Empowering Physical Education Reform with Digital Intelligence Technology A Study on Enhancing the Digital Literacy of Physical Education Teachers under the Field Habitual Theory

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ABSTRACT In response to the contradiction between "technical suspension" and entrenched teaching habits in physical education, this study constructs a bidirectional improvement path of "field reconstruction–habit adjustment" based on Bourdieu's field-habitus theory. The framework first diagnoses teachers' digital capital and existing practice patterns, then designs a systematic intervention integrating situational embedding, reflective practice, and community collaboration. Hierarchical training is conducted around intelligent tool application, data-driven lesson design, and teaching decision simulation, followed by a dynamic evaluation mechanism. Experimental results show that the frequency of " personalized feedback based on data" in teaching behavior increased by 361% ($p<0.001$), the total lesson-plan design score increased by 82.5%, and the data-driven decision simulation score increased by 145%. The findings indicate that theory-guided intervention can promote the endogenous transformation of teacher digital literacy from tool use to data -driven instruction. In engineering and technical training contexts, the model is also relevant to wearable sensing, wireless data acquisition, and electromagnetic-compatible smart teaching environments where practical expertise must be integrated with digital measurement systems.

INDEX TERMS digital intelligence technology, teacher digital literacy, data-driven instruction, wearable sensing, wireless communication

I. INTRODUCTION

WITH the comprehensive advancement of the "digitalization of education" strategy, digital technology has become a key driving force for deepening the reform of physical education and optimizing the technical training standards within the industry. This digital integration facilitates a more rigorous and scientific approach to teaching the complex motor skills shared by athletic performance and high-precision machinery operation [1,2]. However, in current practice, there is a common phenomenon of "disembedding" technology applications from real teaching scenarios. Teachers' insufficient digital literacy leads to the use of technology mostly remaining at the level of tool demonstration, making it difficult to deeply integrate into the core teaching process, which restricts the substantial breakthrough of reform effectiveness [3]. Therefore, exploring effective ways to improve the digital literacy of physical education teachers has become a core issue that must be addressed in promoting the digital transformation of physical education [4]. Existing literature focuses on the digital literacy of physical education teachers, mainly on the construction of literacy models, current status surveys, and skills training models. Wohlfart et al. analyzed the relationship between teacher educator role modeling and the willingness of pre-service teachers to integrate digital literacy through a questionnaire survey of 185 pre-service physical education teachers in Baden-Württemberg, Germany [5]. Xu compiled a digital literacy scale for primary and secondary school physical education teachers based on mathematical statistics and conducted item analysis, exploratory factor analysis, confirmatory factor analysis, and reliability and validity tests on 500 primary and secondary school physical education teachers [6]. Based on the framework of digital literacy and competency theory of teachers at home and abroad, Yin et al. constructed a structure system of digital literacy for physical education teachers covering the basic layer, application layer, development layer and value layer[7]. Compared with the linear model that simply emphasizes skills training, this paper uses this theory to reveal and intervene in the two-way construction process between "digital field of school sports" and "teacher teaching habits", so as to provide a more explanatory and operational sociological perspective for

solving the superficial problems of technology application. This study aims to construct and verify an intervention path aimed at systematically improving the digital literacy of physical education teachers based on the field-habit theory. Specifically, firstly, the characteristics of the teacher's field and existing habits are clarified through diagnosis; then, a two-way intervention program integrating "field structure optimization" and "individual reflective practice" is designed and implemented; finally, evaluation is carried out through multiple dimensions such as teaching behavior observation, lesson plan quality analysis and decision simulation experiment. Studies have shown that this method can effectively promote the paradigm shift of teachers' teaching behavior from "instrumental use" to "data-driven decision-making". The quality of lesson plan design and data-driven decision-making ability have been significantly improved, which confirms the feasibility and superiority of embedding sociological theory into teachers' professional development practice in solving the deep contradictions in the digital transformation of physical education[7].

