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An IoT-Enabled Data-Driven Intelligent Teaching Model for Business Japanese Education in the Era of Big Data

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Abstract The rapid development of big data analytics and Internet of Things (IoT) technologies presents new opportunities for strengthening business Japanese education, particularly in the areas of practical language application, learner engagement, and classroom management. Conventional instruction may provide an insufficient connection between linguistic knowledge, business practices, and intercultural communication. To address these challenges, this study proposes an IoT-enabled, data-driven teaching model structured around three interconnected modules: preparation, learning, and evaluation. The framework establishes a feedback cycle through which information about learners' needs, instructional activities, and evaluation outcomes can inform subsequent teaching decisions. An associated smart classroom architecture integrates a perception layer for collecting environmental and participation data with a control layer for managing classroom resources and authorized access. The study further introduces quantitative indicators for student distribution, knowledge coverage, learning motivation, instructional goal attainment, and classroom management. Two questionnaire-based analyses are presented to examine students' learning needs and preferences for blended instruction. The manuscript reports an average 12% improvement in teaching efficiency, although the measurement procedure and comparative data supporting this figure require further documentation. The study identifies opportunities for integrating technological infrastructure with the pedagogical requirements of professionally oriented Japanese-language instruction while emphasizing the need for more rigorous outcome evaluation.

Index Terms business Japanese; Internet of Things (IoT); big data; intelligent teaching model; smart classroom; data-driven education

I. Introduction

In contemporary higher education, digital technologies are increasingly used to support the organization, delivery, and evaluation of learning. Advances in big data analytics, the Internet of Things (IoT), artificial intelligence (AI), and networked educational platforms have created new possibilities for collecting information about teaching environments and responding to learners' needs [1], [2]. IoT-based sensing and classroom-management technologies may contribute to instructional continuity, resource coordination, and timely feedback, although the benefits of such systems depend on their pedagogical design, institutional resources, and responsible handling of student data [3], [4]. Technology-enabled teaching should therefore be understood not simply as the installation of digital devices but as the careful integration of educational objectives, learning activities, assessment, and technical support.

Business Japanese education provides a particularly relevant context for investigating this integration. Students preparing to work in Japanese-speaking commercial environments require more than grammatical knowledge and general communicative fluency. Professional interaction may also involve appropriate language choice, knowledge of workplace con-

ventions, intercultural sensitivity, negotiation, business correspondence, and the ability to respond to unpredictable communicative situations. Research on active and collaborative approaches to business Japanese instruction suggests the value of connecting classroom learning to realistic workplace tasks and discussion-based activities [5], [6]. Research in Japanese higher education likewise illustrates how language proficiency and academic skills interact in professionally oriented learning settings [7]. These perspectives support the development of curricula that connect language form with practical communicative purposes.

Nevertheless, integrating such objectives into conventional classroom teaching presents several challenges. When vocabulary, grammar, and business-related applications are treated as separate instructional components, students may experience difficulty transferring what they know to workplace simulations or intercultural encounters. Predominantly teacher-directed lessons can also limit opportunities for sustained practice, collaborative problem-solving, and independent learning. Furthermore, classroom time and available learning resources may constrain the frequency with which students encounter authentic communicative scenarios. Studies of educational technology in language learning show

potential benefits for learner engagement and participation, while also emphasizing that positive effects are not automatic and must be assessed in context [8]–[10].

Existing approaches have addressed individual aspects of these problems. Japanese-language mobile learning applications can provide additional learning opportunities beyond scheduled lessons, while blended instruction combines face-to-face teaching with online preparation, exercises, and feedback [9], [10]. Broader research on technology-enhanced language education points to continuing challenges involving personalization, teacher support, and the translation of technical capabilities into measurable learning outcomes [11], [12]. At the level of business and professional education, innovative methods are also increasingly associated with learner participation and applied problem-solving rather than the transmission of isolated factual knowledge [13]. These developments suggest a need to coordinate instructional content, learning processes, technological infrastructure, and evaluation rather than treating them as disconnected initiatives.

A further challenge concerns the relationship between classroom data and pedagogical judgment. Measures such as participation, course coverage, and completion of stated objectives can provide descriptive information, but they do not in themselves establish gains in communicative competence. Similarly, the availability of sensor data does not demonstrate that students have acquired culturally appropriate professional language skills. Intercultural communicative competence and the quality of discussion-based learning require evaluation methods suited to their complex educational purposes [14], [15]. An intelligent teaching model should thus distinguish between the operational efficiency of a classroom, learners' perceptions of instruction, and demonstrable improvements in performance.

