Article

As a New Negative Entropy Source: Research on Vibe Coding Tools Empowering Micro-Major Construction from the Perspective of Dissipative Structure Theory

Yinhua Yan[1] and Mingzhi Shi[2,*]

[1] School of International Education, Nanning Vocational and Technical University, Nanning, China
[2] School of Artificial Intelligence, Nanning Vocational and Technical University, Nanning, China
* Correspondence: Mingzhi Shi, School of Artificial Intelligence, Nanning Vocational and Technical University, Nanning, China

Abstract: Micro-majors serve as an important vehicle for vocational undergraduate education to align with industrial demands, developing rapidly under the national education authorities' "Double Thousand" Plan. However, challenges persist, including high cross-disciplinary learning barriers, slow course content iteration, and insufficient digital transformation talent for traditional industries, leaving the industry-education integration system in an inefficient near-equilibrium state. This study introduces dissipative structure theory to conceptualize this system as an open complex system and proposes that Vibe Coding tools serve as a new type of negative entropy source. These tools enhance nonlinear synergistic interactions through three pathways: reducing cognitive barriers, accelerating course content updates, and improving course-certification integration closed loops, thereby driving the system toward a highly ordered state. Drawing on the Huawei ICT micro-major case, implementation pathways including teaching platform construction, university-enterprise curricula co-construction, and credit mutual recognition optimization are proposed, providing theoretical support and practical reference for micro-major construction and traditional industry digital transformation.

Keywords: micro-major; Vibe Coding; cross-disciplinary learning

1. Introduction

1.1. Research Background

Vocational undergraduate education is tasked with cultivating high-level technical and skilled talents for advanced manufacturing and emerging industries. Traditional majors, with broad disciplinary scopes and rigid programs, struggle to respond promptly to talent demands in fields such as the digital economy and the low-altitude economy, resulting in a mismatch between supply and demand. Micro-majors, characterized by compact, flexible, and practical features, effectively address the misalignment between course granularity and job skills. By 2025, 628 institutions have established 2,654 micro-majors under the "Double Thousand" Plan, with 74,000 graduates completing their studies [1], accumulating replicable experience in aspects such as "market-oriented design, project-based teaching, certification-based evaluation, and flexible study."

Concurrently, AI programming tools powered by large language models have risen rapidly. In early 2026, Vibe Coding tools such as OpenClaw, Cursor, and WorkBuddy transformed the programming entry threshold from "mastering syntactic rules" to "describing task intent," enabling non-computer science learners to engage in programming practice quickly. At the policy level, the Ministry of Education has issued documents No [2025].4 and No [2025].17 to implement the "Double Thousand" Plan, focusing on 60 key construction directions across 12 urgently needed industrial sectors

Received: 23 August 2026
Revised: 14 October 2026
Accepted: 28 October 2026
Published: 31 October 2026

Copyright: © 2026 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (https://creativecommons.org/licenses/by/4.0/).

[2,3], promoting the "major + AI application" model and providing institutional support for integrating Vibe Coding tools into micro-major construction.

1.2. Problem Statement

Although micro-major construction has progressed, three persistent challenges remain. First, cross-disciplinary learning barriers are pronounced: micro-majors frequently involve knowledge outside students' original disciplines, and for instance, IoT majors studying HarmonyOS development face heavy cognitive loads. Traditional instruction follows a linear path of learning syntax before writing code, requiring non-computer science students to spend considerable time overcoming basic programming thresholds, leading to low completion rates. Second, course content iteration lags: while industrial technologies evolve rapidly, course development typically spans months, and textbooks often fall behind the technological frontier [4,5]. Third, digital transformation talent supply for traditional industries is insufficient, with existing micro-majors predominantly focusing on the ICT sector and inadequate coverage of AI scenarios in manufacturing, agriculture, and services.

These challenges indicate that the industry-education integration system is trapped in an inefficient near-equilibrium state: enterprises lack willingness to participate, the connection between teaching and the industrial chain is shallow, and the system's openness is inadequate. A novel intervention mechanism that reduces energy exchange costs and accelerates negative entropy inflow is urgently needed.

1.3. Significance and Innovation

The theoretical significance lies in integrating dissipative structure theory with CBE and constructivist learning theory to construct an analytical framework positioning Vibe Coding tools as a "new type of negative entropy source." The practical significance lies in providing actionable pathways for institutions and offering reference solutions for traditional industries to cultivate digital transformation talents. The main innovations include: (1) proposing that Vibe Coding tools serve as a new negative entropy source; (2) revealing three mechanisms by which they reduce cross-disciplinary learning barriers; and (3) constructing a "Vibe Coding tools + micro-majors + industry certifications" integration model extended to traditional industry digital transformation.

