

Research on AI-Enabled Embodied Teaching Path of SECI Model— Based on the Teaching Practice of “Fundamentals of Architectural Spatial Composition”

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Abstract: The deep involvement of generative artificial intelligence in design education not only improves the efficiency of knowledge transformation, but also causes deep crises such as physical departure, cognitive outsourcing and tacit knowledge digestion. In view of the difficulties in transferring the tacit knowledge of design theory and the decoupling of students' spatial perception and physical experience in the course of “Fundamentals of architectural space composition” in application-oriented universities, this paper takes the four stages of SECI as the basic structure of knowledge transformation, takes the physical presence, situational experience and meaning generation of embodied cognition as the practice path, and takes the perception enhancement of AI technology, cognitive navigation and meaning negotiation as the technical support, and systematically reconstructs the embodied path of the four stages of socialization, externalization, combination and internalization in the SECI knowledge transformation model. The research positions AI tools as “embodied cognitive enhancement system” rather than a substitute subject, activates embodied experience by relying on the immersive perceptual field of the founding field, realizes knowledge sharing through the multimodal Visual Dialogue of the communication field, expands the cognitive boundary through the dynamic situation generation of the virtual field, and completes the internalization of knowledge by returning to the quasi real professional situation of the practice field, so as to promote the spiral rise of tacit knowledge in the presence of the body. It is expected to provide a reproducible theoretical reference and practical path for the knowledge creation of design basic education in the AI era.

Keywords: AI empowerment; SECI model; Embodied cognition; Knowledge creation; Fundamentals of Architectural Spatial Composition; Human-machine cooperation

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1. Raising the question: the “disembodied” dilemma of knowledge creation in design education in the AI Era

1.1. The pain point of knowledge transformation in the basic course of architectural design

As the starting point of environmental design education, the foundation of architectural space composition undertakes the multidimensional mission of building students’ spatial perception, training basic design literacy and laying the foundation for subsequent professional courses. However, in long-term teaching practice, the curriculum faces the dilemma of triple knowledge transformation. First, tacit knowledge of design theory is difficult to transfer explicitly. Core qualities such as the sense of spatial scale, the law of formal beauty, design logic, and aesthetic judgment are often rooted in the physical experience and tacit knowledge accumulated by teachers’ long-term practice, and are highly context-dependent and individually embedded. Second, students’ physical departure leads to the passivation of spatial perception. The cognitive habit of “physical and mental dichotomy” formed under the background of traditional education has made students accustomed to symbolic and screen information reception in learning. The body has been reduced to a “container” or tool, and spatial cognition has become an abstract reasoning away from embodied experience^[1]. Third, in the high-density learning stage of the basic course of architectural design, students are prone to frustration and resistance due to the lack of situational experience of physical presence in the face of abstract design assignment requirements and complex theoretical concepts, and their spatial imagination and creativity are inhibited. Fourth, the ability of knowledge integration is weak. Traditional teaching plans tend to focus on the linear arrangement of knowledge points, which makes it difficult to effectively include the cognitive construction process. Although students can mechanically memorize concepts, they cannot integrate fragmented knowledge into systematic design strategies, resulting in low application flexibility of “drawing inferences from one instance”^[2].

1.2. The dual effect of AI empowerment course teaching

The rapid development of generative artificial intelligence technology provides new technical possibilities for solving the above difficulties. AI tools can reduce the time-consuming nature of mechanical work such as specification review and morphological iteration, and release students’ creativity for high-level decision-making; At the same time, AI knowledge mapping and personalized learning platforms can realize the precise Association of fragmented knowledge and help students build an interdisciplinary cognitive network. However, technology intervention is also accompanied by big risks. Yanglijuan and others pointed out that when intelligent technology is deeply involved in the core process of cognition, it may lead to the triple alienation of “embodied cognition resolution”, “subjectivity crisis” and “cognitive poverty”: the technological intermediary compresses bodily perception, the algorithm black box resolves teaching dialogism, and interface cognition leads to meaning generation flattening^[3]. Zhanghuimin et al. Made an empirical study on the smart education space in Shenzhen.

Now, the strong “human-like” response ability of generative AI can easily promote the subjectization of technology objects, leading to the weakening of the leading role of teachers and students’ subjectivity. The decline of body status and the great compression of physical activity space lead to the decoupling of cognition and physical experience^[4]. Qiu Lijian further revealed that the practical dilemmas such as “perception dislocation”, “emotional disconnection”, “context distortion” and “cognitive decline” existing in the digital classroom are eroding the empirical basis of embodied learning^[5]. Therefore, the application of

AI in design education needs to shift from “detached cognitive agent” to “embodied cognitive partner”, and guard the subjectivity of the body and the generation of knowledge while improving efficiency.