II. DIAGNOSTIC ANALYSIS OF DIGITAL LITERACY AMONG PHYSICAL EDUCATION TEACHERS

In order to understand the real basis and constraining mechanism of digital literacy development, this study diagnoses the digital teaching field and internal habits of instructors by drawing parallels between physical education and the specialized technical training environment of the industry. This approach utilizes Bourdieu's field theory to analyze how the ingrained manual dexterity of traditional weaving influences the adoption of modern digital tools during the instructional process. Firstly, a sample survey of 320 physical education teachers from several middle schools was carried out using the self-designed "Digital Teaching Field Diagnosis Questionnaire for Physical Education Teachers". The questionnaire was developed based on the theoretical dimensions of Bourdieu's field theory, encompassing institutional capital, technological capital, social capital, and teachers' perceived positional status within the field. To ensure the reliability and validity of the instrument, a pilot study was conducted with 120 teachers (not included in the final sample) for item analysis and exploratory factor analysis (EFA). The EFA results supported a four-factor structure consistent with the theoretical framework, explaining 68.4% of the total variance. Subsequently, confirmatory factor analysis (CFA) was performed on the main sample (N=320), yielding acceptable model fit indices ($\chi^2/df = 2.36$, CFI=0.94, TLI=0.92, RMSEA=0.058). The Cronbach's α coefficients for the four subscales ranged from 0.81 to 0.89, indicating good internal consistency. These psychometric properties confirm that the questionnaire serves as a valid and reliable instrument for diagnosing teachers' digital teaching field, thereby providing a credible empirical foundation for subsequent intervention design. Secondly, based on the questionnaire results, 28 representative teachers were selected by stratification for semi-structured in-depth interviews, so as to explore teachers' habitual behavior in digital teaching practice, that is, default attitude towards technology, routine operation pattern and internal evaluation standard [8]. This research has been approved by the ethics committee of the author's institution, and was performed in accordance with the principles of the Declaraton of Helsinki. All eligible partcipants signed an informed consent form. The analysis of data shows that the current digital teaching field of physical education teachers has obvious structural characteristics. In terms of capital level, there are great differences in institutional capital and technological capital between schools, while social capital (such as effective peer support) is generally weak. In the aspect of positional perception, most teachers think they are "passive adaptors" rather than "active constructors" in learning environment. The analysis of three types of habit are: some teachers have formed a habit of "alienation and skepticism", thinking that digital technology is a "additional burden"; most teachers have formed a habit of "instrumental compliance". They can finish the prescribed work, but they are not willing to do innovative integration; only a few teachers have preliminary tendency of "reflective exploration". All of these indicate that improving teachers' digital literacy is not only a problem of digital skills, but also a problem existing in a complex field structure, which is rooted in the unequal resources, role identification and engraved practice pattern. The diagnostic results of fields provide empirical basis and accurate entry point for designing targeted "field reconstruction" and "habit adjustment" intervention program.

III. THEORY-BASED TWO-WAY INTERVENTION PROGRAM DESIGN

Based on the structural contradictions revealed by the previous diagnostic analysis, this study, in accordance with the core dialectical idea of "structure shapes habituation, and habituation reproduces structure" in Bourdieu's field theory, designed a set of intervention programs that promote the two-way interaction and coordinated advancement of "field reconstruction" and "habituation adjustment". First, at the level of "field reconstruction", the focus is on optimizing the external social structure and capital allocation of teachers.

The main measures include: collaborating with pilot schools to institutionalize the "Digital Sports Teaching Innovation Support Program" to provide participating teachers with stable equipment usage rights, dedicated time and incentive policies; at the same time, structurally building a cross-school and cross-disciplinary digital teaching and research community to transform scattered social support into organized social capital and change the original position of teachers who are isolated and helpless in the field [9].