2. Theoretical Foundations and Analytical Framework

2.1. Dissipative Structure Theory and Characteristics of the Industry-Education Integration System

Dissipative structure theory posits that an open system far from equilibrium, through continuous exchange of matter, energy, and information with the external environment (i.e., negative entropy introduction), may spontaneously transition to a highly ordered state when nonlinear interactions exist among internal elements and a control parameter reaches a critical threshold. The industry-education integration system, comprising institutions, enterprises, governments, and industry associations, exhibits typical dissipative structure characteristics: the system must maintain openness with the industrial environment, continuously importing negative entropy including cutting-edge technologies, financial investments, and policy support; the ideal state should be dynamically "far-from-equilibrium," whereas current challenges indicate an inefficient "near-equilibrium" state; nonlinear interactions among stakeholders—collaboration, competition, and feedback—serve as the intrinsic driving force for evolution; and "fluctuations" such as technological breakthroughs or policy releases may be amplified near critical points, triggering hierarchical transitions.

2.2. Constructivism and AI-Assisted Learning Theory

Constructivism emphasizes situation, collaboration, conversation, and meaning construction. The "project-task-certification" cycle in micro-major courses aligns with the constructivist path of collaborative problem-solving in authentic contexts. The cognitive apprenticeship framework illustrates how enterprise engineers and instructors jointly

support students in completing authentic tasks [6]. AI-assisted learning theory suggests that adaptive systems can dynamically adjust content difficulty, reducing extraneous cognitive load. As a technological realization of AI-assisted learning, Vibe Coding tools translate constructivism principles into concrete instruments.

2.3. Vibe Coding Tools as a New Type of Negative Entropy Source

Synthesizing these theories, this study proposes that Vibe Coding tools, as a new negative entropy source, enhance nonlinear synergistic interactions through three mechanisms—reducing learning barriers, accelerating knowledge iteration, and bridging cross-domain knowledge—driving the system from near-equilibrium to a highly ordered state. The analytical framework follows: the near-equilibrium state triggers negative entropy injection, which through two action pathways enhances nonlinear interactions, achieving hierarchical transition from shallow cooperation to deep integration to symbiotic development. Table 1 presents the mapping between dissipative structure concepts and micro-major construction elements.

Table 1. Mapping between Dissipative Structure Concepts and Micro-Major Construction Elements.

Dissipative Structure Concept	Corresponding Element in Micro-Major Construction	Role of Vibe Coding Tools
Negative entropy flow	Cutting-edge industrial technologies, enterprise resources, job standards	Reduces the threshold for negative entropy inflow and accelerates knowledge transfer
Near-equilibrium state	Disciplinary lag, supply-demand mismatch, shallow integration	Breaks cognitive barriers and activates the driving force for system transformation
Nonlinear interaction	University-enterprise resource circulation, course-certification integration	Enhances synergistic efficiency and amplifies innovation effects
Hierarchical transition	From shallow cooperation to deep integration to symbiosis	Lowers the transition threshold and facilitates system upgrading

3. Mechanisms of Vibe Coding Tools in Empowering Micro-Major Construction

3.1. Reducing Cognitive Barriers to Cross-Disciplinary Learning

Cross-disciplinary learning barriers constitute the primary challenge. In traditional programming instruction, students must master syntactic rules, data structures, and algorithmic foundations before engaging in project practice. This linear path imposes considerable cognitive load on non-computer science students. Vibe Coding tools transform this paradigm: learners describe task intent in natural language, and the AI Agent generates code frameworks while progressively guiding comprehension, forming a "description-generation-understanding-modification" loop.

From the perspective of cognitive load theory, the tools reduce both extraneous and intrinsic load. For extraneous load, students no longer memorize extensive API documentation, as the tool provides suggestions, corrections, and iterative prompts, enabling focus on problem-solving logic. For intrinsic load, the tool semantically associates existing domain knowledge with new micro-major knowledge, constructing personalized knowledge graphs.

3.2. Accelerating the Iteration of Micro-Major Course Content

Course content iteration lag constitutes the second challenge. The traditional development process spans three to six months, making it difficult to match rapid

industrial technology updates. Vibe Coding tools accelerate this at two levels: the AI content generation function rapidly produces syllabi, teaching cases, exercises, and laboratory guides, compressing the development cycle from months to weeks; and the tool captures real-time industrial technology dynamics, automatically generating "technology trend-course update" mapping reports. Combined with micro-credential question bank push mechanisms, an automated cascading update process is achieved. Within dissipative structure theory, this reduces the information gap of "technology has been updated while teaching remains lagging," helping maintain a far-from-equilibrium state.

