Education and Lifelong Development Research

Vol. 1, No. 4, p. 192-203, 2024

Original article

Research on instructional design and evaluation of Japanese-language MOOCs for the digital age: An analysis framework based on first principles of instruction

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Keywords:
Japanese-language MOOCs
instructional design
first principles of instruction
e^3 (effective, efficient & engaging)
instruction evaluation
foreign-language teaching approach

Cited as:
Gu, C., Wang, J., Li, T., & Liu, Z. (2024). Research on instructional design and evaluation of Japanese-language MOOCs for the digital ge: An analysis framework based on first principles of instruction. Education and Lifelong Development Research, 1(4): 192-203. https://doi.org/10.46690/elder.2024.04.04

Abstract:
Moocs can be described as a basic form of digital instruction. With the continuous development of AI technology, the production of digital courses based on artificial intelligence is no longer out of reach. However, whether it is MOOCs or future courses automatically generated by AI, Instructional Design (ID) and its related theories will be the key to engaging, efficient and effective courses. This paper empirically investigates 83 Japanese-language MOOCs on major MOOCs in China and the United States, conducts an Instructional Evaluation and analysis of e^3 based on first principles of instruction of digital ID, and considers how to improve the effective participation and human-computer interaction of MOOCs from the perspective of instructional design. This paper finds that although student-centered learning theory has been widely recognized as early as more than 10 years ago, the ID of the most Japanese-languge MOOCs is still difficult to completely get rid of the behaviorism of knowledge transfer. Additionally, the problem-focused instructional design of the demonstration and application of language skills is lacking, and learners' awareness of their own initiative and ability in the learning process is insufficient. Therefore, on the basis of using this theory to evaluate the Instructional design of Japanese-language MOOCs empirically, this paper discusses effective teaching strategies with teaching cases with good human-computer interaction effect, hoping to provide useful enlightenment for future AI digital courses.

1. Introduction

As the pioneer of large-scale digital courses, MOOCs remain the mainstream of digital teaching to this day. However, since the birth of MOOCs, there has been bottlenecks in their development in terms of low completion rates, high turnover rates (Jordan, 2014), continuous investment of teachers in interaction with learners, poor business models, and popularization among users in poverty-stricken areas (Reich & Ruipérez-Valiente, 2019). While most MOOC platforms don't disclose learners attrition rates for their MOOCs, we made indirect statistics on the attrition rates based on the results and numbers of 11 Japanese-language MOOCs (JLMs) published on Freenity. We found that the proportion of learners who could participate in the entire learning process and take the assessment was approximately 50%, while the average pass rate for the assessment was only 40%. Some studies have pointed out that most MOOCs pay more attention to the visual presentation of teaching rather than the instructional design (ID) and content itself (Watson et al., 2016). The purpose of ID is to inspire and motivate engaging and effective knowledge acquisition for automated courses with good results, high efficiency, and high participation (Merrill et al., 1996a).

Facing the problems of MOOCs themselves and the challenges of digital curriculum transformation to digital intelli-

Yandy Scientific Press

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Received September 20, 2024; revised October 25, 2024; accepted November 25, 2024; available online December 23, 2024.

gence brought by the growing development of IT technology, it is obvious that the ID gives us an important entrance to whether MOOCs can complete the upgrading and transformation and adapt to the challenges of the digital intelligence era. Therefore, this paper takes Japanese-Language MOOCs (JLMs) as the research object, aiming to find out the existing problems of its (ID) through empirical investigation and evaluation of its instructional design (ID), seek solutions to course teaching strategies, and provide enlightenment for intelligent transformation of MOOCs.