Against this background, the present study proposes an IoT-enabled, data-driven framework for business Japanese education. The proposed model organizes instruction into three connected stages: preparation, during which prior knowledge and learning needs are identified; learning, during which classroom and online resources support guided and independent activities; and evaluation, during which feedback informs subsequent instructional planning. A complementary smart classroom architecture contains a perception layer responsible for collecting relevant environmental and attendance information and a control layer intended to support classroom administration and authorized data access. The framework also specifies descriptive measures of course coverage, learning motivation, goal attainment, and selected operational outcomes.

The study's empirical component draws on questionnaire responses concerning students' reasons for selecting business Japanese, their self-assessed knowledge and abilities, and their preferences regarding online and classroom activities. These observations are used to discuss how blended instruction might respond to learners' identified needs. Accordingly, the principal contribution is an integrated instructional design connecting curriculum objectives, IoT-enabled classroom support, and feedback-based evaluation. The discussion distin-

guishes this proposed architecture from evidence of its effectiveness, and it identifies additional validation requirements for establishing whether technological integration produces sustained gains in professional Japanese-language competence.

II. Methods

A. Basic Courses

Using a university Japanese-language program with an international business orientation as an illustrative case, the curriculum can be organized into two stages. During the first and second academic years, students develop foundational language knowledge and the capacity to express their ideas accurately and fluently in Japanese. During the third and fourth years, instruction places greater emphasis on integrating language and culture with professionally oriented business knowledge and intercultural communication skills [16]. Course objectives, teaching materials, practical tasks, and assessment activities should be aligned so that progress in individual courses contributes to the broader program outcomes. Figure 1 presents the distribution of courses within this proposed educational structure.

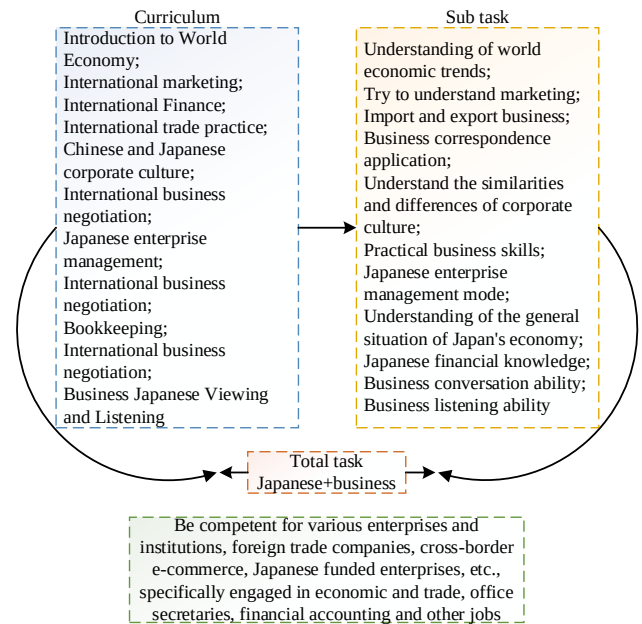


Figure 1: Distribution of Courses in a Business Japanese Program

1. Distribution of Students by Academic Year

The percentage of students enrolled in a particular academic year is calculated using the following expression:

$$P_i = \frac{n_i}{N} \times 100\%, \quad (1)$$

Here, P_i is the percentage of students in academic year i , n_i is the number of students in that year, and N is the total

number of students in the sample. The denominator represents all surveyed students rather than only those in year i .

2. Coverage of Course Content

$$C_k = \frac{n_{ck}}{n_t} \times 100\%. \quad (2)$$

In this expression, n_t denotes the total number of specified knowledge points, n_{ck} denotes the number covered by course k , and C_k indicates the percentage of targeted content addressed by that course. The indicator describes curriculum coverage rather than students' mastery of the material.

3. Distribution of Students' Learning Motivations

The proportion of respondents selecting motivation category j is calculated as follows:

$$M_j = \frac{n_j}{N} \times 100\%, \quad (3)$$

Here, N represents the total number of respondents, n_j is the number selecting motivation category j , and M_j is its reported percentage. If the questionnaire permits multiple responses, individual category percentages need not sum to 100%.