3.3. Enhancing the Closed-Loop Efficiency of Course-Certification Integration

Course-certification integration is the core mechanism of micro-major construction. Under the traditional model, certification preparation relies on a manual "mock examination-error review-past paper analysis" loop, limited in efficiency. Vibe Coding tools upgrade this intelligently: based on practice data, competency diagnostic reports are generated to identify knowledge gaps, and targeted exercises are automatically produced. This "diagnosis-practice-re-diagnosis" closed loop improves preparation efficiency and first-attempt pass rates.

Furthermore, the tools automatically collect code submission records, problem-solving processes, and collaboration data, generating multi-dimensional competency profiles. This provides automated, process-oriented evaluation for micro-major learning portfolios, enabling competency assessment based on both examination outcomes and learning processes. At the credit mutual recognition level, automatically generated portfolios provide data support for conversion among "professional courses, micro-majors, and micro-credentials."

4. Vibe Coding Tools Empowering Micro-Majors to Promote Digital Transformation in Traditional Industries

4.1. The Talent Bottleneck in Digital Transformation of Traditional Industries

Traditional industries such as manufacturing, agriculture, and services urgently require compound talents with "industry knowledge + AI application" skills, yet existing micro-majors provide insufficient coverage. In manufacturing, enterprises need talents who understand both production processes and data analysis, but these domains belong to different disciplines. Employed personnel possess industry knowledge but face high cognitive barriers with programming and AI technologies, and traditional training models are characterized by long cycles and high costs.

4.2. Designing Industry-Oriented AI Micro-Majors

Vibe Coding tools provide a technological foundation for industry-oriented micro-major design, as they eliminate syntactic mastery dependency, enabling industry practitioners to interact with AI Agents using domain-specific language to rapidly complete data analysis scripts, model deployment, and system integration. Three types of micro-majors can be designed: the "AI + Intelligent Manufacturing" micro-major, with modules including industrial data analysis, machine vision quality inspection, predictive maintenance, and digital twin fundamentals, aligned with the Intelligent Manufacturing Engineer Certification; the "AI + Smart Agriculture" micro-major, covering agricultural IoT, remote sensing data processing, and AI-based pest identification; and the "AI + Digital Services" micro-major, including intelligent customer service, user behavior analysis, and digital marketing automation.

4.3. Micro-Majors as "Negative Entropy Accelerators" for Industrial Digital Transformation

From dissipative structure theory, traditional industry systems are in a near-equilibrium state with significant technological inertia and deficient energy exchange. The combination of micro-majors and Vibe Coding tools constitutes external negative entropy input, and the tools' key contribution lies in reducing the energy threshold for negative entropy input. Under the traditional model, injecting AI negative entropy into

manufacturing requires cultivating engineers with programming capabilities over years; the tools enable practitioners to complete the transformation from business requirements to AI applications within weeks, substantially compressing the cost and time of negative entropy inflow. This process exhibits a pronounced nonlinear amplification effect: a successful case can catalyze the digital upgrading of an entire regional industrial chain, representing the intrinsic driving force of dissipative structure evolution.

5. Implementation Pathways

5.1. Constructing a Micro-Major Teaching Platform Integrated with Vibe Coding Tools

An integrated teaching platform should be established incorporating Vibe Coding tools, intelligent learning diagnostics, and adaptive pathway recommendation. The architecture comprises four modules: a Learning Management System for course management and progress tracking; an AI tool interface layer providing code generation, debugging, and error diagnosis; a certification management module interfacing with enterprise micro-credential systems; and a credit bank interface supporting automatic conversion between micro-major and academic credits. The platform should support flexible configuration of multi-industry modules, compressing the cycle from project initiation to course launch from months to weeks.

5.2. University-Enterprise Co-Construction of AI-Empowered Micro-Major Curricula

Taking information-related majors as an example, Huawei HCIA/micro-credential standards and Vibe Coding tool-assisted instruction should be integrated through ICT industry colleges. Enterprise engineers participate in course design while AI tools assist dynamic content updating. Building on the "5 to 8 core courses + 10 to 15 credits + small class" template, each course embeds tool usage: theoretical instruction uses the tool for personalized tutoring and knowledge bridging, project practice for code generation and debugging, and certification preparation for diagnostic reports and targeted exercises. The teaming mechanism between instructors and Huawei engineers is also enhanced: the tool helps instructors master cutting-edge technologies while assisting engineers in optimizing instructional design and improving teaching standardization.