2. Theoretical framework

2.1 FPI and E^3 instructional evaluation

ID is an iterative process of planning outcomes, selecting effective strategies for teaching and learning, choosing relevant technologies, identifying educational media and measuring performance (Branch & Kopcha., 2014). Since the end of the 1960s, ID has gradually developed into an independent subject in the field of educational technology. In the process of ID becoming an independent discipline, representatives of theoretical research on learning psychology and pedagogy have made significant contributions and formed many ID models. With learning theories as the fundamental criterion, ID can be divided into three generations. ID1 is based on the connectional learning theories of behaviorism centered on "teaching", represented by the Kemp model. ID2 is based on Robert Miles Gagné's cognitive strategies and is represented by the Smith and Ragan model. ID3 employs constructivist learning as its theoretical basis and emphasizes "learning-centered" ID principles. The most commonly used ID3 teaching methods are instructional scaffolding, anchored instruction, and random input techniques. As a representative of automated ID, Merrill was an important figure in ID2 theory and a leader in the application field of ID3 (Merrill et al., 1990a, 1990b; He, 1998a, 1998b, 1998c. This paper adopts Chinese scholars using learning theory as the generational classification principle of ID). He first proposed component display theory (CDT) (Merrill, 1983, p. 279-333), instructional transaction theory (ITT) (Merrill et al., 1996b), and automated instructional design (Cline & Merrill, 1995, p. 317-353.) He developed the first principles of instruction (FPI) and the pebble-in-the-pond (PIP) ID model (Merrill, 2013), which emphasize task-centered instruction. In the face of informatization and the ever-increasing demand for innovation, scholars such as Charles M. Reigeluth systematically sorted out the paradigm of ID theories and proposed the concept of everyone becoming a talented person, a new learner-centered paradigm of education (Reigeluth, 2016), etc.

Merrill proposed the FPI and PIP models for realizing e^3 (effective, efficient & engaging) instruction, which were developed by combining and researching more than 300 ID theories and models with a focus on comparing several typical models (Merrill, 2013, p. 407-414). It include a set of interconnected principles: focusing on problems/tasks, and progressing through the stages of activation, demonstration, application, and integration. These principles also develop a classification of learning content and academic performance, aligning the content dimensions (such as memory associations, recognition of parts, classification of concepts, execution of procedures, and understanding of processes) with corresponding instructional methods (such as explanation, questioning, demonstration, and practice). It is the creation of knowledge objects that can be related to each other and sequencing with algorithmic guidance.

Merrill pointed out that FPI is generic, and is best suited for teaching generalization skills. He also demonstrated empirically that under FPI, the number of students participating is higher, the number of students who are satisfied or very satisfied with the course is 3 to 5 times greater, and the number of students who effectively master the course target is 9 times higher (Merrill, 2013, p. 432). Several research articles provide significant empirical and anecdotal support for FPI (Frick et al., 2022; Thomson, 2002). Thomson (2002) showed by using FPI, students achieved a 30% performance improvement over the traditional instruction, including a 41% improvement in time performance. Lee (2013) showed that the implementation of FPI can affect the use of students' deep cognitive strategies.

As show in Fig. 1, the five instructional activity categories of FPI that reflect the instructional process are problem-solving, activation, demonstration, application, and integration.

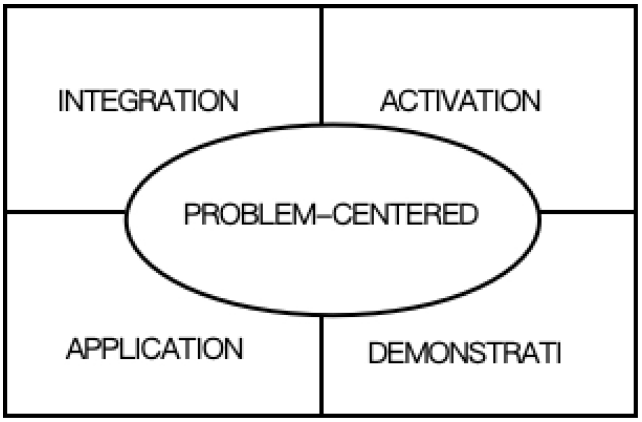

Fig. 1. First principles of instruction.
(From FIRST PRINCIPLES OF INSTRUCTION)

Each activity corresponds to certain behavioral requirements. From this, Merrill provided a course evaluation standard to test the implementation level of instructional strategies:

Information-Only (Level 0): Presenting information only.

Demonstration (Level 1): A level 1 instructional strategy consists of information plus demonstration. A demonstration is one or more worked examples of all or part of the problem that shows how the information is applied to specific situations.