1.3. Raising research questions

Based on the above background, this study focuses on the following core issues: how to reconstruct generative AI from the efficiency tool of “replacing the body” to the embodied cognitive enhancement system of “expanding the body”, and then update the theory of the body turn of the SECI knowledge creation model. Specifically, this study attempts to respond at three levels: at the theoretical level, taking embodied cognition theory as the lens, the four stages of SECI knowledge model are embodied and reconstructed, and a three-dimensional coupling analysis framework of knowledge transformation embodied experience AI empowerment is proposed; At the method level, the reconstructed model is mapped to the whole teaching process of the course, and the knowledge transformation activities of human-computer cooperation and physical presence are designed and Proposed the embodied reconstruction strategy of AI enabled SECI model; At the practical level, through the practice of curriculum teaching, it shows the implementation process of task oriented embodied activity design teaching, verifies the promoting effect of the framework on the efficiency of tacit knowledge transfer, students’ spatial perception and subjectivity maintenance, realizes the efficient transformation of tacit knowledge in the state of physical participation, and reshapes the way of knowledge creation in basic design education.

2. Theoretical basis and analytical framework

2.1. SECI knowledge creation model: from organizational knowledge management to teaching field

The SECI knowledge creation model proposed by Japanese scholars Yoshihiro Nomaka and Hiroko Takeuchi reveals the dynamic mechanism of the spiral rise of tacit and explicit knowledge at the organizational level^[6]. The model includes four transformation stages: socialization realizes the sharing of tacit knowledge to tacit knowledge; Externalization translates tacit knowledge into explicit knowledge through metaphor, analogy and conceptualization; Combination integrates and reconstructs the existing explicit knowledge systematically; Internalization absorbs explicit knowledge into individual tacit knowledge through practice. The four stages correspond to “Founding field”, “communication field”, “virtual field” and “practice field”^[7].

The four knowledge fields emphasize that knowledge creation highly depends on specific social and cultural situations and interactions between subjects. However, the traditional SECI framework is rooted in the context of organizational knowledge management, and its pre-set knowledge carrier tends to be symbolic, linguistic and cognitive. It does not pay enough attention to the dynamic role of “body” in knowledge transmission, and there is an obvious “off-body” tendency. In design education, core knowledge such as spatial perception, material touch, and body size is difficult to fully integrate into the implicit-explicit binary division, which needs to be supplemented and expanded by the introduction of embodied cognition theory.

2.2. Embodied cognition theory: The “body turn” as knowledge transformation

Embodied cognition theory, as the core proposition of the second generation of cognitive science, emphasizes that cognition is not isolated from symbolic operations within the brain, but rooted in the dynamic interaction between body structure, sensory-motor system, and environment^[8]. Yehaosheng pointed out that cognition,

body and environment constitute an inseparable whole. The body is not only the subject of cognition, but also the boundary and medium of cognition^[9]. Merleau-Ponty's body phenomenology further promoted the body from "object body" to "phenomenon body", and believed that the body was the starting point of world perception, and spatial meaning was generated through the body's living existence^[10].

For the education of architecture and space design, embodied cognition has special disciplinary affinity: space design is essentially the shaping of the "body space environment" ternary relationship. Students' understanding of scale, light and shadow, material and atmosphere can only be truly achieved through body measurement, touch, walking and immersion. In the research on architectural enlightenment education, it is found that through the three-stage teaching of "sensory stimulation, body recognition connection and embodied practice", the students' thinking inertia of "physical and mental dichotomy" can be effectively reversed, and the body's keen perception of spatial elements can be activated^[11]. However, in the digital teaching environment, embodied cognition faces the risk of being digested by the technological intermediary. When the teaching interaction depends on screen clicking and keyboard input, the original complex physical activities are simplified into programmed actions, and the physical experience and cognitive processing are separated, resulting in the "virtual crisis of physical presence"^[12]. Therefore, AI-enabled design education must respond to a key proposition: how can technology expand the body's cognitive boundaries without emptying the body schema?

2.3. A new paradigm of human-computer collaboration in AI-enabled education

Facing the risk of technology alienation, the philosophy of educational technology proposed a paradigm transformation from "auxiliary" to "symbiosis". Based on the phenomenology of technology, Yang Lijuan et al. proposed the cognitive Ecological Reconstruction Path of human-computer cooperation in Education: repair the body perception topology by constructing the embodied cognition enhancement system, design the reflexive cognitive navigation framework to achieve algorithm transparency, and create an open meaning generation interface to form a recognition gap, so as to promote the human-computer relationship from tool assistance to cognitive symbiosis^[3]. Zhanghuimin and others constructed a three-stage reconstruction framework of "representational fusion evolution", emphasizing that the embodiment of education space should realize technology representational (transforming Abstract algorithms into perceptible experience), environmental education integration (deep coupling of teaching function and spatial structure) and scene generation (dynamic adaptation based on cognitive feedback)^[4]. Xiao Lin and others pointed out from the perspective of discipline practice that the body is not only the carrier of practice, but also the basis of cognition and meaning construction. Discipline practice must realize the paradigm transformation from "disembodied" to "embodied", and anchor the unity of body and mind by creating real problem situations and carrying out discipline activities based on core literacy^[13]. The above research points to a core direction: AI should not be used as a cognitive outsourcing tool to replace human thinking labor, but should be used as a "cognitive scaffolding" and "reflective interlocutor", while enhancing perception, expanding the situation and stimulating the generation of meaning, while retaining learners' cognitive sovereignty and physical subjectivity.