4. Instructional Goal Attainment Rate

$$T_a = \frac{n_a}{n_t} \times 100\%, \quad (4)$$

In this equation, n_a is the number of instructional objectives achieved, n_t is the total number of stated objectives, and T_a denotes the corresponding goal attainment rate. The criteria used to judge whether an objective has been achieved should be specified in the evaluation protocol.

5. Classroom Environment Adaptation Score

A weighted index may be used to summarize how closely measured classroom conditions correspond to the selected environmental criteria:

$$E = \sum_{i=1}^n w_i \times S_i, \quad (5)$$

Here, S_i is the score for environmental condition i , and w_i is its assigned weight. Interpretation of E requires clearly defined scales for the individual indicators and an explicit weighting procedure.

B. Intelligent Teaching of Business Japanese

Recent information technologies and network-connected devices provide opportunities to extend business Japanese instruction beyond the physical classroom. An intelligent learning environment may link preparatory tasks, classroom interaction, and follow-up practice through a shared digital platform, allowing teachers to coordinate in-person and on-line activities and students to access appropriately sequenced materials [17], [18]. For example, learners can prepare vocabulary and situational expressions online, practice spoken interaction during lessons, and receive formative feedback after class. This arrangement is intended to make instructional

resources available at different stages of learning rather than to replace the instructor's role. Figure 2 summarizes the proposed characteristics of intelligent teaching in business Japanese education.

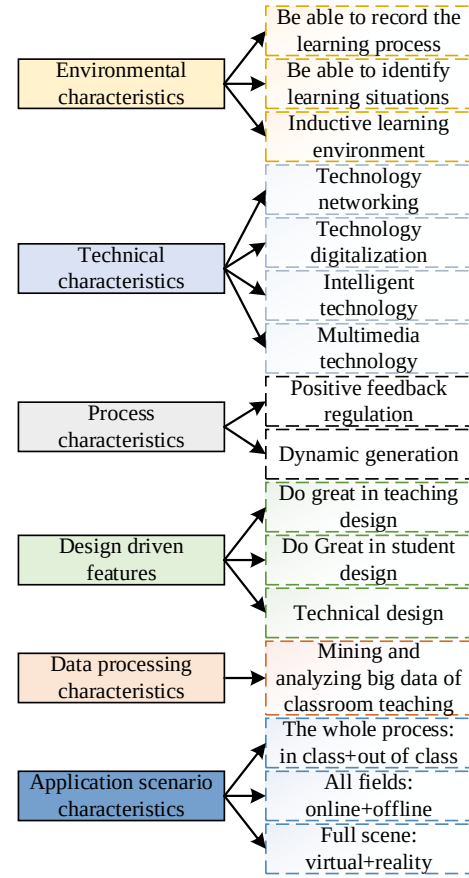


Figure 2: Characteristics of Intelligent Teaching Supported by IoT Technology

The proposed system is intended to support routine classroom management, improve access to learning resources, and reduce the administrative work associated with activities such as attendance recording and environment monitoring. These are design objectives rather than established effects of the proposed installation. The following discussion presents selected sensing and control indicators before describing the preparation, learning, and evaluation modules and their anticipated relationships.

Illuminance Sensor Calibration

$$I = K \cdot R, \quad (6)$$

In Eq. (6), R is the sensor reading, I is the estimated light intensity, and K is a calibration coefficient. The units and calibration procedure must be specified for practical measurement.

Smart Curtain Adjustment

$$A = \max(0, L_s - L_t), \quad (7)$$

Here, L_s denotes the current light intensity, L_t the target light intensity, and A the nonnegative adjustment quantity. The correspondence between this quantity and the physical curtain movement should be calibrated.

Weighted Indoor Air-Quality Indicator

$$AQI = \frac{\sum_{i=1}^n C_i \cdot W_i}{\sum_{i=1}^n W_i}, \quad (8)$$

In Eq. (8), C_i is the measured concentration of pollutant i , and W_i is its corresponding weight. This weighted aggregate is a proposed classroom indicator and should not be confused with an officially standardized air-quality index without the appropriate conversion and threshold methodology.

