptions, including "error," "cannot," "difficult," and "bad."

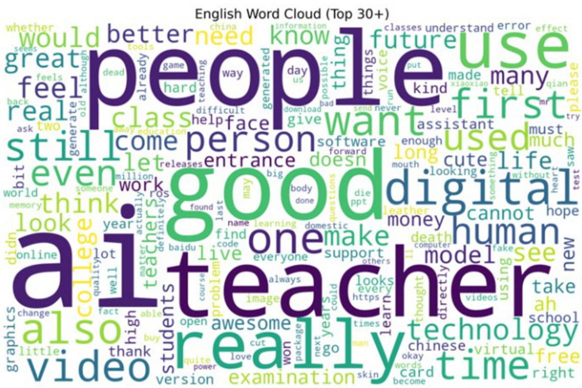

Fig. 2. Commentary text word cloud visualization.

Semantic Network Analysis. Semantic network analysis is a method for analyzing relationships among constructs inside a text by quantifying network connections [7]. It overcomes the constraints of standard frequency-based lexical analysis by mining semantic correlations between keywords, exposing deeper structural relationships [17]. This study used the NetDraw function in ROST CM6 software to create a semantic network diagram using comment text data, as shown in **Figure 3**. Additionally, the Categorical tool in UCINET program was used to distinguish between core and peripheral layers within the network.

The core layer comprising "teacher," "digital," "generation," and "tool" links to "student," "model," "software," and "learning," indicating that digital human teachers require user competence with specific models and software, transforming teaching methods. Peripheral terms like "powerful," "technology," "development," "intelligent," and "time" connect to "real person," "free," and "effect," suggesting potential to free instructor time and advance intelligent education, while also highlighting challenges of unproven efficacy, high costs, and unstable realism, necessitating balanced assessment.

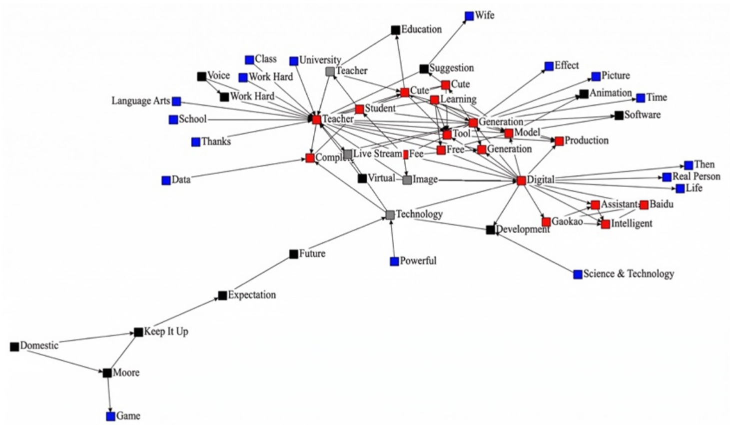

Fig. 3. Semantic network graph of textual commentary.

Sentiment Analysis of Review Texts. Sentiment analysis of textual comments was conducted using the SnowNLP package. This machine learning-based approach entailed data annotation and the extraction of textual features such as word frequency and part-of-speech. These features were then trained using a Naïve Bayes model. By synthesizing the likelihood of sentiment categories, the emotional tendency of each comment text was derived, classifying comments as positive or negative sentiment categories [4]. Subsequently, a sentiment distribution pie chart, histogram, and box plot were generated for the comments. The algorithm's principle is illustrated in Formula (2), where $P(c_i)$denotes the prior probability and $P(\omega_k|c_i)$represents the probability of all feature terms appearing given a specific category. The core logic assumes that each word (Feature $\omega_1, \omega_2, \omega_3$ ……)constituting the comment text is conditionally independent given the sentiment category. For a given text to be analyzed, scores for belonging to the positive classc_1 and the negative class $c_2$are calculated separately. This score is proportional to the product of $P(c_i)$ and $P(\omega_k|c_i)$. Ultimately, the text is assigned to the sentiment category with the higher score.

$$P(c_i|\omega_1, \omega_2, \dots \omega_n) \propto P(c_i) \cdot \prod_{k=1}^{n} P(\omega_k|c_i) \quad (2)$$

Pie Chart of Sentiment Distribution. Employing SnowNLP, sentiment scores were assigned to reviews, with higher scores indicating positive sentiment. Reviews scoring below, equal to, and above 0.5 were classified as negative, neutral, and positive, respectively. Analysis revealed that among 11,248 genuine comments, 63.42% were positive, 35.3% negative, and 1.28% neutral (Figure 4).