2.4. Theoretical integration: a three-dimensional coupling analysis framework of

knowledge transformation, embodied experience and AI empowerment

Based on the above theory, this study proposes a digital linkage integration analysis framework from the SECI model to embodied experience as the core analysis tool of the full text. The framework takes the four stages of SECI as the basic structure of knowledge transformation, the physical presence, situational experience and meaning generation of embodied cognition as the practice path, and the perception enhancement, cognitive navigation and meaning negotiation of AI technology as the technical support, so as to realize the physical turn and technological empowerment of the process of knowledge creation. In the integration of AI and teaching, technology should not replace the perception of the body, but should extend people's cognitive possibilities and become an "Invisible Bridge", rather than a barrier between thinking and the world.

The transformation of knowledge has never been the transportation of abstract symbols, but a process of continuous generation in the triple interweaving of body, technology and environment - which means that the four stages of SECI need to be redesigned as embodied learning activities. At the same time, human-computer collaboration should also follow the natural evolution of roles: AI was initially used as a tool to assist perception, then became a partner in CO creation, and finally evolved into a guide to provide critical feedback; However, no matter how iterative the technology is, the bodies of teachers and students are always irreplaceable cognitive subjects. base on For this understanding, the four stages of SECI will be embodied and reconstructed one by one, which will be specifically implemented in the foundation of architectural space composition In course practice.

3. Embodied reconstruction strategy of AI enabled SECI model

In the four stages of the SECI knowledge transformation model, the body presence mechanism must run throughout, and AI should also turn from "the efficiency tool of leaving the body" to "the embodied cognitive enhancement system", which is an extension of body perception, situational experience and meaning generation, rather than a substitute. The following will discuss the AI empowerment strategy and embodied field reconstruction path of the SECI model one by one around the four stages of socialization, externalization, combination, and internalization of the SECI model.

3.1. Socialization stage: Teachers' team building embodied perception field and tacit knowledge group cohesion

The socialization stage is the starting point of the transformation from tacit knowledge to explicit knowledge. Its core mechanism is to realize the flow and cohesion of knowledge among individuals through sharing experience, deep interaction and direct perception between the body, this stage is named "originating Ba". In the course of the foundation of architectural space composition, the creator of this "Founding field" is, first of all, the teacher team - teachers are not isolated knowledge communicators, but builders of a knowledge exchange field and sharers of subjects of physical experience.

However, the socialization process in traditional teaching often has a double fracture. First, the transformation of tacit knowledge within the teacher team is insufficient. College teachers are relatively independent in the process of lesson preparation, and the teaching preparation of the same course fails to fully condense teaching ideas and form a team teaching mode. Due to differences in knowledge background, digital literacy, and practical experience among different teaching individuals, they can easily fall into the

information cocoon, form barriers to knowledge creation, and fail to build a common place for knowledge transformation. Second, due to the lack of communication between teachers of different courses, there are problems in the connection of the curriculum system, with overlapping or missing content. Teachers of various disciplines independently design teaching content and lack a grasp of the overall curriculum system, which makes some knowledge points appear repeatedly in multiple courses, while some important cohesive knowledge is omitted, affecting the continuity and integrity of students' knowledge system.

In view of the above fracture, embodied cognition theory provides a solution path of body turning for the socialization stage. Socialization is not pure information transmission, but a process of “body calibration” and “sensory stimulation”^[14]. At the teacher team level, this means that the sharing of tacit knowledge cannot stop at the text exchange of teaching plans or the digital transmission of courseware, but must be through the direct demonstration and on-site communication of teachers' bodies. When teachers express their design experience with the body as the medium, the mirror neuron system of the teaching team resonates and starts the body-to-body transfer of tacit knowledge in observation and imitation^[15].

The core value of the AI empowerment strategy in the socialization stage is to expand the boundary and depth of the embodied perception field created by the teacher team, and help the teacher team build a cross-border integrated tacit knowledge sharing platform. Through the smart teaching platform and digital resource library, the teacher team can extract and structurally integrate the scattered teaching experience, enterprise design cases, and industry-leading trends, break the information cocoon of individual lesson preparation, and realize the explicit aggregation and re-sharing of group tacit knowledge.

3.2. Externalization stage: From “language and literal expression” to “body expression - visual translation”

The externalization stage is the key link of the transformation from tacit knowledge to explicit knowledge. Its traditional path depends on the logical expression of language, characters and symbols. This field is called the communication field. However, a large amount of tacit knowledge in architectural design, such as spatial imagery, design creativity, and aesthetic intuition, is prelinguistic and physical, and often exists before language in sketches, body perception, material collage, and model deliberation. Forcibly expressing such knowledge in linear language will not only cause the loss of transformation efficiency, but also lead to the flattening and distortion of physical experience.

Embodied cognition theory reveals another possibility of externalization stage: the body itself is the medium of expression. Merleau Ponty pointed out that the body “speaks” to the world through posture, movement and perception, and gestures and sketches are the physical extension of thought^[10]. In the basic education of architectural design, students experience the openness and enclosure of space, feel the spatial scale through the range of physical activity, and stimulate morphological association through material touch. These “body expressions” constitute the original form of design thinking, and stimulate the designer's physical memory and emotional resonance, which is an effective way to transform physical experience into design concepts.

