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Digital Pedagogy in Makeup Schools: The Impact of Online Learning and the Use of AI and AR/VR Tools on the Development of Professional Skills

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Abstract- The study analyzes how pedagogical approaches in makeup schools are being transformed under the influence of artificial intelligence (AI), augmented reality (AR), and virtual reality (VR) tools, and determines their role in the formation of cognitive and psychomotor skills. The methodological basis relies on a systematized review of publications from Scopus and IEEE and a qualitative comparative analysis in a case study format of leading technological solutions (Modiface, PerfectCorp, Pivot Point LAB). The interpretation of materials was carried out through the theoretical lens of TPAACK (Technological Pedagogical Aesthetic and Content Knowledge), which makes it possible to consider the technological component in conjunction not only with pedagogical and content knowledge, but also with the aesthetic component that is critical for the makeup artist profession. The results obtained indicate that AI tools are most effective at the cognitive stage of learning: algorithmic processing of appearance parameters and facial morphology contributes to the automation of analytical operations and reduces the share of routine procedures, reallocating the educational emphasis toward semantic interpretation of data and the adoption of artistically justified decisions. AR simulators, in turn, provide a safe format for psychomotor practice, making it possible to train movement accuracy and application technique without material losses and without risk to the model. At the same time, the didactic return of these tools decreases due to systematic distortions in learners self-assessment of mastered skills, as well as due to a pedagogical gap manifested in a mismatch between the pace of updating teaching methods and the speed of implementing technological tools. A comparative review of the cases shows that the greatest degree of maturity is characteristic of pedagogical ecosystems in which digital solutions are integrated with their own educational model and mechanisms for objective monitoring of progress; Pivot Point LAB is highlighted as an example, demonstrating a more coherent architecture of learning and control of the dynamics of competency formation. The set of conclusions confirms that the TPAACK framework serves as a necessary foundation for designing effective and inclusive digital learning environments in professional makeup education, as it ensures consideration of technological, pedagogical, content, and aesthetic components within a single logic. The conducted study has practice-oriented value for the EdTech research community, developers of educational software, and management teams of vocational education organizations in the beauty industry.

Keywords: digital pedagogy, TPAACK, makeup, AI, AR/VR, psychomotor skills, Pivot Point LAB, Modiface, morphology analysis, personalized learning.

Introduction

Contemporary vocational education has entered a phase of structural change initiated by the convergence of two major technological segments: educational technologies (EdTech) and beauty industry technologies (Beauty Tech). According to analytical reviews, in 2024 the global EdTech market was valued at $163.49 billion [1], whereas the volume of Beauty Tech reached $66.16 billion [2]. In both domains, artificial intelligence (AI) is the dominant scaling factor. In Beauty Tech, the share of AI-based solutions in 2024 accounted for more than 34% of total revenue [2], which is primarily associated with the use of algorithms for hyper-personalization of products [3] and for diagnostics of skin parameters [4].

This technological shift generates a new social and market demand. Audiences accustomed to personalized AI recommendations in retail services [4] transfer similar expectations to educational programs, requiring a comparable level of adaptivity and individualization. For makeup schools as an element of career and technical education (CTE) [6], a qualitatively new situation is emerging: it is necessary to align the traditional training logic with digital tools that change the ways of diagnosis, practice, and assessment of outcomes. Historically, makeup education relied on the master–apprentice model and was oriented toward developing two complex groups of competencies: fine psychomotor skills (tactile sensitivity, precision of movements, stability of motor control during application) [7] and aesthetic knowledge, a predominantly intuitive, affective, and perceptual component that provides a sense of harmony of color, form, and proportion [9].

Against this background, a critical research deficit is becoming apparent, described as a pedagogical gap [10]. Technological solutions, from AI tools for morphology analysis to AR systems of virtual try-on (VTO) and VR simulators, demonstrate an exponential development trajectory. However, by analogy with adjacent fields in which psychomotor skills are central (in particular, medicine), scientifically verified didactic approaches to their implementation and pedagogically appropriate use lag substantially behind the pace of technological updating [10].