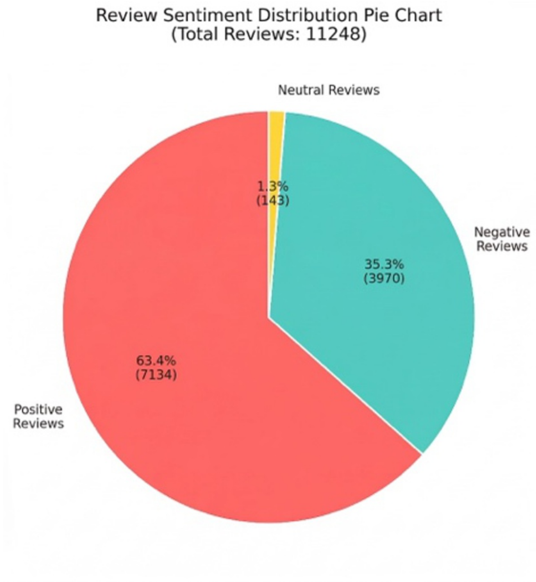

Fig. 4. Sentiment distribution pie chart for comments.

Sentiment Distribution Histogram. Figure 5 displays the sentiment distribution histogram. The mean and median scores are 0.6204 and 0.6759, respectively, showing an overall positive public disposition toward digital human teachers.

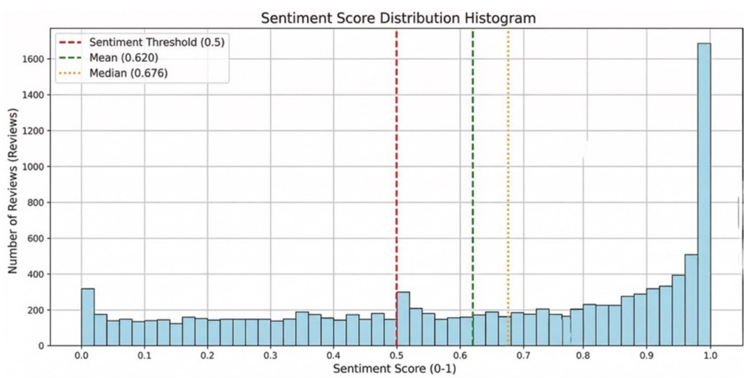

Fig. 5. Affect Scoring Distribution Histogram.

Emotional Distribution Box Plot. Figure 6 presents sentiment score distributions for review texts. Positive reviews exhibit a mean of 0.83 and a median of 0.88, significantly exceeding the 0.5 threshold; their narrow interquartile range confirms consistent, unambiguous positive sentiment. Conversely, unfavorable reviews show a mean and median near 0.24, entirely below the 0.5 threshold with tight data concentration, indicating strongly negative sentiment. Neutral reviews cluster tightly around 0.5, precluding a standard box plot.