AI in the externalization stage can be condensed into “visual translation” and “narrative assistance”. Generative AI tools can quickly translate the tacit knowledge that teachers want to teach into a visual prototype through body expression, and realize the transformation from “body perception” to “visual table”. In this process, AI is not a substitute for body expression, but an “amplifier of body perception”,

solidifying fleeting body intuition into a visual anchor that can be discussed and corrected. At the same time, the large language model can assist in the design of narrative generation, structure the fragmented physical experience into theme concepts, design strategies and scene stories, and improve the accuracy of explicit tacit knowledge. In this field, body movements, sketch traces, AI-generated images, and language interpretation constitute a multi-dialogue system. Teachers, students and AI negotiate around visual representation to make the original.

3.3. Combinatorial stage: From “knowledge splicing” to “situational integration - field construction”

The combination stage is a process of systematic integration and reconstruction of existing explicit knowledge. Traditional understanding regards it as static information splicing and logical arrangement, ignoring the situational dependence and physical participation of knowledge combination. Embodied cognition theory points out that cognition does not occur in isolation within the individual mind, but is a positive and dynamic embodied action carried out by living organisms to adapt to survival and development in a complex environment^[13]. Therefore, the combination of knowledge is not an abstract puzzle in front of the desk, but a “situational integration” through the dynamic coupling of body action and environment in a real problem situation.

Embodied mechanism is embodied in “field construction” and “collaborative exploration” in the stage of combination. Field construction is the context generation logic intertwined with context and reality. It is an organizational clue throughout the teaching process. It realizes distributed co-construction through task traction and physical interaction. In the basic course of architectural design, students integrate fragmented design inspiration in the process of “doing” through group collaboration, brainstorming, entity model building, and situational role-playing. At this stage, the body assumes the role of “cognitive organizer”: the operation sequence of the hands, the movement trajectory of the body and the cooperation of the team together constitute the implicit logic of the complete design workflow scene knowledge combination in the “virtual field”. In this stage, the real design task is used as the anchor point, the interactive practice of group collaboration is used as the link, and the dynamic resources generated by AI are used as the support to realize the organic integration of knowledge in the process of “doing”.

AI empowerment strategy focuses on “dynamic knowledge mapping” and “intelligent situation generation” in the combination stage. On the one hand, AI knowledge mapping technology can semantically associate scattered design theories, design techniques and normative provisions, build a visual spatial cognitive network, and help students connect fragmented knowledge into clues.

On the other hand, based on the collection of students’ physical behavior data (such as action trajectory, operation stay time, and distribution of discussion hotspots), we can understand students’ learning interest, interaction and classroom learning effect, and optimize students’ learning experience. The AI agent of the smart course can dynamically push appropriate answers and cases according to the questions and interactive data asked by students, and realize the situational knowledge integration of “teaching students in accordance with their aptitude”.

3.4. Internalization stage: From “individual absorption” to “practice cultivation - physical memory”

The internalization stage is the end of the transformation from explicit knowledge to individual tacit

knowledge, and also the starting point of a new round of knowledge spiral. Traditional teaching often equates internalization with “after-class review” or “homework practice”, ignoring the situational Embeddedness and physical participation in the internalization process. Embodied cognition theory emphasizes that the real mastery of knowledge is not symbolic memory, but the transformation of explicit knowledge into physical skills and intuitive judgment through practice, forming “muscle memory” and “body schema”^[16].

Embodied mechanism is embodied in “quasi-real practice” and “reflective physical action” in the internalization stage. In architectural design education, internalization means that students can transform design theory, specification requirements and formal rules into design intuition that can be invoked without deliberate thinking. This transformation depends on repeated practice in real or highly simulated situations: cultivating a sense of scale through the production of entity models, expressing instincts through on-site defense exercises, and establishing professional identity through simulating the workflow of the design institute. This field is a practice field that simulates the organizational structure, project process, and evaluation system of the real design institute. Students complete the complete design process as designers, and realize the deep transformation from explicit knowledge to individual implicit design ability in the double cycle of “learning by doing” and “thinking through evaluation”.

In the internalization stage, AI, as the amplifier of reflective practice, constructs the feedback of “data to the body” through the collaborative operation of the intelligent platform, reporting and evaluation, and behavior mirror system. The smart platform continuously tracks the interactive trajectory of students’ behavior in completing learning tasks, identifies the blind spot of individual implicit ability and generates customized training programs; The report and evaluation tool analyzes the on-site defense from the multiple dimensions of voice logic and body posture, and transforms the identity of professional designers into physical literacy that can be practiced item by item; The behavior mirror system extracts the physical action mode in the embodied teaching activities and visualizes the feedback, so that the sense of scale and emotional feelings move from vague body sense to clear awareness. The feedback data is integrated and interwoven with the real physical experience of students’ practice and on-site evaluation. In the cycle of “learning by doing - Thinking in evaluation - Data echo - re practice”, it accelerates the deep transformation of explicit knowledge to individual implicit design ability and professional physical quality .