An additional complication is related to the fact that widely used models of digital pedagogy, for example TPACK (Technological Pedagogical Content Knowledge) [9], prove insufficiently relevant to the artistic-practical profile of training. This framework productively describes the coupling of technology, pedagogy, and content, yet it does not include the affective-aesthetic dimension, which constitutes the core of the professional activity of a makeup artist and determines the quality of the result no less than the technical correctness of execution [9].

The goal is to analyze the transformation of pedagogical approaches in makeup schools under the influence of AI and AR/VR tools, as well as to assess the effectiveness of current digital platforms (Modiface, PerfectCorp, Pivot Point LAB) in developing professional skills, both cognitive and psychomotor.

The author's hypothesis is formulated as follows: effective integration of AI and AR/VR into makeup artist training, ensuring simultaneous development of cognitive components (including morphology analysis) and psychomotor components (including application technique), is achievable only through a transition from the technology-oriented TPACK approach to a pedagogical framework in which aesthetic knowledge is embedded, that is, to the TPAACK model (Technological Pedagogical Aesthetic and Content Knowledge).

Scientific novelty is determined by substantiating the need to adapt the standard TPACK model to TPAACK as applied to digital pedagogy in the field of makeup. Such adaptation makes it possible to evaluate, not fragmentarily but systematically, the contribution of AI tools to the development of cognitive skills and the contribution of AR tools to the development of psychomotor skills, considering both directions within the logic of a unified educational ecosystem.

Materials and Methods

The methodological framework of the study is interdisciplinary in nature and is built around a qualitative logic of analysis that ensures achievement of the stated goal. The research design is based on a combination of a systematic literature review and a comparative case analysis of technological platforms, which makes it possible to align the theoretical foundations of digital pedagogy with the practices of specific instrumental ecosystems.

The systematic literature review was conducted using peer-reviewed publications selected from leading academic databases, including Scopus, IEEE Xplore, and Springer, as well as from high-impact journals (MDPI, Frontiers). The search and analytical focus of the review was aimed at identifying dominant pedagogical models in the field of digital art, descriptions of methods for developing psychomotor skills in a virtual environment, and barriers that hinder the sustainable implementation of technologies in vocational education. This structure of the review made it possible to cover simultaneously the conceptual level (pedagogical frameworks and the epistemology of artistic learning) and the applied level (conditions of skill transfer and limitations of digital practice formats).

The comparative analysis was implemented as a qualitative comparison of the functional capabilities, didactic potential, and modes of pedagogical integration of three key platforms identified in the initial theses: Modiface (L'Oréal), PerfectCorp (including the didactic tool YouCam Tutorial), and Pivot Point LAB. The empirical base of the case analysis was formed through the examination of technical documentation, published case studies, and academic reviews of the use of these solutions in educational and professional contexts, which makes it possible to evaluate not only the set of tools but also the nature of their inclusion in the didactic learning scenario.

The source corpus is systematized according to the principle of prioritization. The main body consists of academic publications devoted to the theoretical foundations of digital pedagogy, pedagogy of arts education, training of psychomotor skills, ethical aspects of AI, and the use of AR/VR in education. An additional layer is formed by industry reports and analytical materials from leading consulting agencies, including McKinsey & Company and Grand View Research, used primarily to verify market statistics and trends for 2024–2025.

Results and Discussion

The primary stage of a makeup artist’s professional activity traditionally has a pronounced cognitive nature and includes analytical reading of facial morphology, identification of skin type and current condition, as well as a substantiated selection of a color palette. The integration of AI tools fundamentally restructures this stage by transferring a significant portion of diagnostic operations into an automated mode and thereby expanding the potential for deep personalization of training.