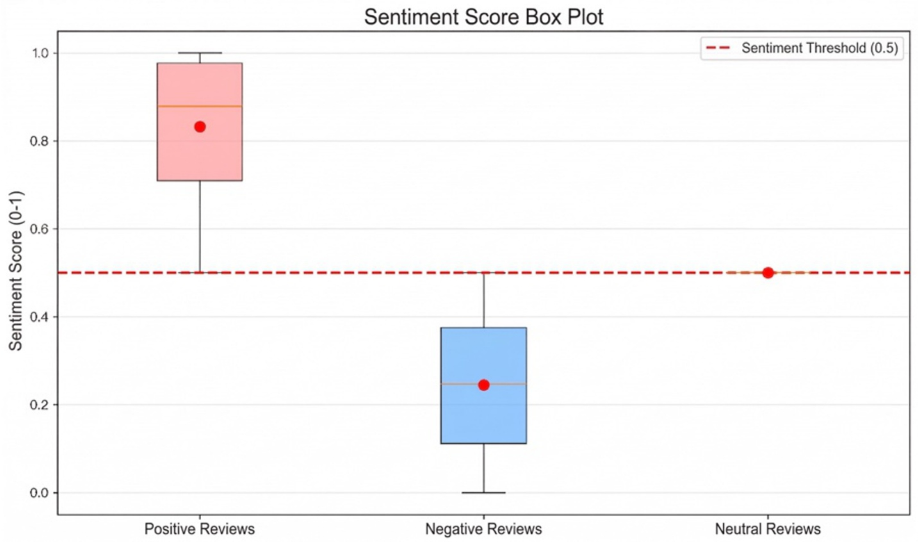

Fig. 6. Box plot of sentiment scores.

Thematic Analysis of Commentary Text. This work uses Latent Dirichlet Allocation (LDA) topic modeling to perform subject clustering on review texts. This analytical method models documents as mixtures of topics, where each topic is a probability distribution over keywords, enabling the extraction of latent thematic structures from a corpus. [13]. Applying this methodology yielded a pyLDAvis visualization for the review text data. The algorithmic foundation is formalized in Equation (3), where D denotes the total number of documents in the corpus, K is the preset total number of topics, and N_d represents the number of words in the d-th document. The variable $\theta_d$signifies the topic distribution for document d, indicating the probability of the document belonging to each topic. The variable φ_k represents the word distribution for topic k, denoting the probability of each word under that topic. $\alpha$and β are the hyperparameters of the Dirichlet priors. The variable $z_{d,n}$ denotes the topic assignment for the n-th word in document d, sampled from the multinomial distribution θ_d. The variable $\omega_{d,n}$ represents the observed word itself, sampled from the word distribution$\varphi_{z_{d,n}}$ corresponding to its assigned topic $z_{d,n}$. Finally, W, Z, Θ, andφ collectively represent the sets of all observed words, latent topic assignments, document-topic distributions, and topic-word distributions, respectively.

$$P(W, Z, \Theta, \varphi|\alpha, \beta) = \prod_{d=1}^{D} P(\Theta_d|\alpha) \prod_{n=1}^{N_d} P(\omega_{d,n}|\varphi_{z_{d,n}}) \prod_{k=1}^{K} P(\varphi_k|\beta) \tag{3}$$

The study used the perplexity metric from statistical language models to identify the best number of topics, and the pyLDAvis tool for model visualization [17]. Figure 7 shows that when the number of topics was reduced to two, the confusion decreased significantly. At this point, the topics were uniformly dispersed with little overlap, indicating effective clustering. The top 30 high-probability feature terms for each topic were summed to map public interest toward "digital human teachers," resulting in the Top-ic-High-Probability Feature Term distribution shown in **Table 3**. Public attention focused on two major themes: (1) Topic 1 concentrated on the "development prerequisites and application conditions for digital human teachers," such as modeling with popular tools like 3ds Max and Maya. With advancements in generative artificial intelligence, deep learning-based modeling techniques [8] for digital human teachers are emerging as a cutting-edge trend. Furthermore, high-performance GPUs serve as the computational core for development because training deep learning models necessitates extensive parallel processing. (2) Topic 2 focused on the "practical application outcomes of digital human teachers," which included their visual appearance and stylistic presentation. Particular emphasis was made to their anthropomorphic capacity to promote a sense of social presence through aural, emotional, and gestural cues [21]. Additionally, ethical considerations were noted, such as the potential for a digital human teacher—as a form of digital life—to adversely impact or "counter-exploit" human counterparts during deployment [19].

