RESEARCH-ARTICLE

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Integrating Generative AI with Human-Centered Pedagogy: An Innovative Path for Vocational Education

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Abstract

The proliferation of Generative AI necessitates a re-evaluation of educational strategies, particularly in vocational fields. Traditional vocational education faces challenges like limited resource access, high software costs, and a lack of personalized feedback. This paper explores how integrating generative AI, guided by a human-centered philosophy, can address these issues. Through a qualitative analysis of four pedagogical interventions at a vocational school (e-commerce, art, math, and computer science), we find that AI, as a pedagogical co-pilot, boosts instructional efficiency, nurtures creativity, and enables individualized learning. The case studies show AI's ability to lower costs, remove practice barriers, and provide data-driven insights. We synthesize these findings into a conceptual framework for human-centered AI integration, emphasizing AI's role in empowering educators and learners. This research offers a transferable model and discusses ethical considerations for creating effective and equitable learning environments.

CCS Concepts

• **Applied computing**; • **Education**; • **Computer-assisted instruction**;

Keywords

Generative AI, Vocational Education, Personalized Learning, Human-Centered AI, Case Study, Educational Technology

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1 INTRODUCTION

The rise of generative AI is transforming many sectors, with education at a critical juncture. For vocational education, which focuses on practical skills, this shift presents both opportunities and challenges. Vocational institutions often struggle with resource constraints, expensive training platforms, and the difficulty of providing calculable mentorship, creating a gap between theory and practice.

This study argues that strategically implementing generative AI within a human-centered framework can overcome these obstacles. Unlike traditional AI in education, which focused on analytic or rule-based system, generative AI creates new content—text, images, or code—unlocking novel pedagogical possibilities.[1, 2] It can generate dynamic simulations, customized problem sets, or visualize concepts on demand, offering interactivity and personalization beyond the scope of static software.[3] A human-centered approach views AI not as an autonomous teacher but as a co-pilot that enhances the capabilities of both educators and students, prioritizing user empowerment and creative exploration.[4]

To provide empirical evidence, we analyze four case studies from a vocational school integrating AI across diverse subjects:

- **E-commerce:** An interactive H5 application for customer service simulation.
- **Art and Design:** Image generation models to enhance creativity and accelerate design iteration.
- **Mathematics:** AI for intelligent assessment generation and data-driven performance analysis.
- **Computer Science:** An AI-driven "dual-teacher" for personalized coding assistance.

By examining these applications, this paper aims to formulate a practical, human-centered framework for integrating generative AI in vocational education. We provide tangible evidence of AI's impact on instructional efficiency and student outcomes, proposing a replicable model for other institutions.

2 A MULTI-FACETED APPROACH TO AI INTEGRATION: CASE STUDIES

Our methodology is a qualitative analysis of four embedded case studies, each representing a distinct application of generative AI to solve a specific pedagogical problem. The study received ethical approval, and all participant data were anonymized.

2.1 Case 1: Accessible Skill Simulation in E-Commerce

Led by Tingjie Xu, this case tackled the high cost and limited accessibility of e-commerce training software. The goal was to enable students to practice customer service dialogues with instant feedback outside the classroom.

Solution: Using the DeepSeek-V2 API, structured prompts were used to generate a self-contained HTML5 application simulating

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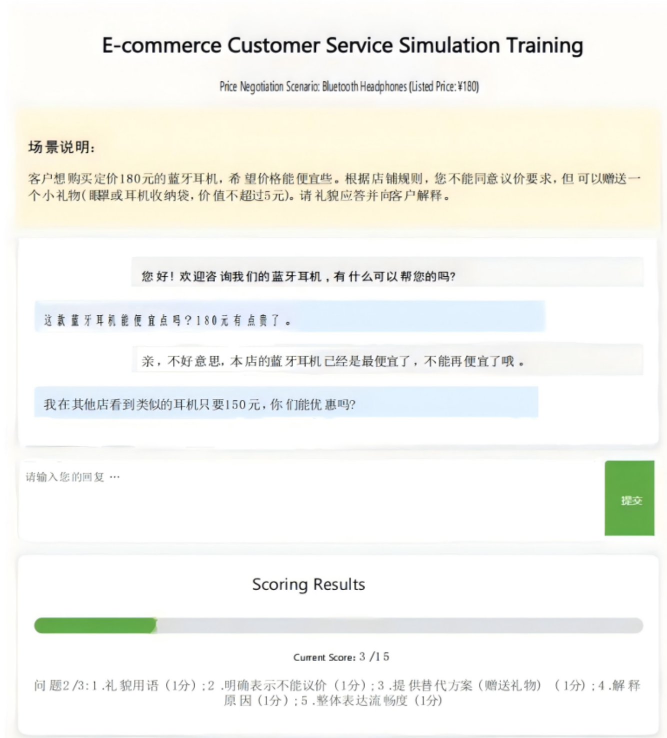