Application (Level 2): A level 2 instructional strategy adds an application to an information plus demonstration strategy. Application requires learners to use their skill to solve specific problems.

Problem-centered (Level 3): Level 3 instruction adds a problem-centered strategy to demonstration and application. Learning is promoted when learners acquire knowledge and skill in the context of real-world problems or tasks.

Activation: Learning is promoted when learners recall or acquire a framework or structure for organizing the new

knowledge, when the structure is the basis for guidance during demonstration, coaching during application, and reflection during integration (Merrill, 2013, p. 20-29).

2.2 The advantages of E^3 instruction evaluation

ID indicators for evaluation have long been proposed (Chickering & Gamson, 1991; Chickering & Ehrmann, 1996; Cuseo, 2008) and have been used in both face-to-face teaching and online teaching. Academic organizations have also issued relevant quality guidelines for MOOCs (Commonwealth of Learning, 2016; Stracke et al., 2018). There are many studies on the quality evaluation of MOOCs or online teaching, which generally integrate the characteristics of various evaluation systems or perform specific data verification, such as a study that developed an evaluation framework on the basis of predecessors to introduce a BL framework based on a single criterion and standard of practice to support evaluation and advancement (Mirriahi et al., 2015). A study using the VIKOR analysis method ranked the platform quality of the chosen five MOOC websites for sorting and provided quality reference indicatorsand (Su et al., 2021). There is also a study on the evaluation model based on support vector regression (Liu, 2022). Tong & Jia (2017) explored the quality evaluation system of MOOCs, involving the index content of instructional design. Similar research from the same perspective also includes Qiu & Ou (2015), etc. From the learner's perspective, there are discussions on the learning quality model by AN & Zhang (2018), the construction of the MOOC evaluation system by Liu et al. (2021), and the research on the quality evaluation indicators of foreign language online courses by Zhang et al. (2022). In China, there is not much practice (Guo & Qiu, 2024) or research (Feng & Zhao, 2005) pertaining to the use of FPI for evaluation, but all extant studies affirm the evaluation system of FPI. In the more than ten years since the birth of this model, the progress of integrated ID, measurement and evaluation has not advanced as well as expected.

Because FPI regards the problem and realistic situation as the center and emphasizes the acquisition of skills as well as the interaction between teaching and learning, it is in accord with the characteristics of foreign-language teaching with pragmatic competence as its learning objective, its focus on the creation of the target language context and its requirements of online courses for the interactions. Therefore, this paper uses Merrill's e^3 instruction evaluation method to examine the ID of MOOCs, aiming to identify issues in the instructional design of MOOCs and offer solving ideas for the transformation of digital education.

3. Research methods

3.1 The E^3 instruction evaluation of JLMs based on the FPI

Based on the levels of the instructional strategies scale of FPI and combined with the actual situation of foreign-language teaching, the evaluation form is based on the four-step framework. Since the MOOC platforms lack the module design for "activation", we temporarily excludes the activation from the evaluation system for the time being. As "integration" requires learners to solve real problems and achieve it through reflection, discussion, and consolidation of new knowledge, this paper contrasts "integration" with the assignment column and discussion area of the MOOC platform to assess the activity level of the course and the support provided for learners to achieve " integration". Meanwhile, this paper also considers the application or pop-up exercises in the MOOC lecture videos as "application". Based on the E^3 instruction evaluation standard, this paper designs the evaluation indicators as follows according to the characteristics of Japanese language teaching, it is presented as in Table 1. Each sub-item has 3 to 7 rubric indicators, with each indicator scoring 1 point. In the four-step instructional design framework from focusing on the problem to integration, obtaining one indicator score in each step is regarded as the achievement of that step. The degree of achievement depends on the specific score obtained in that step. The higher the score, the higher the degree of completion. Demonstration only is Level 1 (abbreviated as L1), Level 2 (L2) add application to L1, Level 3 (L3) adds a problem-centered strategy to demonstration and application, at level 4 (L4), learners integrate new skills into existing skills by reflecting on, discussing, etc.