4. Embodied teaching practice of AI enabled SECI model

4.1. Course overview and the Trinity architecture of “AI SECI embodied”

The foundation of architectural space composition is the core course of the environmental design major, which is open to sophomores. The course aims to cultivate applied design talents and emphasizes the comprehensive improvement of spatial perception, design logic, and innovation practice ability. In the course construction, the team built a trinity teaching architecture of “AI SECI embodied” relying on AI empowerment (**Figure 1**)^[17].

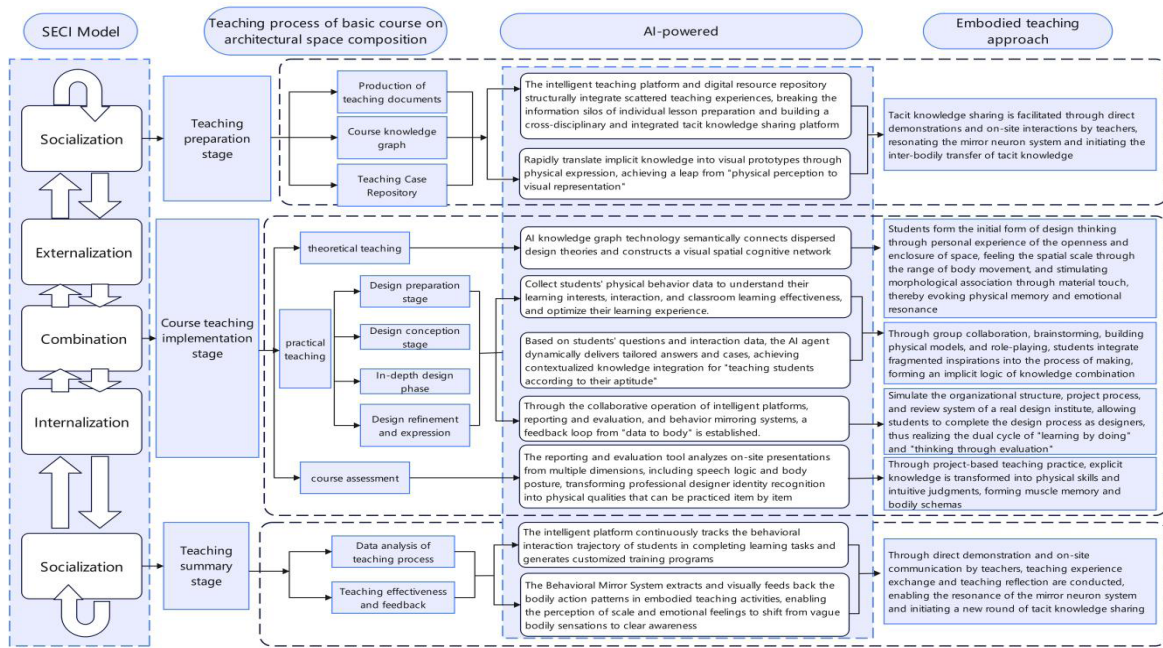


Figure 1. AI SECI embodied experience Trinity Teaching Architecture.

The core design logic of this architecture comprises three interwoven threads. The teaching practice process runs from preparation through implementation to summary. First, the SECI knowledge transformation process, with its four stages, is embedded throughout course teaching. Second, embodied cognition activities corresponding to each knowledge transformation stage. Third, AI provides cognitive enhancement support along the entire knowledge transformation path, expanding capability boundaries around the bodily subjectivity of teachers and students, jointly promoting the spiral transformation of tacit and explicit knowledge.

4.2. Task-oriented teaching implementation and embodied activity design

The course takes “body perception - spatial translation - comprehensive construction” as the progressive logic to promote the continuous transformation from implicit experience to explicit design ability. Teaching starts with body intervention. Students mark the trajectory of action through improvisation, measure the real space with their body, internalize the abstract scale into muscle memory and emotional source, and establish the intuitive relationship between body and space; Then, through hand-painted, surveying and mapping and entity model building, the body traces and spatial emotions are solidified into drawing language and form narration, and the preliminary transformation from body experience to design expression is completed. At the level of space and form research, through the body perception of the generation logic of space theme and scale and space emotion, the individual body memory is the emotional source of space limitation, and the application of AI tools is further deepened. The AI large language model is used to generate creative ideas and prompt words of wenshengtu, and multiple conceptual schemes are automatically generated and diversified through AI image generation tools. On this basis, students screen, judge and select appropriate schemes for further expression. Next, students comprehensively train the function and architectural form

corresponding to the composition of composite space and form. Students use their bodies to feel the spatial needs of emotions, and then solidify the spatial elements into a solid model to build the transition of narrative space and fully experience the expression of body and emotion. Finally, under the guidance of real projects, students complete the final comprehensive architectural design task, realize the organic integration of knowledge in “doing,” and complete the closed loop of embodied design practice through physical interaction and distributed co-construction.

At the same time, embodied teaching activities have been integrated throughout every task - from impromptu performance and body mapping, to the establishment of body measurement and muscle memory, to the empowerment of body memory at the emotional source and the construction of the entity model of narrative space, and finally to the physical interaction in the distributed co-construction, and the deepening of embodied cognition. Each task has gone through four stages of socialization, externalization, combination, and internalization of the SECI model. Students transform tacit knowledge into explicit expression in the experience of physical presence, and then realize the systematic combination, internalization, and sublimation of explicit knowledge through the empowerment of AI tools, forming a continuous rising spiral of knowledge innovation (Figure 2).