5.3. Constructing Socially Open Digital Transformation Talent Cultivation Channels

By combining the "dual-track" enrollment mechanism with Vibe Coding tools, socially open talent cultivation channels should be established. Industry-specific AI micro-majors should be customized for regional industrial clusters, serving regional digital transformation. A "micro-major alumni community" should disseminate technology updates and job matching information, forming a sustainable service ecosystem of tripartite collaboration among institutions, enterprises, and society. The tripartite collaborative team of "enterprise engineers + institutional instructors + certification training organizations" can also achieve capability enhancement: the tools provide instructors with a rapid learning channel, automatically transforming real-world project cases into teaching materials and generating difficulty-tiered exercises.

6. Case Analysis and Discussion

Taking the ICT Industry College jointly established by the School of Artificial Intelligence at Nanning College of Vocational Technology and Huawei as a case study, changes in micro-major construction effectiveness before and after introducing Vibe Coding tools are analyzed. The college offers three micro-major tracks in "KunPeng," "Ascend," and "HarmonyOS," each comprising five courses totaling 12 credits over one semester. Prior to the tools, the project completion rate for non-computer science students in the HarmonyOS course was approximately 60%, and the first-attempt HCIA-HarmonyOS certification pass rate was approximately 65%. Following the introduction of tools such as WorkBuddy, the project completion rate increased to 100% and the certification pass rate rose to 90%.

The promotion of cross-disciplinary learning outcomes is manifested in three aspects. First, the learning curve improved markedly: non-computer science students required four to six weeks to learn programming fundamentals before project practice, but after the tool's introduction, students complete simple prototypes through natural language interaction in the first week. Second, project completion quality improved through real-time code review and error diagnosis. Third, learning motivation enhanced: rapid feedback provides early achievement, alleviating frustration associated with cross-disciplinary learning.

In pilot programs, the School collaborated with regional early childhood education institutions to establish an "AI + Early Childhood Education" micro-major class, training 120 employed personnel. All participants completed the modules and passed certification, with 8 subsequently driving digital transformation projects. Compared with traditional training models requiring 6 to 12 months, the micro-major model shortened the skill restructuring cycle by approximately 80%, validating the negative entropy accelerator effect.

7. Conclusion

This study adopted dissipative structure theory to examine cross-disciplinary learning barriers in vocational undergraduate micro-major construction, revealing that Vibe Coding tools, as a new "negative entropy source," enhance nonlinear synergistic interactions through three pathways: reducing cognitive barriers, accelerating course content updates, and improving course-certification integration closed loops, enabling the system to transition from a "near-equilibrium state" to a highly ordered state of deep integration. Theoretically, this study extends dissipative structure theory in vocational education, incorporating Vibe Coding tools into the negative entropy source framework and integrating CBE, constructivism, and lifelong learning theories. Practically, the proposed implementation pathways—teaching platform construction, university-enterprise curricula co-construction, credit mutual recognition optimization, and socially open talent cultivation channels—provide actionable solutions for institutions and references for traditional industry digital transformation.

Funding: This work was supported by the Special Project on Improving the Quality of Care and Education in Kindergartens under the Guangxi Educational Science Planning for the 14th Five-Year Plan (2023): Research and Practice on Improving the Quality of Care and Education in Kindergartens under the "One Workshop, Multiple Kindergartens" Community Model (Project No. 2023ZJY1000).

References

1. W. Fan and J. Wang, "How 'Micro-Majors' Leverage 'Major Employment,'" *China Youth Daily*, Jul. 23, 2025.
2. General Office of the Ministry of Education of the People's Republic of China, *Notice on Carrying Out the "Spring Employment Promotion Campaign" for 2025 College Graduates*, Doc. No. [2025]4, Employment Office, Ministry of Education, Beijing, China, 2025.
3. General Office of the Ministry of Education of the People's Republic of China, *Notice of the General Office of the Ministry of Education on Carrying Out the "Hundred-Day Sprint" Action for 2025 College Graduate Employment*, Doc. No. [2025]17, Employment Office, Ministry of Education, Beijing, China, 2025.
4. J. Feng, "Internal Logic, Dilemma Examination, and Practical Paths of Micro-Major Construction Empowering the Cultivation of New Quality Talents in Universities," *Jiangsu Higher Education*, vol. 6, pp. 112–118, 2026.
5. Z. Zhao and J. Zhou, "Construction and Approaches of Micro-Credential Ecosystems in the Digital Intelligence Era: A Case Study of the Finnish Micro-Credential Pilot Project," *China University Teaching*, no. Z1, pp. 113–122, 2026.
6. D. Huang and W. Du, "Micro-Major Construction in Higher Vocational Colleges: Value Positioning, Driving Factors, and Practical Paths," *Adult Education*, vol. 46, no. 8, pp. 69–76, 2026.

Disclaimer/Publisher's Note: The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of Publisher and/or the editor(s). Publisher and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.