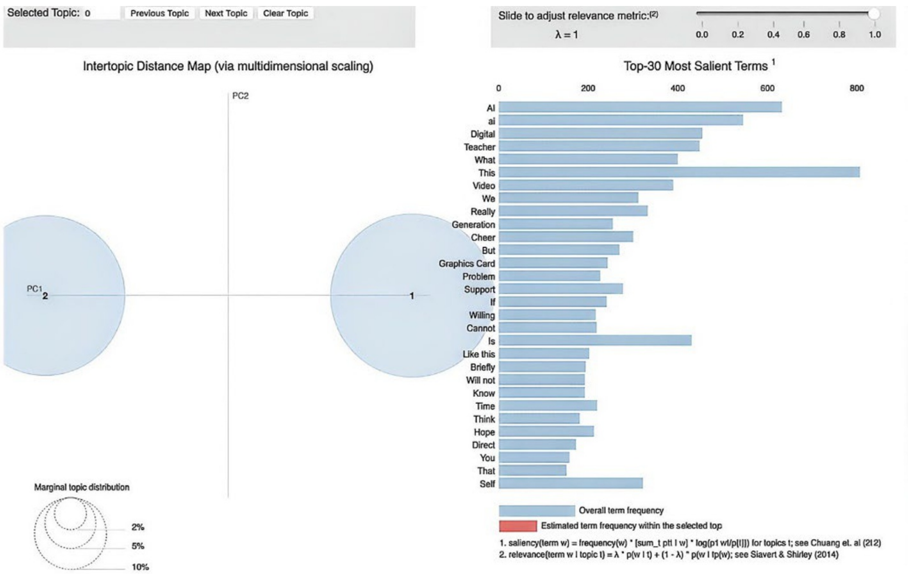

Fig. 7. Analytical Findings from the LDA Topic Model on " Digital Human Teachers ".

Table 3. Topic Focus and High-Probability Feature Term Distribution for Digital Human Teachers.

Identifier	Topic identification categories	Top 30 high-probability feature terms for the topic.
Topic1 (51.00%)	Development and implementation prerequisites for digital human teachers	this, feasible, what, indeed, persevere in your endeavors, self, but, graphics processing unit, if, still, currently, infeasible, consents, moment, anticipate, thus, briefly, having been, ascertain, will not, consider, technology, you, entity, does not, necessitate, mole, software, model, game
Topic2 (49.00%)	The practical application efficacy of digital human teachers	AI, ai, digital, teacher, video, specifically, we, support, feel, feasible, generate, problem, direct, does not, that, somewhat, subsequently, still, indigenous, should, human subject, Is it indeed, furthermore, auditory signals, future prospects, biological systems, reminiscent of, utilization, ros, in conclusion

4 Conclusions and Discussion

4.1 Results of Textual Sentiment Analysis

A sentiment survey reveals overwhelmingly positive public attitudes toward digital human teachers, with minimal neutral (1.28%) or negative views. Respondents cited benefits such as reduced instructor effort, immersive learning environments, and enhanced engagement and logical thinking. Primary concerns involved implementation costs, infrastructure requirements, practical efficacy, limited emotional interaction, and potential impacts on critical thinking. Aligned with Social Construction of Technology (SCOT) theory, the development of this technology is shaped by interactions among relevant social groups, not solely by intrinsic logic or economic factors. Different groups may attribute different meanings to the same technology; interpretive flexibility reveals its multifaceted possibilities, while closure mechanisms stabilize the technology by resolving disputes [2]. Disparities in public perception arise from both varying comprehension levels and distinct patterns of integrating digital human teachers as distinct technological products across different social groups. Frontline educators weigh pedagogical autonomy against workload and job displacement, viewing them as intelligent aides or competitors. Students prioritise interactive novelty, perceiving them as either companions or intrusive monitors. Administrators and education authorities evaluate cost, efficiency, and educational outcomes. Parents emphasise visual health, emotional communication, and learning effectiveness; developers focus on innovation, refinement, and market adoption. Consequently, implementation requires identifying these key groups and acknowledging the technology's multifaceted interpretations. Ongoing optimisation, informed by public needs and social negotiation, can shift negative perceptions and foster consensus.