Second, at the level of "habituation adjustment", the whole program intends to induce the change of teachers' individual and group internal cognition and behavior pattern. Its core is to construct a series of reflective practice activities to force teachers to be situated at the "conflict point" of old and new habits. For instance, the design of

teachers' comparison and analysis on the major differences of teaching debriefing based on video trajectory data and traditional experience-based debriefing forced teachers to face their own "experience-driven" default mode of decision-making. Moreover, the requirement of using a common data dashboard to explain their instructional design logic in collaborative lesson planning forced them to adjust their previous speaking and thinking pattern by adopting these new "rules of the game". The whole intervention was not "skills-driven", but rather, it was trying to transform the learning environment's structure by reconstructing the rules and resources. We carefully designed practical tasks (actions) to trigger cognitive conflict so as to facilitate the emergence of a "new habit" of digital and intelligent teaching by continuously adjusting the interaction between structure and action. This design ensured the high degree of unity between theoretical logic and practical path, which laid the foundation for the subsequent intervention implementation.

IV. CONTEXT-EMBEDDED LAYERED TRAINING AND PRACTICE

The training and practice were structured as a three-tiered progression, each tier building upon the previous one. To begin with, the foundational tier focused on contextualizing basic skills. Rather than isolated equipment demonstrations, training centered on authentic tasks—for instance, interpreting heart rate data from a basketball class to monitor exercise load. Using wristbands and motion capture apps, teachers collected and analyzed on-site data, directly anchoring abstract technical functions within concrete teaching scenarios[10]. Following this, the second tier emphasized supported integration into instructional design. Working in groups, teachers undertook specific unit tasks—such as improving eighth-grade students' accuracy in soccer passing—and collaborated with 教研人员 and technical support to develop lesson plans incorporating data collection, analysis, and feedback mechanisms. This "learning by doing" approach turned design-stage challenges (e.g., determining optimal camera angles for motion analysis) into powerful drivers of learning.

The final tier centered on reflective review of classroom implementation. Teachers delivered their self-designed lessons while recording the process. Subsequent community discussions examined the alignment between expected and actual outcomes—asking whether technology revealed anticipated issues and how data-informed decisions diverged from spontaneous judgments. Such deep, practice-based reflection proved critical for transforming entrenched "lecturing habits" into "data-driven decision-making habits." Collectively, this three-tiered structure formed a complete cycle—from foundational awareness, through design integration, to critical application—supporting teachers in gradually internalizing new pedagogical logic within authentic professional contexts.

V. BUILDING A COMMUNITY OF REFLECTIVE PRACTICE

To elevate scattered individual practical experiences into a kind of "structural force" promoting the evolution of collective "habitus", this study consciously built a kind of "reflective practice community" combining online and offline approaches. First, an "evidence-first" dialogue rule was established. In any discussion, any claims or reflections must quote some concrete teaching data (video clips, a group of heart rate curves, etc.) as evidence to anchor the discussion from subjective feelings to experiential facts analyzable from concrete experiences, which were somehow changing professional communication habits of the teacher group unconsciously.

Second, a process of "structured conflict" in discussion was designed. Regular comparative case analysis meetings were held on the theme of "same technology but different uses", and purposeful efforts were made to show successful cases and unsuccessful cases of technology application in class. In addition to focusing on "how to do it", teachers were stimulated to deeply discuss "why it works or does not". Such conflict situation designed to reveal cognitive differences in this way plays an important role in promoting deep reflection and breaking stereotypes.