1) Analysis of System Functional Requirements

The intelligent teaching model illustrated in Figure 3 comprises three interrelated modules: preparation, learning, and evaluation. Preparation involves identifying learners' initial knowledge, instructional requirements, and learning objectives. The learning module coordinates digital resources with teacher-guided activities and practical business-language exercises. The evaluation module collects relevant assessment information and returns feedback to the earlier stages of instruction. Together, these components form a proposed cycle for revising lesson plans on the basis of observed learning needs and progress.

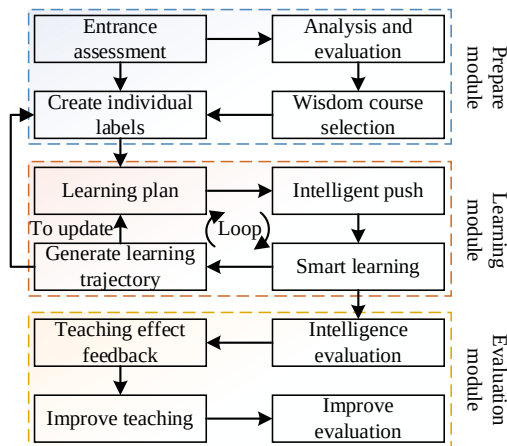


Figure 3: Preparation–Learning–Evaluation Model for Intelligent Business Japanese Education

Classroom Energy Savings

The difference between expected and observed energy consumption is expressed as follows:

$$E_s = E_t - E_u, \quad (9)$$

Here, E_s denotes estimated energy savings, E_t represents the reference energy consumption, and E_u represents observed energy consumption. Meaningful comparison requires

an equivalent classroom-use period and an explicitly defined baseline.

Relative Attendance Processing Efficiency

$$E = \frac{t_t}{t_m}, \quad (10)$$

Here, t_m is the time required by the smart attendance procedure, and t_t is the time required by conventional attendance recording. Values of E above 1 indicate that the proposed procedure requires less time, assuming comparable attendance tasks.

C. Perception Layer

At the perception layer, classroom sensors are intended to measure relevant environmental conditions and provide information needed for equipment management. Light sensors may support adjustment of room illumination, while radio-frequency identification devices can assist with authorized attendance or access checks. System design should specify which data are necessary for each educational function, distinguish environmental measurements from personally identifiable information, and minimize data collection accordingly. Sensor outputs require calibration, secure transmission, and appropriate access controls before they can be used for instructional or administrative decisions [2], [3].

D. Control Layer

The proposed control layer links classroom-level equipment with an administrative platform. Authorized personnel may use this system to view occupancy information, manage classroom schedules, inspect equipment status, and coordinate maintenance across teaching facilities. A central management interface can provide an overview of participating classrooms, while local interfaces retain control over individual rooms. Access to personal records must be restricted by role, and identity verification should be combined with data-protection safeguards, retention limits, and institutional authorization procedures.

Adjustment of Instructional Plans

Differences between the original instructional target and an evaluated outcome can be summarized by the following expression:

$$A_c = C_o - C_e, \quad (11)$$

Here, C_o is the original target, C_e is the observed or evaluated level, and A_c is the difference to be considered in subsequent planning. A positive difference indicates that the evaluated level remains below the specified target, provided that the two quantities share the same scale.

Relative Change in Language Proficiency

$$G = \frac{L_{t+1} - L_t}{L_t} \times 100\%, \quad (12)$$

In Eq. (12), L_t is the initial measured proficiency level, L_{t+1} is the later measurement, and G is their relative percentage change. This calculation is meaningful only when proficiency is measured on a comparable quantitative scale and L_t is nonzero.

III. Case Analysis

A. Current Situation of Business Japanese Teaching at a University

1) Characteristics of the Business Japanese Course

The curriculum is intended to develop business Japanese competence through the coordinated acquisition of language knowledge, professional communication strategies, and intercultural understanding. Three areas are particularly relevant. First, learners require the ability to interpret and produce Japanese appropriately in professional interactions, using both linguistic knowledge and contextual information. Second, a staged curriculum should connect initial language development with progressively more authentic tasks, moving from controlled classroom practice toward workplace simulations and applied communication. Third, instruction should assess communicative appropriateness and practical effectiveness as well as formal linguistic accuracy. Opportunities for discussion and collaborative problem-solving can help students apply language resources to realistic professional situations [19].