4.2 Visualizations of High-frequency Lexical Items and Semantic Network Analyses.

Analysis of public debate on digital human instructors centers on three themes: technology, cost, and physical features. 1) Usability is rapidly improving, with developers lowering entry barriers and making user-friendliness mainstream. Yet, effective use now requires higher digital literacy, stable technology, creative educational approaches, and better judgment. 2) Costs have become clearer, mainly in avatar procurement, broadcasting, and interactivity. Standard avatars and basic functions are cheaper, but personalized, interactive digital humans remain expensive, segmenting the market into basic and premium offerings. 3) Physical features are advancing from basic resemblance to lifelike realism, using 3D modeling, scanning, AIGC generative modeling, motion capture, and voice-driven lip sync. Technologies simulating personality and language are also progressing. However, hyper-realistic avatars demand high computing power, risk the "uncanny valley effect," and emotional expressions—still algorithmic—struggle to truly understand students' needs. In summary, digital human teachers are becoming easier to use, costs are more transparent, and realism is increasing. Each advance, however, brings new challenges, calling for balance between technology and educational values.

4.3 Results of Thematic Analysis

Analysis of public discussion on digital human teachers reveals three main flaws: 1) High technical barriers. Development and deployment require powerful GPUs, complex AI models, and specialized software, making setup and maintenance difficult for traditional schools. The costs of hardware, software, and updates can strain budgets. 2) Lack of realism and emotional interaction. Digital teachers struggle with lip-sync errors, rigid movements, and limited facial expressions, causing the "uncanny valley effect" and reducing student engagement. Poor speech synthesis and shallow emotional feedback further limit meaningful interactions. 3) Uncertain necessity and value. Digital teachers often perform similarly or worse than humans, making their unique value questionable. Human teachers excel in knowledge delivery, classroom management, and emotional connection. In most classrooms, digital teachers are used mainly for demonstrations, not as essential tools. These flaws risk harming education quality, wasting resources, and widening the digital divide. Therefore, development should focus on real needs, streamline technology to lower barriers, and clearly define the complementary roles of digital and human teachers for synergy.

5 Recommendation

Digital human teachers are evolving from supplementary tools to central educational figures, redefining classrooms, teaching roles, and pedagogy, and driving data-based education. Key challenges remain: high adoption barriers, limited realism, and questionable necessity. To research answers, this study includes Socio-technical Systems Theory, developed by British professor Eric Trist and colleagues. [16]. This theoretical framework, based on joint optimization, incorporates social, technical, and environmental subsystems to inform organizational design,technological innovation, and complex system management [1]. This study views digital human teacher development as a socio-technical harmonization. The technological subsystem includes related technologies and infrastructure; the social subsystem covers educational stakeholders and their interactions; and the environmental subsystem involves market and regulatory factors. The study explores ways to optimize these three subsystems (see Figure 8).

5.1 Technological Subsystems: Overcoming Bottlenecks in Technological Integration and Consolidating Foundational Infrastructure Support.

Despite modeling progress, digital human teachers still face high costs, operational challenges, unrealistic features, and stiff emotional interactions. Solutions include refining technology and upgrading infrastructure: standardizing lightweight deployment, improving realism with multimodal fusion and richer gestures, and advancing affective computing for genuine emotion. Infrastructure should focus on better hardware, shared corpora, and tiered services. Shared avatar libraries and feedback mechanisms, along with industry-academia collaboration, can speed development.

5.2 Social Subsystems: Role Transformation for Teachers, Students, Families, and Schools in a Human-Machine Collaborative Framework for Synergistic Development.

Negative views of digital human teachers stem from doubts about teaching effectiveness and limited roles. Solving these issues requires a holistic, collaborative approach involving students, teachers, schools, and parents. For students, learning to collaborate with digital humans helps develop AI literacy. Students should develop skills in questioning, confronting, probing, and collaborating with digital teachers across four basic dimensions: information and understanding, use and application, evaluation and production, and ethical issues [12]. These advances will enable digital instructors to provide more personalized tutoring. Students should distinguish between digital and human educators, seeking appropriate help and avoiding over-reliance on digital agents. Highlighting teachers' unique strengths reinforces their roles and eases job-security worries, fostering complementary classroom roles. Human teachers should retain autonomy in tasks requiring critical thinking, discussion, or emotional engagement, while digital teachers can handle basic instruction and simulations for effective tech use. In independent learning, digital agents can address routine questions, allowing teachers to offer individualized support and optimize resources. Schools should embed digital teachers into infrastructure, especially for language and lab subjects, and create systems to assess student and teacher collaboration with technology. Educational authorities can use data from digital instructors for real-time feedback and instructional improvement. Parents should adopt an open, supportive attitude toward new technology, actively participating as supervisors and collaborators. Removing barriers among all stakeholders is key to building a collaborative ecosystem, enabling resource sharing, mutual benefit, and a professional development community for digital teachers.