Figure 1: The AI-generated H5 application provides a simulated dialogue and real-time scoring for e-commerce customer service training.

a customer service scenario. The AI back end evaluates student responses in real-time against a predefined rubric, providing an immediate score and constructive feedback.

Findings: This cost-effective solution bypassed expensive platforms, allowing students to practice on mobile devices. Post-intervention surveys (Cronbach's $\alpha = 0.88$) showed that 91.7% of students felt their skills improved, and 70.8% found the real-time feedback highly effective. This case demonstrates how generative AI can democratize access to practical training.

2.2 Case 2: Enhancing Creative Expression in Art and Design

Educator Xiaofang Ding sought to bridge the gap between abstract concepts and visual artifacts for students with varying drawing skills in her "Store Display Design" course.

- **Solution:** A multi-tool strategy used AI platforms like Doubao and Jimeng. The workflow included:
- **Image-to-Image Generation:** AI refined students'; hand-drawn sketches into photorealistic renderings.
- **Text-to-Image Generation: Students** used text prompts to rapidly explore diverse design concepts.
- **Collaborative Refinement:** AI-generated visuals were imported into a digital whiteboard for team-based synthesis.
- **Findings:** The from 4-5 hours to under one hour, and students produced 2-3 times more design variations. The quality of final submissions, assessed by a standardized rubric, improved by 15-20%, highlighting AI's role as a creative catalyst.

2.3 Case 3: Intelligent Assessment and Analysis in Mathematics

Xiaohua Li's team focused on automating the time-consuming process of creating and analyzing mathematics assessments to gain deeper, data-driven insights.

- **Solution:** AI platforms, including Doubao and DeepSeek-V2, were used to build an intelligent assessment system. The AI generated balanced tests based on curriculum objectives and historical data, which educators could review. After exams, the AI performed a multi-dimensional analysis, generating reports on performance, score distributions, and mastery levels for specific topics.
- **Findings:** The system reduced test creation time from 3-5 hours to under one hour. The automated analysis provided actionable insights for more targeted teaching. Test reliability was high (KR-20 > 0.85), and in pilot groups, student average scores increased by 8-12 points, demonstrating the impact of data-informed instruction.

Figure 2: An AI-generated rendering from a text prompt, enabling rapid visualization of a design concept.

Table 1: Summary of AI Integration Case Studies

Case Study	Discipline	Core Problem	AI Application	Key Human-Centered Outcome
Case 1 (Tingjie Xu)	E-commerce	Inaccessible/costly training	AI-generated H5 simulation	Democratizing access to practice
Case 2 (Xiaofang Ding)	Art & Design	Creative/technical Skill gap	Image/text-to image Generation	Accelerating creativity and iteration
Case 3 (Xiaohua Li)	Mathematics	Laborious/subjective assessment	Intelligent test generation & analysis	Empowering teachers with data
Case 4 (Mengyun Zhao)	Computer Science	Lack of scalable, Personalized support	AI ”dual-teacher” Platform	Providing on-demand, personalized guidance

2.4 Case 4: The ”AI Dual-Teacher ” for Personalized Tech Education

The ”AI Xiaomei” project, led by Mengyun Zhao, was developed to provide scalable, personalized support for students in the demanding field of Big Data, especially for academic competitions.

- **Solution:** ”AI Xiaomei”; is an AI platform functioning as a ”dual teacher,” built on a custom knowledge
- Base using a Retrieval-Augmented Generation (RAG) framework. It offers 24/7 Q&A support, generates personalized coding challenges, and provides educators a dashboard to monitor student progress and identify common difficulties.
- **Findings:** The platform increased the volume of resolved queries sixfold compared to traditional Q&A sessions. Educator preparation time was nearly halved, from 4.1 to 2.5 hours per class. Student feedback was overwhelmingly positive, with participants citing the tool as crucial for optimizing their study and problem- solving skills.