3.2 Data collection range

To obtain a wide range of application data, we conducted a search with "Japanese" as the keyword on 14 major MOOC platforms in China, the United States, Britain and Japan. 202 JLMs resources were found across 12 platforms at that time, while the platforms of Gacco in Japan and Futurelearn in the UK have not offered JLMs. After eliminating duplicate courses, there were a total of 11 platforms, namely 10 from China and 2 from the US, offering approximately 150 Japanese language courses. This paper randomly selected 83 of them and collected data through observing and participating in the teaching based on the e^3 teaching evaluation indicators of JLMs. Meanwhile, the foreign language teaching approaches of the target courses were adopted to conduct a secondary inspection of the e^3 instruction evaluation of JLMs. The time required to search and select the JLMs, observe and collect data lasted from January 2021 to September 2023. Data were collected and judged by three professional personnel. When there were discrepancies in the data, they would reobserve and judge until a unified result was obtained.

4. Results

4.1 Outline of JLMs

This paper categorizes 25 repeated (including single or multiple occurrences) courses into the platform "www. icourse163. org", 5 courses into "www. xueyinonline. com", 3 courses into "www. zhihuishu. com", 4 courses into "moocs. unipus. cn", and 1 course into "www. zjooc. cn". As shown in Table 2, the most common distribution of JLMs is "www. icourse163. org", followed by "www. xueyinonline. com", "www. zhihuishu. com"and "moocs. unipus. cn" , etc.

Table 1. The e^3 instruction evaluation standard of JLMs.

Principles	Prescription indicators
1. Problem-centered	1-1. Does instruction make the instructional objectives clear to learners? 1-2. If so, do the instructional objectives point to solving realistic problems? 1-3. Does instruction make it clear that the goal is a certain or connected whole in the concept (what), principle (why), mechanism (how), or involve a series of deepening related problems rather than presenting a single problem?
2.Demonstration	2-1. Is the demonstration consistent with the instructional objectives? 2-2. Determine whether the demonstration is set in a realistic situation or imagined real situation. 2-3. Explain the concept, learning point, subitem or whole (what), why (principles). 2-4. Show how to do in parts and as a whole. 2-5. Respond to the problems after demonstration, what instructional objectives have been achieved. 2-6. Diversified demonstration (evidence from different angles, aspects, problem points, comparative evidence, etc.), whether the connection between knowledge has been paid attention to. 2-7. Proceed from simple to complex.
3.Application (language practice in the instructional video or pop-up exercises in the instructional video)	3-1. Are the applications (exercises or associated tests) consistent with the instructional objectives? 3-2. Does instruction require the learners to use new knowledge or skills to solve a series of variant problems? (They are best directed via a simple to complex progression or in a way that is linked to previous knowledge, providing examples of solving realistic problems.) 3-3. Are there relevant explanations, systematic feedback and coaching, in the drills in the course? (For example, showing the consequence of learners' responses; in the options, asking why it is wrong or right, or highlighting error-prone, difficult points, and guidance on expected problems; prompt previous knowledge to help problem solving.)
4. Integration of settings and activity on the MOOC platform	4-1. Has the teacher initiated discussion in the discussion area? 4-2. Are there questions for learners in the discussion area? 4-3. Decide whether to provide feedback or coaching for questions, discussion. 4-4. Determine whether homework, exercises, or tests have been arranged in the homework area. 4-5. Determine whether homework is multi-intelligence-oriented, such as that promoting listening, speaking, reading, writing and other skills, pictures, sounds, error correction, tasks, and games (connection, guessing, dubbing, etc.)

Table 2. Number of JLMs on the platform(with duplicate courses excluded).

Platform	Number of JLMs
www. icourse163. org	31
www. xueyinonline. com	29
www. zhihuishu. com	26
moocs. unipus. cn	17
www. zjooc. cn	13
www. xuetangx. com	10
www. edx. org	10
www. ulearning. cn	5
www. ehuixue. cn	3
www. icourses. cn	2
www. coursera. org	4
Total	150

JLMs can be divided into comprehensive MOOCs for the purpose of cultivating the comprehensive language skills of listening, speaking, reading, writing, and translation and MOOCs focusing on one language skill, including Japanese pronunciation, conversation, grammar, audiovisual, reading and writing courses, as well as translation practice (including courses that combine translation theory and practice). As shown in Table 3, there are 94 courses of comprehensive Japanese, 15 courses of audio-visual learning (speaking), 9 courses of Japanese grammar, 7 courses each of conversation and translation, 6 courses of writing, and other JLMs are equal to or less than 5.