Finally, distributed leadership and expert roles were cultivated. Teachers who had achieved effective results in the specific application of a technology were invited to play the role of "rotating facilitator" and share their strategies and experiences. This mechanism operates beyond temporary motivational effects through two interconnected processes. First, the rotation itself institutionalizes the expectation that expertise is distributed and accessible, gradually normalizing the idea that any teacher can legitimately assume a leadership position based on demonstrated competence. Second, repeated exposure to peer-led facilitation alters the group's tacit norms regarding professional authority, shifting the basis of credibility from formal seniority to demonstrated pedagogical innovation. Over time, these repeated micro-interactions accumulate into a durable shift in collective habitus: the community's implicit "rules of the game" are reconfigured such that peer-led, data-informed practice becomes the expected standard, not merely a temporary intervention-driven activity. The community to which he belongs is not simply a technology exchange community, but a social space continuously producing new meanings and norms. Crucially, the community functions not merely as a provider of previously missing social resources, but as a structured space where new discursive rules (e.g., evidence-first argumentation) and role expectations (e.g., rotating facilitation) are collectively enacted. It is this reconfiguration of interactional norms—rather than the mere addition of resources—that enables the transformation of external supports into internalized teaching habits, thereby distinguishing a sociological shift in habitus from a simple technological capacity-building intervention.

VI. QUANTITATIVE ASSESSMENT OF THE EFFECTIVENESS OF PHYSICAL EDUCATION TEACHERS' DIGITAL LITERACY DEVELOPMENT

A. EXPERIMENTAL PREPARATION

In order to guarantee validity and reliability of the three behavioral experiments, we did a lot of preparatory works before conducting the three behavioral experiments. First, we randomly chose 40 teachers from those teachers participated in "Field-Habituation" intervention project according to the stratified random method based on teaching grade level (middle/high school) and initial digital skill level to construct experimental sample in order to keep teachers' participation in three experiments as same as possible. Second, we did standardization works for common environment and experimental materials, that is, same kind of smart fitness tracker, motion capture app and data analysis chart were offered. For teaching topic of "Crouch Start" and "Volleyball Passing Stability" respectively, we also constructed standard teaching context package including common teaching objectives, common difficult points and common practice methods to control teaching content variables as well. Finally, all four evaluators for behavioral code and lesson plan score did two days training before conducting pre-experiment, and chose same kind of smart fitness tracker, motion capture app and data analysis chart. The evaluation of teachers' lesson plan was based on the package, and all evaluators did calibration experiments based on the pre-experiment videos and example lesson plans. All evaluators did training until the main observation dimensions and scoring items reached a high consistency.

B. OBSERVATIONAL EXPERIMENT ON CHANGES IN TEACHING BEHAVIOR

The experiment adopted a single-group pre- and post-test design, and directly filmed and observed the teaching behaviors of 40 physical education teachers in the intervention program. The entire lesson (45 min) was video-recorded for each of the teachers after and before they participated in the intervention program to teach a lesson on the "Crouch Start" technique. The researchers coded and counted the frequency of three typical teaching behaviors based on a predesigned structured observation scale. That is, they recorded the frequency of teachers using smart devices to demonstrate the teaching contents, the frequency of teachers collecting student movement data and the frequency of teachers giving feedback to students based on collected movement data after and before the intervention. The comparison results are presented in Table 1.

TABLE 1. Comparison of Observations on Changes in Teaching Behaviors

Observed Behavior Category	Pre-Intervention (Mean ± SD)	Post-Intervention (Mean ± SD)	t-value	p-value
Using Equipment for Demonstration	1.25 ± 0.78	3.80 ± 1.12	12.74	< 0.001
Collecting Practice Data	0.70 ± 0.66	2.95 ± 1.04	11.89	< 0.001
Providing Personalized Feedback Based on Data	0.90 ± 0.72	4.15 ± 1.27	14.02	< 0.001