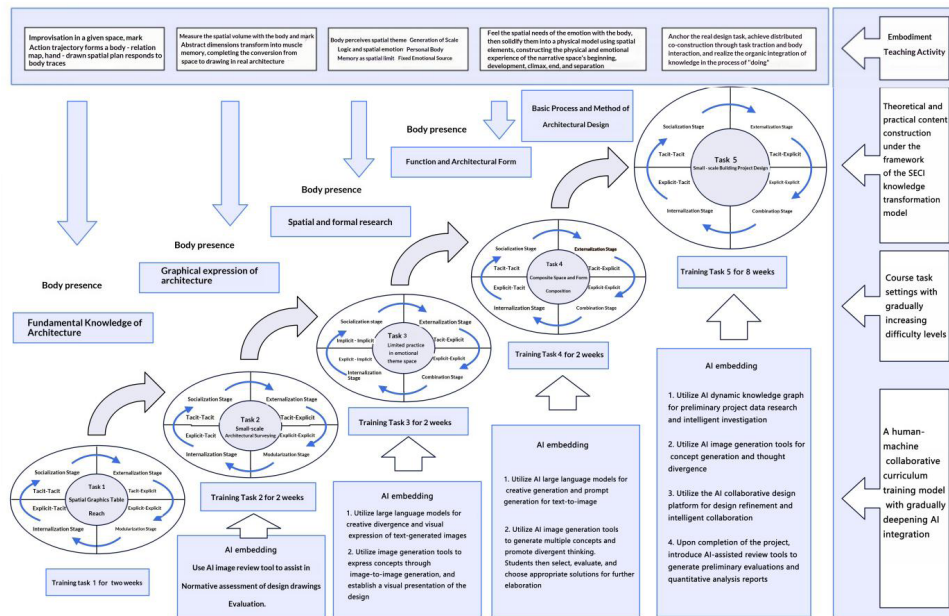


Figure 2. Embodied teaching implementation of AI enabled SECI model under task orientation.

4.3. Human-machine role evolution chain and body subjectivity maintenance

In the embodied teaching design of the course, AI is always regarded as the extension and amplifier of body cognition, rather than a substitute; Students' physical subjectivity has not been eliminated in the step-by-step intervention of technology, but has obtained a more solid anchor.

At the beginning of the course, AI is mainly responsible for the manifestation of physical experience and the expansion of perceptual boundaries. Students use improvisation to generate a “body relationship map”, and use palms and steps as “living feet” to establish muscle memory. Multimodal AI translates the pre-language experience of “walking, watching, crossing and meeting” into discussable suggestions for space

limitation by identifying the intersection frequency and line-of-sight sector of trajectory. All technical outputs at this stage need to be verified by students' walking and body again. The right to decide the design always depends on the presence of the body. With the spatial operation moving towards compound emotion, the role of AI has leaped to concept symbiont and emotion negotiator. When students take themselves as walls, columns and tops, and put the combination of enclosure and penetration in a 1:1 grid to personally experience the somatosensory differences between safety and depression, wenshengtu technology becomes an extension of the common divergent image with students' bodies. At the stage of emotional translation, students spatialize their emotions by performing impromptu performances with curled, stretched and wandering bodies. AI generates visual behavior tracks based on limb parameters. The output of the algorithm must be repositioned and verified by the body. AI is responsible for providing options, and the body is responsible for making value judgments. By the end of the course, AI has evolved into an embodied collaborator of the whole process. From site cognition, functional layout, and detail verification to generative iteration, virtual user simulation, and intelligent drawing review, these build a "body AI context" tripartite negotiation network.

5. Teaching evaluation and feedback

This study explains the teaching effect from three dimensions: learning behavior data, task achievement and students' subjective satisfaction. The objective behavior logs collected by the smart teaching platform and the subjective feedback data obtained by the questionnaire are cross-verified to systematically evaluate the teaching effect^[18].

5.1. Analysis of learning activity

Based on the background behavior log of the smart classroom platform, this study conducted frequency statistics and comparative analysis of the learning behavior of the traditional teaching class and the AI+SECI embodied teaching experimental class. The results show that the experimental class is significantly better than the traditional class in all learning behavior indicators, which fully reflects the activation effect of the embodied teaching situation on students' classroom participation. In terms of expanding resource learning, the experimental class is 3.5 times that of the traditional class, indicating that the AI recommendation algorithm can effectively extend the boundaries of students' autonomous learning (Figure 3).