Solutions of the Modiface class (acquired by L'Oréal) [25] and PerfectCorp rely on contemporary neural network approaches, including convolutional neural networks used for detailed facial analysis [24]. For Modiface, the capability is reported to track 68 facial parameters in real time, perform measurements across key zones (lip and eye contours), account for head pose, and diagnose clinically significant skin conditions (including acne and pigmentation) with a declared accuracy of up to 88% [24]. In essence, this represents a transition from subjective-intuitive diagnosis to an instrumentally verifiable description of baseline data suitable for subsequent interpretation and pedagogical annotation.

From a didactic perspective, this establishes a fundamental shift. Automation of the diagnostic component reduces the relative share of recognition and classification operations that previously required prolonged accumulation of empirical experience, and transfers the educational emphasis to levels of higher cognitive complexity. In terms of Bloom's taxonomy, a shift occurs from lower-order tasks (memorization of features and primary identification of skin types) to higher-order tasks (analysis, interpretation, application, and creation). As a result, the key learning task becomes not guessing skin characteristics, but critically correct interpretation of AI-objectified data and subsequent adoption of artistically and technologically substantiated decisions regarding correction, product selection, and construction of a coherent overall image.

The diagnostic potential of AI simultaneously forms the basis for constructing individualized educational trajectories. Research in AI-adaptive learning demonstrates that algorithmic systems are capable of acting as an ally, adjusting the pace, methods, and content of instruction to the individual characteristics of the learner [21]. In the professional training of makeup artists, such a logic can be represented by a sequential didactic chain (see Fig. 1). At the diagnostic step, an AI tool functionally comparable to Modiface [24] is used to scan the face—one's own or a models. Next, the system generates a morphological report containing quantitative and qualitative indicators (e.g., eyebrow asymmetry N mm, pronounced oiliness in the T-zone, cool skin undertone). At the subsequent stage, this report is matched with the learner's current competency profile, which makes it possible to identify deficits in specific domains (e.g., insufficient development of coloristic analysis or techniques for correcting asymmetry). The final step is adaptive delivery: the AI system, on the basis of diagnostic and profiling data, generates a personalized training module (e.g., advanced work with complex undertones or a practicum on visual correction of eyebrow asymmetry).