Data from the teaching behavior observation experiment showed that after the intervention, the frequency of teachers using digital technology for demonstrations, data collection, and personalized feedback in the classroom all showed a statistically significant increase ($p < 0.001$). Crucially, "data-driven personalized feedback" increased from 0.90 to 4.15 times per lesson ($p < 0.001$). To assess whether this frequency increase reflected genuine pedagogical improvement, feedback quality was also evaluated based on data specificity, individualization, and actionability. Post-intervention, 84.2% of feedback instances met all three quality criteria, compared to 28.6% at baseline, indicating that the increase in frequency was accompanied by substantive quality gains. This shift reflects more than the acquisition of previously unavailable technological resources. Rather, it demonstrates a qualitative transformation in teachers' professional dispositions—from technology-as-tool to data-as-routine—which is the hallmark of habitus change. Such transformation was enabled not by resource provision alone, but by the structured interplay between field reconstruction (institutionalized support) and sustained reflective practice within a community that reshaped professional norms. This dual evidence—increased frequency and improved quality—demonstrates that teachers' "teaching habits" have shifted from sporadic technological displays to continuous, data-driven professional practices, achieving a genuine embedding of digital literacy into the core of teaching.

C. EXPERIMENT ON QUALITY ANALYSIS OF LESSON PLAN DESIGN AND IMPLEMENTATION

The experiment adopted a paired-samples pre- and post-test design. We randomly selected 40 secondary school physical education teachers who accepted the intervention program as research subjects. Each teacher was asked to complete a standard lesson plan and teach a segment independently before and after the intervention. The teaching theme of the lesson was "volleyball passing stability." We used blind experts to compare the teachers' instructional design ability after the intervention in terms of technical appropriateness, depth of integration, and data decision-making based on the three dimensions. Comparison results are shown in Figure 1.

Figure1(a) uses a box plot to compare the distribution and mean changes of teachers ' scores on the three core dimension

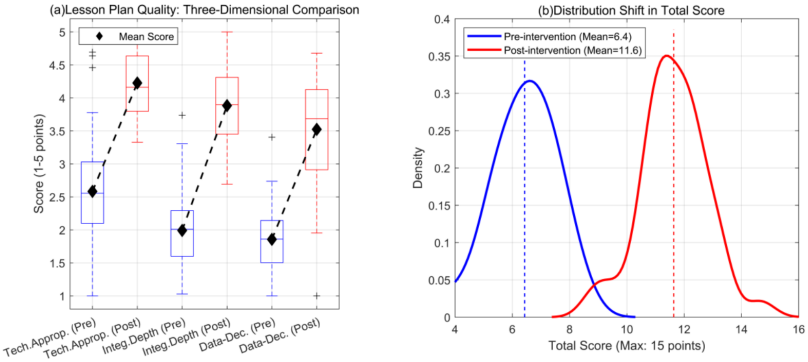

FIGURE 1. Comparison of Lesson Plan Design and Implementation Quality

of instructional design before and after the intervention; Figure 1(b) reflects the overall quality improvement.

The experimental results show that teachers exhibited highly significant improvements in all three core dimensions of lesson plan design after the intervention ($p < 0.001$). The improvement in the "data-driven decision-making" dimension was the most prominent, with the average score increasing from 1.82 to 3.52, an increase of 93.4%. The scores for the "technology appropriateness" and "integration depth" dimensions increased from 2.53 and 2.01 to 4.18 and 3.91, respectively, representing increases of 65.2% and 94.5%. The overall score for lesson plans significantly increased from 6.36 to 11.61, an overall increase of 82.5%. The results demonstrate that systematic intervention based on the "field-habituation" theory can effectively guide teachers to transform digital technology from a peripheral tool into a core element of instructional design, realizing a paradigm shift in their digital literacy from "technology as a tool" to "data-driven instructional design".

D. DATA-DRIVEN TEACHING DECISION-MAKING SIMULATION TASK EXPERIMENT

This was a standardized situational simulation test experiment designed to assess transfer of learning rather than simple task repetition. Prior to and after the intervention, the 40 participating teachers were given a novel "teaching situation data package"—featuring a sport (badminton) and student performance metrics not covered in any training session—including heart rate curves, movement trajectory overlays, and practice performance records. Teachers independently wrote a brief teaching diagnosis and decision-making report within a specified time, proposing three concrete teaching improvement suggestions. A pre-established scoring rubric evaluated three dimensions: data citation accuracy (0–3), relevance of suggestions (0–4), and operational feasibility (0–3). Two blinded experts scored each report independently, with inter-rater reliability exceeding 0.85. The comparison results are listed in Table 2.