2) Questionnaire Analysis

A questionnaire was administered to students across the four academic years of a university business Japanese program. The survey aimed to describe respondents' learning motivations, self-reported command of business Japanese knowledge, and perceived areas for improvement. Descriptive percentages were used to summarize responses. Figure 4 presents the distribution of the participants by academic year; the figure should be interpreted alongside the stated sample size and the survey's selection procedure.

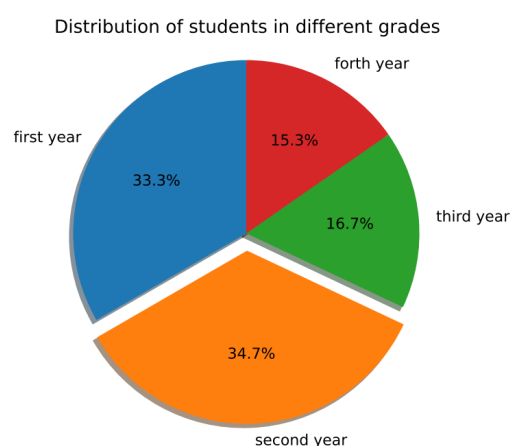


Figure 4: Distribution of Surveyed Students by Academic Year

The principal descriptive findings are summarized in the following tables.

Table 1 reports reasons for selecting business Japanese as a major among 150 respondents; Table 2 summarizes students' perceived level of business Japanese knowledge and ability; and Table 3 presents the areas in which respondents wished to improve. The main stated reasons for choosing the major include personal interest, overseas study, and employment prospects. The listed response categories in Table 1 total more than the 150 survey participants, which could reflect a multiple-response question; however, the reported percentages for some categories also differ from the percentages calculated using the stated counts. Accordingly, the frequency and percentage records require verification against the original questionnaire data before firm conclusions are drawn. Tables 2 and 3 suggest perceived needs in business communication, listening, writing, and intercultural interaction, although these self-reports should not be interpreted as objective measures of language proficiency.

Table 1: Reported Motivations for Choosing Business Japanese as a Major

Option	Subtotal	Proportion
Obtain employment	40	26.67%
Study abroad	45	30%
Interested in this major	65	41.33%
Other	53	33.13%
Number of respondents	150	-

Table 2: Self-Reported Understanding of Business Japanese Knowledge and Skills

Option	Subtotal	Proportion
Good	22	14.67%
Average	118	78.67%
Not good	10	6.67%
Number of respondents	150	-

Table 3: Areas in Which Students Wish to Improve Their Japanese-Language Skills

Option	Subtotal	Proportion
Intercultural communication ability	110	73.33%
Business Communication Knowledge	82	54.67%
Listening Comprehension	99	66%
Business Writing	85	56.67%
Other	40	26.67%
Number of respondents	150	-

The questionnaire discussion indicates that students perceived a need for stronger practical application of their language knowledge. As a professionally oriented program, business Japanese education can incorporate subject matter from international trade, commerce, and workplace communication while continuing to develop the linguistic foundations needed for accurate expression. Where instruction offers insufficient opportunities for integrated practice, students may find it difficult to apply classroom learning in unfamiliar professional situations. Figure 5 illustrates the reported practical-ability profile during university study. These observations suggest areas for curriculum development, but they do not by themselves

establish the employment outcomes or objective competence levels of graduates.

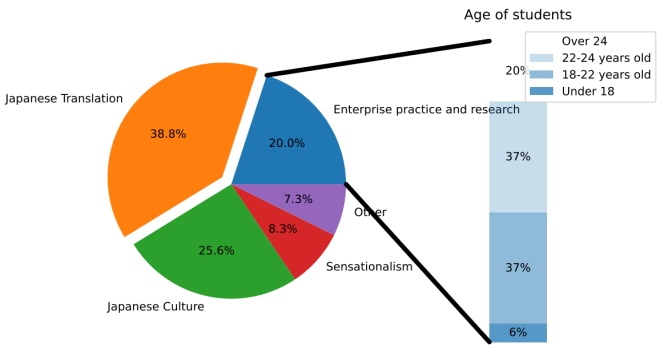


Figure 5: Reported Practical Business Japanese Abilities During University Study

B. Analysis of Teaching

A second questionnaire concerned students enrolled in Japanese and business Japanese undergraduate courses during 2019, following the use of an intelligent teaching platform alongside conventional instruction. A total of 74 questionnaires were collected. Respondents were asked whether they wished to retain online learning activities after returning to conventional classroom teaching. Their reported preferences are summarized in Table 4. This survey addresses the acceptability of the blended format rather than directly measuring changes in language proficiency or teaching efficiency.