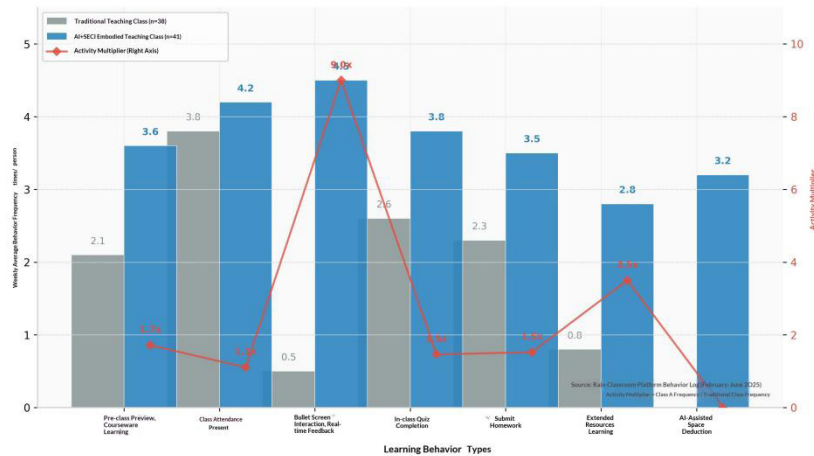


Figure 3. Distribution and comparison of learning activity based on smart course platform statistics.

The thermal image of the learning period distribution of the smart platform further reveals the big changes in students' learning mode. The learning activity of the traditional class is concentrated in the fixed time of the day from Monday to Friday (9:00-16:00), showing obvious characteristics of classroom dependence; The learning time of the experimental class is more evenly distributed and extended to the evening and weekend. The activity index after 20:00 from Monday to Sunday is higher than that of the traditional class. The activity after 22:00 p.m. on Sunday reached 38%, nearly 16% higher than that of the traditional class. This change shows that the AI-enabled hybrid teaching mode has effectively broken through the space-time constraints of the traditional classroom and promoted the formation of students' autonomous and ubiquitous learning habits (**Figure 4**).

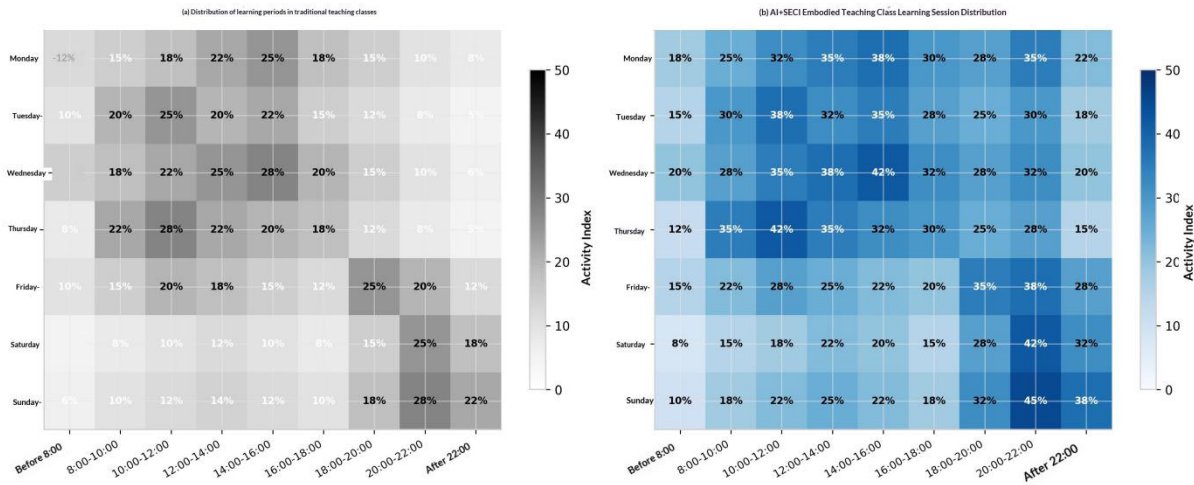


Figure 4. Thermal image of students' learning time distribution.

5.2. Analysis of achievement degree of capability objectives

In the evaluation of the achievement degree of the ability goal of the typical task results, the study selected three representative tasks for horizontal comparison: “spatial perception experience and expression” (T1), “composite space and form formation” (T4) and “comprehensive curriculum design” (T5). The average achievement rate of AI embodied teaching experimental class in the three tasks was 87.2%, 82.5% and 84.4%, respectively, which was significantly higher than that of the traditional class (74.4%, 75.8% and 73.6%, respectively) increased by 14.8%, 6.7% and 14.8% respectively, and the T1 and T5 tasks achieved a significant gain of more than 14%. It is worth noting that the distribution of achievement degree of students in the experimental class in the two dimensions of spatial perception experience and comprehensive design performance is more concentrated, and the lowest values are higher than the median level of the corresponding indicators of the traditional class, reflecting that AI assisted embodied cognitive scaffolding effectively reduces the ability differentiation within the student group and improves the balance of the overall teaching quality (**Figure 5**).

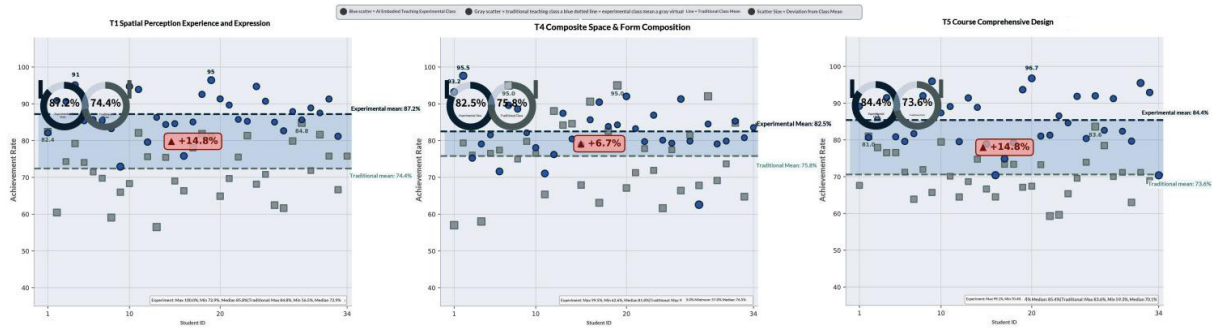


Figure 5. Analysis of achievement degree of typical task achievement capability objectives.