3 DISCUSSION: A FRAMEWORK FOR HUMAN-CENTERED AI INTEGRATION

A cross-case analysis reveals a consistent pattern of successful, human-centered AI integration. We synthesize these themes into a four-pillar conceptual framework to guide vocational institutions.

3.1 Pillar 1: AI as a Teacher’s Co-Pilot

A core principle is positioning AI as a supportive instrument that augments, not replaces, the educator. In all cases, teachers acted as architects of the learning experience, designing prompts (Case 1), curating workflows (Case 2), setting parameters (Case 3), and building knowledge bases (Case 4). AI handled repetitive tasks, freeing educators to focus on higher-order teaching activities like

Figure 3: The "AI Xiaomei" system architecture, illustrating its role as a bridge between students and teachers

building rapport and providing socio- emotional support. This "co-pilot" model enhances the teacher's professional capacity, aligning with the "teacher-AI collaboration" concept[3] and positioning them as strategic learning designers.

3.2 Pillar 2: AI for Deep Personalization

Generative AI enables personalization at an unprecedented scale. The "AI Xiaomei"; platform (Case 4) delivers customized exercises, while the H5 simulation (Case 1) allows self-paced practice. This aligns with learning theories like Vygotsky's Zone of Proximal Development (ZPD), where tasks are tailored to a student's readiness. By creating dynamic, adaptive learning paths, AI fosters student agency and intrinsic motivation, which are cornerstones of human-centered pedagogy.[5Cotton,]

3.3 Pillar 3: AI as a Bridge to Practice

The case studies show AI's ability to create low-cost, high-fidelity bridges to professional practice, addressing a core challenge in vocational education. AI-generated environments, like the e-commerce simulation (Case 1) and design renderings (Case 2), serve as "cognitive apprenticeships" where students can apply theory in safe, low-stakes settings. This iterative cycle of practice and feedback is essential for building robust skills and professional confidence.

3.4 Pillar 4: AI for a Data-Informed Culture

The mathematics (Case 3) and computer science (Case 4) cases demonstrate how AI can shift teaching from an intuition-driven art to a data-informed science. AI systems capture rich process data, allowing educators to diagnose not just *what* a student doesn't know, but *why* they struggle. For instance, the "AI Xiaomei" dashboard (Case 4) can reveal common misconceptions, enabling targeted interventions. This creates a virtuous cycle of continuous improvement where teaching strategies are refined based on real-time evidence.[1]

4 COMPARATIVE ANALYSIS WITH EXISTING FRAMEWORKS

Our four-pillar framework, derived from our case studies, contributes to the broader discourse on technology integration. Foundational models like TAM, SAMR, and TPACK were instrumental for previous technologies but were conceived before the rise of generative AI. As scholars note, traditional educational AI was primarily analytical, whereas generative models represent a paradigm shift to a creative and productive partner.[1, 6]

Generative AI creates novel artifacts—text, images, code, and simulations—on demand. This critical distinction requires a new perspective. Existing frameworks do not fully capture the pedagogical affordances of an AI that can co-create a design portfolio (Case 2), generate a functional app (Case 1), or act as a bespoke tutor (Case 4). Our framework complements these models by providing a practice-oriented lens for harnessing AI's unique generative capacity in vocational education. The comparison below with a contemporary framework for teacher-AI collaboration highlights this contribution.

The comparison shows our framework's novelty in its explicit focus on leveraging the generative nature of modern AI. While Holstein et al.'s work is a crucial foundation, our framework extends it by incorporating AI's role as a creative and developmental partner ("Bridge to Practice," "Co-Pilot"). This is particularly salient in vocational education, where creating authentic artifacts is paramount. Thus, our framework adapts and builds upon existing models for the unique concordances of generative technologies.

Table 2: Comparative Analysis of AI Integration Frameworks

Dimension	Our Proposed Framework(Generative AI Focus)	Holsteinetal. (2019)Framework (Orchestration Focus)
Core Principle	Human-centered empowerment of both teachers and students through AI as a co-pilot.	Supporting teacher-AI collaboration for real-time classroom orchestration.
Role of AI	Content generator, creative partner, personalized tutor, and data analyst. Proactive in creating new materials.	Data visualizer and commandeer. Provides real-time analytic to inform teacher decisions.
Role of Teacher	Architect of the learning experience, prompt engineer, curator of AI outputs, and mentor.	Orchestrator of classroom activities, interpreting AI insights to provide targeted support.
Key Distinction	Emphasizes the creative and generative capabilities of AI to build new tools and learning experiences, particularly suited for practical skill development in vocational settings.	Focuses on the analytical and assistive capabilities of AI to manage complex, real-time learning environments.