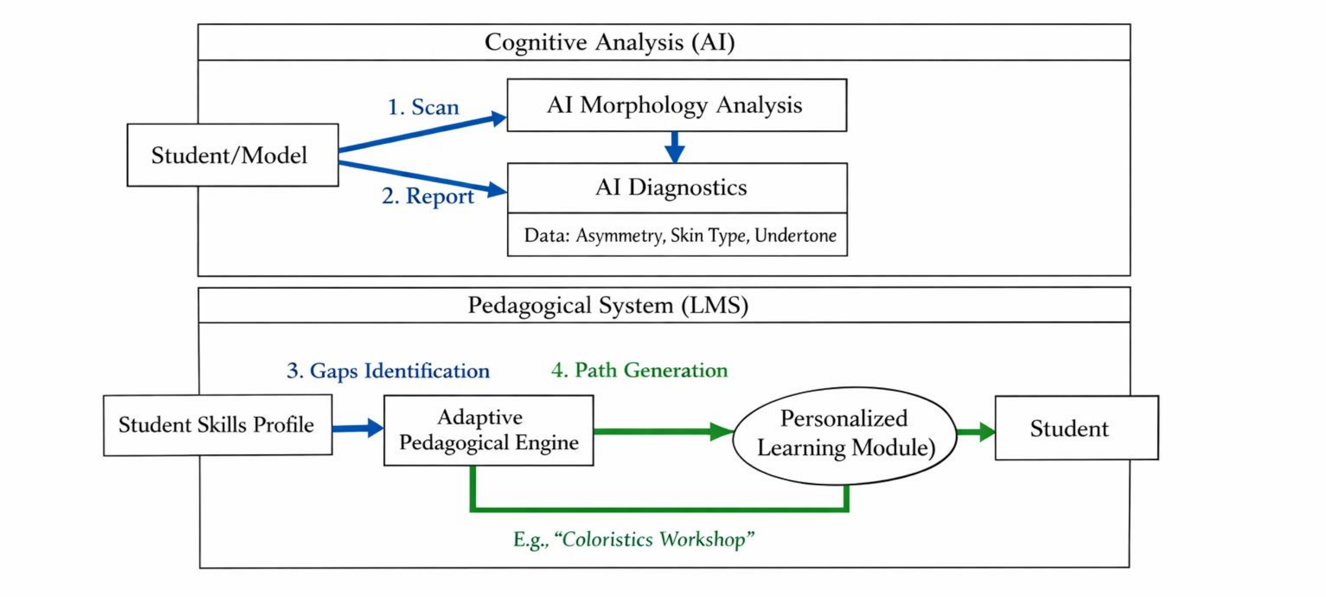

Fig.1. Conceptual model of an AI-adaptive trajectory of cognitive learning in makeup artistry (compiled by the author based on [21]).

Thus, AI tools in the context of professional training in makeup artistry cease to be predominantly marketing try-on applications and acquire the status of a cognitive-diagnostic core from which the design of an individual educational trajectory begins, followed by the adjustment of instructional content to the actual facial data and the learner's competency profile.

Table 1. Comparative analysis of AI diagnostic functions on the Modiface and PerfectCorp platforms (compiled by the author based on [24, 25]).

Criterion	Modiface (L'Oréal)	PerfectCorp (YouCam)
Core technology	Convolutional neural networks (CNN) trained on L'Oréal data.	AI deep learning, AR engines.
Key AI functions (Diagnostics)	Analysis of skin condition (up to 88% accuracy), determination of face shape, skin tone, and hair color.	AI-based skin analysis (accuracy not specified), AI facial analyzer, AI-based skin tone determination.
Face tracking (AR)	High-precision tracking of 68+ parameters, with a focus on lips and eyes, adaptation to lighting.	High-precision AR tracking, recognition of bone structure and skin defects.
Claimed accuracy	88% (for skin analysis), 98.3% (for skin tone determination in early tests).	Not specified in %; exceptional accuracy.
Primary pedagogical focus	Indirect (non-didactic). A strong diagnostic tool. Focus on e-commerce (B2B/B2C).	Direct (didactic). The YouCam Tutorial tool is specifically designed for training.

Immersive technologies (AR/VR) [19] in the logic of professional training for makeup artists perform a function different from that of AI: with the automation of cognitive diagnostics, the main burden of skill formation is shifted to the psychomotor loop—precision of movements, pressure dosing, brush trajectory, and reproducibility of technique. AR/VR environments are intended to convert declarative knowledge into procedural skills through application simulation and controlled repeatability of practice.

An illustrative example is YouCam Tutorial (PerfectCorp), which implements step-by-step AR lessons that are visually overlaid with the user's or a model's face via the device camera [18, 20]. The instructional layer is presented through animated prompts that mark application zones and set the sequence of actions, including indication of the tool type (brush, applicator) and the logic of product distribution. This architecture creates conditions for repeated reproduction of complex techniques, rapid visual fixation of errors, and symmetry training in a mode close to real execution, yet free from a number of constraints of traditional practice.

A strong aspect of the AR/VR approach is the creation of a safe, risk-free environment for training—an effect well described in medical education, where simulation is used to practice procedures without risk to the patient. In makeup training, an analogous principle lowers the entry threshold to intensive practice: dependence on consumable materials and the search for models, which is characteristic of traditional training formats [14], is reduced, and time costs for organizing training are also decreased. In an AR scenario, the marginal cost of repeating a practical step tends toward zero, and the possibility of training outside classroom constraints supports the principles of learning autonomy. Thus, psychomotor training receives a critically important resource—high repetition frequency, necessary for stabilizing the motor pattern.

At the same time, it is precisely at the psychomotor level that the problem of result measurability manifests most acutely. A significant portion of VR simulators in adjacent fields (including surgical simulators) relies on the learner's self-assessment as a key or auxiliary mechanism for monitoring progress [23]. However, empirical data indicate the fundamental unreliability of such an approach: a study conducted in Berkeley [23] demonstrates that self-assessment is characterized by systematic inaccuracy and can worsen the dynamics of psychomotor skill acquisition due to forecasting errors and instability of learning progression. In applied terms, this means that evaluation of the type has symmetry been achieved or is the line sufficiently clean, when based on subjective feeling, cannot be regarded as a pedagogically valid basis for quality control.