5.3. Survey and analysis of students' satisfaction

After the course, the research team used the 5-point Likert scale to conduct a questionnaire survey on the satisfaction of students in two teaching classes. The average satisfaction score of the experimental class was 1.22 points higher than that of the traditional class in six dimensions: acceptance of teaching methods, theoretical understanding, organization quality of classroom interaction, difficulty and challenge of the course, personalization and adaptability of the course, and willingness to participate in group cooperation and communication. Among them, the personalized and adaptive dimensions of the course increased the most (+1.60 points), indicating that the AI-driven embodied learning path can provide effective differentiated support for students at different basic levels. The distribution of Likert scale options in the experimental group showed that more than 85% of the students chose “agree” or “very agree” in six dimensions, and the proportion of negative evaluation was less than 3%, which verified that the new teaching mode was generally recognized by the student group (Figure 6).

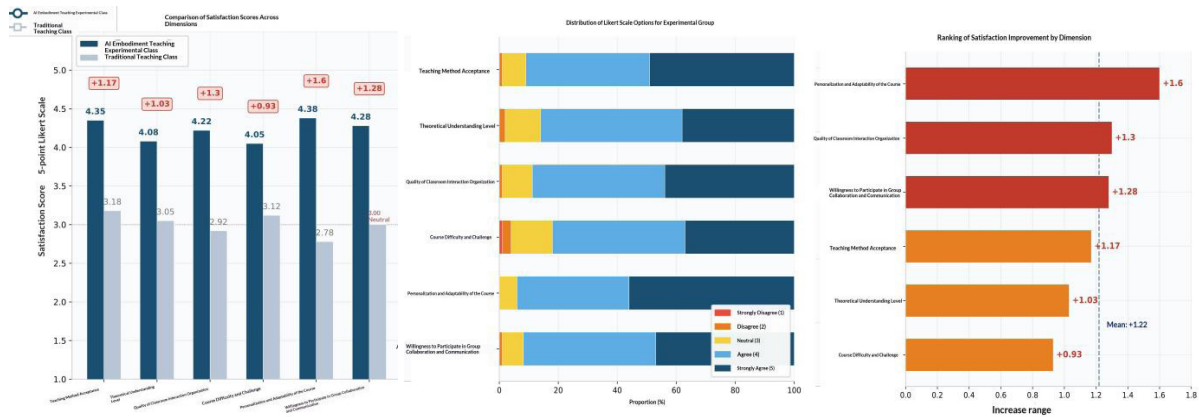


Figure 6. Analysis of student satisfaction questionnaire survey results.

The above analysis results show that the embodied teaching path of AI enabled SECI model has achieved multi-dimensional positive results: at the level of learning behavior, students' interactive participation and autonomous learning frequency have significantly increased; At the level of ability achievement, the core teaching objectives, especially the spatial perception ability, have been effectively improved; On the level of subjective perception, students' satisfaction with the teaching mode is higher than that of traditional teaching. However, this teaching review still has the following limitations: first, the sample size and coverage period

are limited. There are 69 students in the two teaching classes. The generalization of the statistical results needs to be verified by a larger sample. The evaluation cycle only covers one semester, and there is a lack of longitudinal tracking on the maintenance and transfer of students' long-term ability trace; Secondly, the satisfaction questionnaire belongs to subjective self-evaluation data, which may be affected by the expected effect of students and deviate from the objective learning effect; Third, the platform behavior data only reflect the learning participation and frequency, which is difficult to measure the process of high-order thinking and deep cognition directly; Future research can further improve the evaluation system by expanding the sample size, extending the observation period, and introducing a third-party blind evaluation.

6. Conclusion

This study reconstructs the SECI knowledge creation model based on embodied cognition theory, and repositions AI from an “off-body tool” to an “embodied cognition enhancement system”. Course practice shows that when AI is deeply embedded in the knowledge creation field of the SECI model, tacit knowledge can be effectively transformed in the presence of the body. The deeper the degree of technology intervention in cognition, the more it needs to anchor the subjectivity of the body. Future design education should adhere to the symbiotic logic of “body as anchor and technology as bridge”, cultivate embodied designers based on physical experience and AI as cognitive extension, and promote knowledge creation from efficiency optimization to meaning generation while protecting the essence of education. Only in this way can AI truly become a “transparent bridge” to expand the boundaries of human cognition, and design education can guard its educational essence in the wave of technology, and realize the transition from “knowledge acquisition” to “knowledge construction” and even “knowledge production”.

Disclosure statement

The author declares no conflict of interest.

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