Table 4: Students' Preferences for Retaining Online Learning After Returning to Classroom Instruction

Problem	Question: After returning to traditional classroom teaching, do you still want to keep online learning?
Option	
A. Yes	65.77%
B. No	34.23%

The survey also asked which elements of instruction students would prefer to complete online. Table 5 summarizes the reported distribution of preferences across pre-class preparation, classroom exercises, after-class assignments, and enrichment activities beyond the textbook. These findings can inform the allocation of tasks between online and face-to-face learning environments.

Table 5: Preferred Learning Activities for Online Completion

Problem	If you want to continue online learning after returning to the traditional classroom, which link do you want to finish online
Option	
A Preview of words, sentence patterns and texts before class	26%
B Exercises in class	17.31%
C After class homework	28.69%
D Expansion of knowledge points beyond textbooks	28%

The responses indicate an interest in retaining selected online activities alongside classroom instruction. However, the preferred distribution of instructional time cannot be determined from these descriptive percentages alone. Decisions about which activities should be completed online should consider the need for individualized preparation, the value of face-to-face speaking practice, the accessibility of digital resources, and teachers' capacity to provide feedback. A blended design should therefore be evaluated in relation to clearly specified learning objectives, rather than assuming that students' willingness to use technology necessarily produces better learning outcomes.

C. From Knowledge Transfer to Competency Development

The term "golden courses" has been used in Chinese higher education reform discussions to describe courses intended to promote substantive learning and improved instructional quality. For business Japanese education, this emphasis invites consideration of how short preparatory videos, independent vocabulary study, and classroom interaction might be sequenced to create additional opportunities for language use. Table 6 reports respondents' views on whether new vocabulary and sentence patterns could be studied independently before class, leaving more classroom time for speaking exercises, guided practice, and feedback. The policy terminology and historical details of the "golden courses" initiative require a specific documentary citation before publication.

Table 6: Students' Preferences for Pre-Class Learning in a "Golden Course Model

Problem	Do you think it is possible to preview and learn independently the new words and sentence patterns in each lesson in the form of short videos, to improve speaking less and practicing more in class?
Option	
A Sure. In class, you can monitor the effect of self-study of words and sentence patterns through various games and exercises; Let's talk and practice more.	87.88%
B May not. I prefer to learn new knowledge through traditional teaching.	12.12%

The responses suggest that a substantial proportion of surveyed students would accept an approach in which preliminary content is introduced through short videos and then reinforced through interactive classroom activities. This preference supports investigating a stronger connection between independent preparation and guided communicative practice. Nevertheless, approval of a teaching format is not equivalent to demonstrated effectiveness. Future evaluation should compare learning performance, practical communication tasks, participation quality, and student perceptions under clearly defined instructional conditions.

IV. Conclusion

This study develops an IoT-enabled, data-driven framework intended to support business Japanese teaching through the integration of instructional preparation, learning activities, and evaluation. The proposed architecture links pedagogical planning with smart classroom functions, including environmental sensing, attendance support, classroom management, and feedback-based revision of teaching strategies. The framework also introduces descriptive indicators for curriculum coverage, students' learning motivations, instructional goal attainment, and selected operational measures. These elements together provide a structured basis for considering how digital infrastructure may be used in professionally oriented language instruction.

The two questionnaire analyses offer preliminary evidence about student preferences and perceived areas for improvement. Participants identified needs involving business knowledge, listening, practical communication, and intercultural competence, while a separate group expressed preferences for retaining selected online learning activities within conventional instruction. These findings support further exploration of blended learning and interactive classroom approaches. They do not, however, independently establish causal improvements in Japanese-language proficiency or verify the manuscript's reported increase in teaching efficiency.

Further research should specify the sensing devices and operational procedures, establish transparent data governance practices, reconcile the questionnaire counts and percentages, and use appropriately designed comparative evaluations to assess learning outcomes. Objective measures of workplace-oriented communication, together with repeated observations and clearly reported sample characteristics, would provide stronger evidence about the effectiveness and transferability of the proposed teaching model.

Conflicts of Interest

The author declares no conflicts of interest.

Data Availability

The summary questionnaire results discussed in the study are presented in the manuscript.

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