This gap between technological simulation and didactically valid organization of learning corresponds to the description of a pedagogical gap [10]: the presence of an AR environment in itself is not equivalent to pedagogy, because the tool provides neither correct diagnostics of skill formation nor a mechanism of guiding feedback. Effective digital pedagogy requires an additional layer in the form of objective assessment and coaching that structures practice, sets criteria, and provides corrective feedback on top of the simulator. As an alternative to self-assessment, the literature describes data-driven models for forecasting skill mastery, for example Bayesian Knowledge Tracing (BKT), which makes it possible to estimate the probabilistic level of skill possession and its dynamics [23].

Within the coordinates of TPAACK [9], the assessment task acquires a dual nature. Progress monitoring must cover not only technical accuracy (symmetry, line evenness, gradient stability, correct placement of accents), but also aesthetic knowledge—harmony, appropriateness, expressiveness, and creativity of the solution [9]. In practice, most AR tools remain predominantly in the domain of technical reproduction and visual prompting, whereas the aesthetic dimension is more often placed outside algorithmic assessment and retained as an area of expert pedagogical judgment, which limits the completeness of the didactic effect of immersive technologies in the professional training of makeup artists.

Below, Figure 2 reflects the level of adoption of AI/AR technologies in the beauty industry.

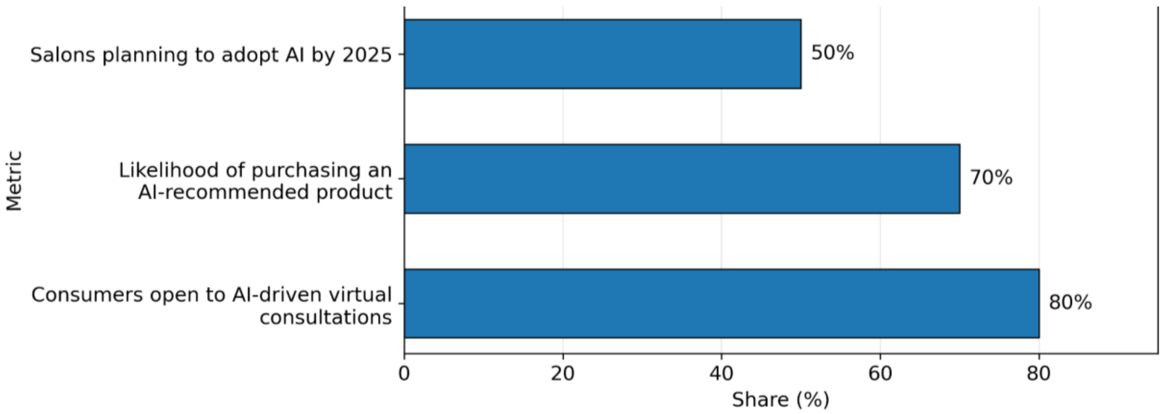

Fig. 2. Level of adoption of AI/AR technologies in the beauty industry (compiled by the author based on [4]).

Comparison of the three platforms indicated in the theses makes it possible to reconstruct a continuum of digital pedagogy maturity—from a technologically strong but didactically mute instrument to a comprehensive educational ecosystem combining the technological layer, a pedagogical model, and data-driven assessment (see Table 2).

Table 2. Comparison of pedagogical models and functionality (Modiface, PerfectCorp, Pivot Point LAB) (compiled by the author based on [23, 24]).