5.3 Environmental Subsystem: Market Reversion to Pedagogical Fundamentals; Policy Reinforcement of Ethical Guardrails.

Digital human teachers face barriers: supply-demand gaps, similar products, fragmented data, weak standards, and poor security. Solutions require market and regulatory coordination. Shift to education-driven development focused on stakeholder needs to match supply and demand. Main aims: lower cognitive load, boost engagement, and improve curriculum fit. Break data monopolies and enable secure data exchange. Improve policies for access, evaluation, and privacy, ensuring efficacy, compliance, and ethical safety.

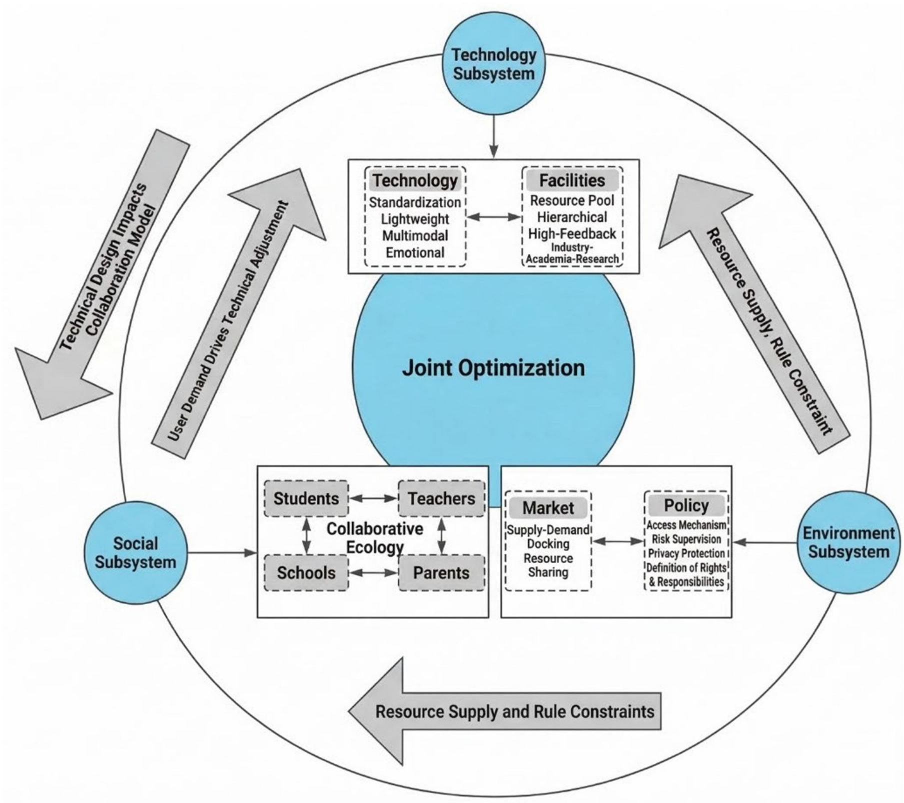

Fig. 8. A Refinement Framework Based on Socio-Technical Systems Theory.

6 Conclusion

Digital human teachers are reshaping pedagogy and expanding digital education. Social media analysis shows mostly positive public sentiment, focusing on technology, cost, and appearance. Main concerns are high adoption barriers, limited realism, and low perceived necessity. Using Socio-Technical Systems Theory, this study suggests optimizing technical, social, and environmental subsystems for healthy growth. Limitations include low exposure, small sample size, and lack of long-term analysis. Future studies will use larger, longitudinal samples to inform evidence-based recommendations.

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