TABLE 2. Comparison of Data-Driven Teaching Decision-Making Simulation Tasks

Evaluation Dimension	Pre-intervention (Mean ± SD)	Post-intervention (Mean ± SD)	t-value	p-value
Data Citation Accuracy (Max:3)	1.05 ± 0.52	2.58 ± 0.50	13.82	< 0.001
Relevance of Suggestions (Max:4)	1.35 ± 0.67	3.20 ± 0.62	12.94	< 0.001
Operational Feasibility (Max:3)	0.93 ± 0.48	2.38 ± 0.49	13.52	< 0.001
Total Score (Max:10)	3.33 ± 1.45	8.16 ± 1.41	14.91	< 0.001

The results of the simulated task experiment, evaluated against the established rubric, showed that teachers' data-driven decision-making ability improved significantly across all indicators after the intervention ($p < 0.001$). Their total task score increased from 3.33 to 8.16, a 145% increase. Critically, because the assessment used a novel sport and data format not encountered during training, this improvement reflects genuine transfer of learning and endogenous transformation of decision-making competence, rather than mere compliance with trained procedures. Among the three dimensions, "data citation accuracy" showed the most pronounced gain (from 1.05 to 2.58, a 146% increase), indicating a fundamental strengthening of teachers' ability to extract and interpret key information from data. Meanwhile, the "operational feasibility" score increased from 0.93 to 2.38, demonstrating that their decision-making has shifted from vague perception to concrete and actionable teaching plans. Together, these findings verify that the "field-habitus" intervention effectively promoted a shift in teachers' cognitive framework, enabling them to systematically transform complex multi-source data into precise teaching interventions—a substantial breakthrough in digital literacy

at the highest level of "decision innovation."

VII. CONCLUSION

This study, developed based on the field-habitus theory, validates an effective path to improve digital literacy by reconstructing the instructional environment and adjusting habits to align with the technical precision required in modern manufacturing. These procedures ensure that the embodied skills of traditional weaving are systematically integrated with digital tools to standardize technical training and enhance operational mastery. Experimental results demonstrated that this path could significantly promote the change of teachers' teaching behavior toward data-driven model and substantially improved teachers' instructional design ability and data-driven decision-making. The limitations of this study were its relatively narrow sample source and lack of long-term follow-up to track the sustainability of inter-vention effects. Future research could broaden the sample scope to validate the crossregional applicability of th is the-oretical model within both physical education and technical training centers to establish a universal professiona l devel-opment framework for digitalization. This expansion aims to optimize instructional strategies that harmoniz e human motor skills with the precise operational require ments of modern machinery across diverse educational and industrial contexts.

AUTHOR CONTRIBUTIONS

Feng Liu designed, collected and analyzed the data, and drafted the manuscript. Feng Liu conducted the study, critically revised the manuscript for important intellectual content, and gave final approval of the version to be published. Feng Liu participated fully in the work, take public responsibility for appropriate portions of the content, and agreed to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

CONFLICTS OF INTEREST

The author declares no conflict of interest.

FUNDING

This research was supported by,

Project 1: The first Hunan Provincial Basic Education Teaching Reform Research Project, project number: Y20230606

Project 2: Hunan Province Vocational College Education and Teaching Reform Research Project: (Project No. ZJGB2023330)

Project 3: Research Results of the Philosophy and Social Sciences Planning Project of the Social Sciences Association of Changsha City (Project No: 2026CSSKKT308)

HUMAN RESEARCH SUBJECTS

This research has been approved by the ethics committee of the author's institution, and was performed in accordance with the principles of the Declaraton of Helsinki. All eligible partcipants signed an informed consent form.

ACKNOWLEDGEMENTS

Not applicable.

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