Platform	Primary function	Pedagogical model (TPAACK integration)	AI tools	AR/VR tools	Assessment / Progress tracking (LMS)
Modiface	Tool (E-commerce)	Low (Only T, A, and C)	AI skin diagnostics, analysis of 68+ facial parameters	AR Virtual Try-On (VTO)	No (Not an LMS)
PerfectCorp (YouCam Tutorial)	Didactic tool	Medium (T, P, C)	AI skin analysis, AI facial analyzer	AR tutorials (step-by-step practice), VTO	No (Not an LMS); assessment implies self-assessment
Pivot Point LAB	Pedagogical ecosystem (LMS)	High (Integration of T, P, A, C)	Not specified (LMS-focused)	Not specified (LMS-focused)	Yes. Mindful Teaching, activity tracking, auto-assessment, reports

Modiface (L'Oréal) is positioned as one of the global leaders in the segment of AR/AI solutions for the beauty industry [24]. At the same time, the logic of developing and scaling the platform is determined predominantly by the market architecture of B2B/B2C and the objectives of e-commerce [25]. The very fact of Modiface being acquired by the L'Oréal Group is interpreted as a strategic step aimed at strengthening digital research and supporting commercial objectives, including sales growth [25; 40]. In the educational dimension, Modiface has high applied capacity as a diagnostic tool that provides high-quality analysis of the face and skin condition [24]; however, it does not include structured components of digital pedagogy: there is no curriculum, no embedded coaching procedures, and no contours of objective progress assessment. Consequently, the pedagogical value of Modiface is predominantly mediated: the technology can enhance the cognitive stage of training, but in itself does not form a learning environment and does not manage competency development.

PerfectCorp, by contrast, demonstrates a shift from a purely retail logic toward a didactic function. The most illustrative development in this respect is YouCam Tutorial, which acts as an explicitly didactic AR tool [8, 25]. Functionally, the platform allows professional makeup artists to construct step-by-step lessons; when creating content, mechanisms are used that emulate familiar practices of visual planning (for example, a face chart), including precise markup capabilities comparable to manual work using a stylus. For learners, the AR mode turns the lesson into an interactive demonstration by overlaying an instructional layer onto the face of the user or a model. The didactic strength of such a solution lies in supporting a constructivist logic of learning through action, where mastery of technique is ensured by repeatable practice and visually guided execution. However, the level of pedagogical integration remains moderate: YouCam Tutorial functions as a strong instrument within a course, but does not operate as an environment that manages the full learning cycle (planning, assessment, progress analytics, coaching), that is, it does not replace a full-fledged platform infrastructure.

The most mature form of digital pedagogy is demonstrated by Pivot Point LAB, which represents not a single tool but a comprehensive educational ecosystem. In descriptions, the platform is qualified as a digital social learning environment, which indicates an embedded organization of interaction rather than only the provision of digital content. The fundamental distinction of Pivot Point is associated with the purposeful integration of pedagogy and technology aimed at overcoming the pedagogical gap between the development of tools and the methodologies for their application [10, 11]. Within this strategy, an in-house pedagogical model, Mindful Teaching, has been developed and embedded into the architecture of teacher training and into the logic of the platform's functioning. Mindful Teaching is oriented toward developing the coaching competencies of the master educator, managerial practices for working with a group, and assessment procedures [12, 13], thereby moving the digital environment from a content + tool state to a methodologically managed learning state.

The LAB platform serves as the technological shell for this pedagogy and functions as a full-fledged LMS, which ensures the presence of formalized mechanisms for progress control and learning-activity analytics. This approach makes it possible to rely on tools of objective assessment, minimizing dependence on learners' self-assessment, which is methodologically recognized as unreliable in psychomotor learning [23]. The administrative layer of LAB provides capabilities for monitoring development dynamics, accounting for time spent, automated checking of test tasks, and generating detailed reports. An additional dimension is the social component that ensures exchange of experience and inclusion in a professional community [16, 17], which aligns with the principles of connectivism that interpret knowledge as a distributed network supported by connections, platforms, and collective practices.