Table 3: Ethical Risks and Mitigation Strategies in AI Integration

Ethical Risk	Description	Mitigation Strategy
Data Privacy & Security	Student data could be vulnerable to breaches or misuse.	Strict data anonymization; use of secure platforms; transparent data usage policies; compliance with regulations.
Algorithmic Bias	AI models may perpetuate existing inequalities.	Regular auditing of AI-generated content by educators for fairness; using diverse training data where possible.
Student Over-reliance	Dependence on AI may hinder critical thinking.	Designing tasks that require students to evaluate and refine AI outputs; explicit instruction on ethical AI use.
Academic Integrity	Potential for AI-assisted plagiarism or cheating.	Redesigning assessments to focus on process and application; use of detection tools coupled with clear institutional policies.[7]

5 ETHICAL CONSIDERATIONS AND MITIGATION STRATEGIES

Integrating AI into education is a profound ethical undertaking that requires balancing efficiency with student welfare, equity, and academic integrity. Our approach is grounded in ethical frameworks like the ACM Code of Ethics, which mandates fairness, privacy, and the avoidance of harm.[8] The study protocol received IRB approval, ensuring adherence to ethical standards, including data de-identification and informed consent.

6 CONCLUSION AND FUTURE WORK

The evidence from our four case studies supports the proposition that generative AI, applied within a human- centered framework, can be a transformative force in vocational education. By viewing AI as a co-pilot for educators and a personalized tutor for learners, it is possible to address challenges of cost, access, and scale, creating more efficient and effective learning ecosystems. Our four-pillar framework offers a transferable model for other institutions.

This research is an initial exploration. Future work should include longitudinal studies on skill retention and career outcomes. Further investigation is also needed into the ethical dimensions, particularly the subtle impacts of student over-reliance on AI. As one educator noted, some students tried to game the system, highlighting the need for pedagogic that promote authentic learning.

Ultimately, successful integration depends on empowering educators with the training, resources, and autonomy to innovate. These cases are not just technological successes but pedagogical triumphs, showing that when educators lead integration, AI can serve the core mission of education.[9, 10]

7 DATA AND CODE AVAILABILIT,

To support the principles of reproducible research, the anonymized survey data and evaluation rubrics used in this study are available from the corresponding author upon reasonable request. Key code snippets and prompt engineering examples are provided in the Appendix.

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Appendix

A Case 1 (E-commerce): Prompt Engineering Example

A simplified version of the master prompt used to generate the H5 application:

```
You are an expert H5 application developer. Create a single, self-contained
HTML file with embedded CSS and JavaScript. The application should simulate a customer service chat.
Scenario: A customer wants a discount on a product.
User Role: Customer Service Agent.
AI Role: The Customer.
Functionality:
```

- Display the customer's initial message.
- Provide a text input for the user (agent) to reply.
- On submission, use a predefined rubric (politeness, policy adherence, offering alternatives) to score the user's reply from 1-100
- Display the score and provide specific, constructive feedback.
- The interface must be clean, mobile-friendly, and professional

B Case 2 (Art & Design): Workflow

The workflow was structured as a three-step process:

Ideation: Students produce rough hand sketches.

AI-Augmented Exploration: Sketches are fed into an image-to-image model for refinement, while parallel text-to-image prompts are used to generate diverse concepts.

Synthesis: All generated visuals are imported into a Bosi Whiteboard for collaborative annotation, critique, and final composition.

C Case 3 (Mathematics): Analysis Dimensions

The AI's automated analysis report for mathematics exams included:

Overall class average and standard deviation.

Score distribution histogram.

Item analysis for each question (difficulty index, discrimination index).

Performance breakdown by specific curriculum knowledge points (e.g., "Quadratic Functions," "Trigonometry").

D Case 4 (Computer Science): RAG Architecture

The "AI Xiaomei"; platform was built on a Retrieval-Augmented Generation (RAG) architecture. The knowledge base was a vector database created by embedding:

All course lecture notes and textbooks.

Official documentation for relevant technologies (e.g., Python, Hadoop).

A curated dataset of past competition questions and solutions. When a student asks a question, the system first retrieves the most relevant document chunks from the vector store and then feeds them, along with the original question, into the LLM to generate a precise, context-aware answer.