Taken together, Pivot Point LAB can be considered the most holistic platform at present, close to a TPAACK-oriented type of educational architecture, because it integrates technological infrastructure (T) in the form of LAB, a pedagogical layer (P) in the form of the Mindful Teaching model, an aesthetically oriented training framework (A) expressed through a focus on the culture of professional beauty and talent incubation, content that is structurally organized (C) through the formalized Fundamentals curriculum, and their coupling into a unified system of knowledge and learning procedures (K). Such integration transforms a digital makeup school from a set of disparate tools into a managed ecosystem in which technological progress becomes didactically meaningful and measurable [15-17].

Accelerated digitalization of professional training in makeup, despite the pronounced potential of AI and immersive technologies, is accompanied by a systemic set of barriers and risks manifested at pedagogical, ethical, and technical levels and capable of reducing educational effectiveness in the absence of a managed implementation strategy.

The key pedagogical limitation is associated with a deficit of AI literacy among the teaching staff [15]. Embedding AI, AR, and VR into the learning process requires not so much the acquisition of software products as the restructuring of methodological thinking, the language of assessment, and feedback formats. In career and technical education (CTE), of which makeup schools are a part [6], this problem is intensified by the historical orientation of educators toward in-person practice, manual work, and direct interaction in a mentorship model. Studies devoted to CTE document recurring obstacles: lack of time to master new technologies, deficits of technical support and infrastructure [6], as well as psychological resistance to change. As a result, digital solutions are often implemented as a superstructure over prior didactics, which leads to technologization without pedagogical effect.

From this follows a managerial conclusion: acquiring expensive platform ecosystems without parallel investments in teacher training and in mastering the corresponding pedagogical models proves resource-inefficient. An example of a critically important linkage is the coupling of a technological platform with a pedagogical model similar to Mindful Teaching, because it is precisely this model that sets the procedural culture of coaching, assessment, and practice support. Technology does not eliminate the role of the teacher, but complicates it, shifting the professional function from content transmission to coaching support, facilitation, and management of reflection [22]. Without such a transition, digitalization effectively entrenches the pedagogical gap in which the tool exists separately from the methodology of its didactically correct application.

At the level of ethical risks associated with AI, the most significant is the phenomenon of algorithmic bias. Systems of face recognition and skin analysis have repeatedly demonstrated a tendency toward reduced accuracy across an insufficiently represented spectrum of phenotypes. A report by the Alan Turing Institute reveals the historical and technological foundations of this problem: for decades, photographic material technologies were developed with a priority on accurate reproduction of light skin, which institutionalized distortions in visual standards and, subsequently, in the data used to train models. As a result, such inherited shifts are reproduced in the datasets on which neural networks are trained. In the educational context, this has direct pedagogical consequences: AI diagnostic modules (for example, those used in solutions of the Modiface level [24]) when trained on biased data may systematically output less accurate morphological and dermatological characteristics for darker skin tones. Here the issue is not a neutral technical error, but a didactic failure that violates the principle of inclusivity and undermines the aesthetically significant component of training conceptualized within TPAACK.

The second major ethical risk of AI is related to privacy and data governance. Adaptive educational platforms require large-scale collection of information about learners; in makeup this dataset includes biometric data, primarily face scans [5]. The use of such data for training and fine-tuning models requires strict protection protocols, transparent grounds for processing, minimization of the collected volume, and access control. In the EdTech context, these requirements are often met inconsistently, which increases the likelihood of improper data use, leaks, and secondary use of information beyond educational purposes.

Immersive AR/VR technologies form a separate cluster of ethical and technical risks. In the ethical dimension, distortion of reality is critical: commercial AR filters, which gradually penetrate instructional practices, often do not limit themselves to simulating makeup, but optimize the face by enhancing glow and smoothing texture and skin tone. In training, this creates a substitution of the object of practice: a skill of working not with real parameters of skin and face is formed, but with a digitally improved image, which can reduce transferability of the skill into offline practice and produce an anti-pedagogical effect. Additionally, such practices are associated with the exacerbation of dysmorphic tendencies and the problematization of appearance perception, which moves the issue from the plane of technological convenience to the plane of responsibility of the educational environment.The technical limitation of AR/VR is determined by the absence of haptic feedback. Makeup as a professional practice is based on sensitivity to pressure, texture, degree of moisture, and microrelief of the skin; modern immersive infrastructure, as a rule, is not capable of transmitting these parameters at a level sufficient for a full replacement of in-person psychomotor training. Consequently, AR/VR are effective as an environment for preliminary mastering of action sequences, visual control, and increasing repetition frequency, but not as a complete alternative to tactilely rich practice.

Finally, physiological risks of using VR headsets limit the duration and density of sessions: educational research describes the phenomenon of cybersickness, which includes nausea, disorientation, and general discomfort [22]. These effects reduce tolerance for prolonged sessions and require the design of learning scenarios that take into account dosage of load, alternative formats, and sanitary-hygienic constraints, especially in the context of regular simulator practice.

Conclusion

The conducted analysis confirms that the integration of AI, AR, and VR tools restructures professional makeup education at the level of goals, means, and assessment mechanisms, shifting it from traditional craft-based models to hybrid digital ecosystems. The obtained results demonstrate the functional differentiation of technologies and simultaneously reveal the limits of their educational productivity in the absence of a methodologically organizing pedagogical superstructure.

The synthesis of empirical and theoretical findings identifies a stable separation of roles. AI tools (including Modiface-class solutions) assume a significant share of the cognitive block of the profession by automating diagnostics and morphological analysis, which changes the structure of learning requirements: instead of mechanical identification of skin and facial characteristics, the key becomes analytical interpretation of objectified data and its transformation into a creatively grounded decision. AR/VR tools (including YouCam Tutorial) form a risk-free psychomotor environment, removing part of the resource constraints of traditional practice and ensuring repeated iterations critical for consolidating motor patterns. At the same time, the initial hypothesis is confirmed that the effectiveness of these means is determined not by the technology itself but by the quality of the pedagogical superstructure. The introduction of tools into a methodological vacuum leads to a reduction in didactic effect and runs up against barriers, in particular the inaccuracy of self-assessment in the formation of psychomotor skills and the reproduction of the pedagogical gap between the speed of technological development and the maturity of teaching methodologies.

A key condition for effective digitalization is the transition from the standard TPACK model to the adapted TPAACK framework, in which aesthetic knowledge becomes the central reference point for the design of learning and assessment. As a result of comparative analysis, it is established that solutions predominantly focused on the technological component (Modiface, PerfectCorp) have limited didactic value: they either retain a dominant linkage to e-commerce or function as narrowly specialized simulators that do not ensure full-cycle management of learning. At the opposite pole are comprehensive ecosystems represented by Pivot Point LAB, which demonstrate a higher level of pedagogical integration. Their maturity is determined by the fact that the pedagogical gap is compensated through embedding an in-house methodology for teacher training and support (Mindful Teaching), support for social learning conceptually aligned with connectivism, and the presence of tools for objective progress control implemented through LMS functionality. This configuration shifts the digital environment from an instrumental supplementation mode to a managed educational system mode, where the technological layer is coupled with methodology, criteria, and performance analytics.

The practical significance of the findings lies in substantiating the TPAACK framework as an instrument for auditing and implementing digital technologies in makeup schools. The managerial logic of implementation within this approach shifts from purchasing individual technological solutions to building an integral pedagogically valid digital environment, in which a mandatory condition is the systemic development of AI literacy among the teaching staff. In this context, technological solutions are considered as infrastructure requiring methodological configuration, teacher preparation, and regulation of assessment procedures, rather than as an independent substitute for professional mentorship.

The limitations of current technologies define directions for further research. First, the problem of the absence of haptic feedback in AR/VR simulators remains unresolved, which limits the completeness of transferring psychomotor skills from virtual practice to in-person training. Second, the ethical dimension of digitalization remains a priority: the development of AI in the training of makeup artists requires the creation of inclusive and unbiased datasets for training diagnostic models, as well as the development and implementation of strict protocols for protecting learners' biometric data in EdTech systems. These directions are critically important to ensure that digital transformation does not reduce the quality and fairness of education, but strengthens its professional and social viability.

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