4.2 The E^3 level of JLMs instructional strategies

After data collection and statistics of 83 JLMs, the JLMs were distributed in grades L1-L4, ranging from grade 1 to 4. As shown in Fig. 2, only 40 JLMs (48% of the total) could demonstrate new knowledge at L1 level. Two JLMs (2% of the total) could demonstrate new knowledge and apply it at L2 level. Five JLMs (6%) could demonstrate new knowledge, focus on problems, and further apply it at L3 level. In addition to meeting the standards of the first three grades, a total of 36 JLMs (43% of the total) reached L4 level by conducting discussions, homework/quizzes, and achieving integration.

From the individual criteria of the rubric, as shown in Fig.

Table 3. Types and Numbers of JLMs.

	Comprehensive	Viewing, Listening and Speaking	Grammar	Conversation	Translation	Writing	Reading	Pronunciation	Speech	Total
Number of JLMs	94	15	9	7	7	6	5	5	2	150

3, the demonstration in the exemplar case is best in explaining concepts (2-3) around the instructional objectives (2-1). The demonstration is conducted from easy to difficult (2-7) and the recap of the target (2-5) indicates what has been done, with a low overall completion rate of 10 and 9 JLMs, or about 12% of the JLMs. The recap of the target refers to a clear explanation of how the learned content can be used in real life to achieve communicative effects, rather than a general summary of the learned content. The completion rate of setting real-life scenarios (2-2) and diversifying arguments (2-6) is also not optimistic, around 25%, with L4 outperforming other levels in these two categories.

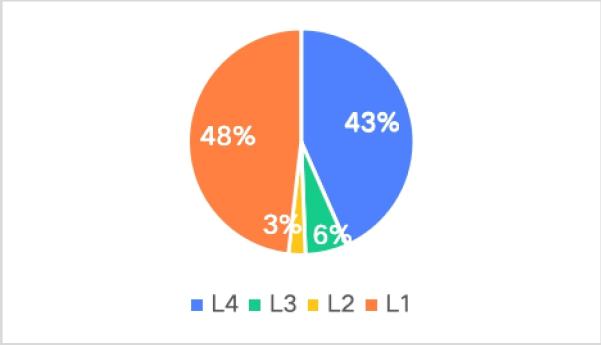

Fig. 2. JLMs E^3 Level and PercentageJLMs E^3 Level and Percentage.

Fig. 3 shows that no matter what level of JLMs can be demonstrated around the instructional objectives, but the examples do not integrate well with the scenarios (real-world problems), the diversity of arguments is lacking, and the hierarchy of reasoning is relatively weak. Single demonstration, the same kind and level examples, and the lack of demonstration in actual communication are not conducive to a complete understanding of new knowledge and skills.

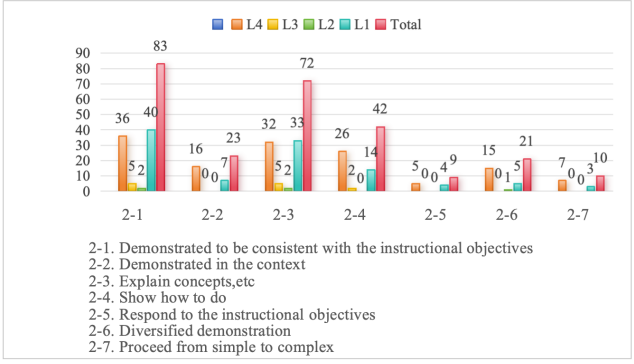

Fig. 3. Number of Demonstration Realizations.

There are three rubric indicators for application as illustrated in Fig. 4. Although all the JLMs in L2, L3, and L4 have made corresponding application designs in accordance with the instructional objectives (3-1), in the two sub-items of (3-2) and (3-3), among the MOOC videos or pop-up windows, 14 JLMs in L4 and 1 JLM in L3 have implemented the progressive variation exercises from easy to difficult (3-2). In the sub-item of whether key and difficult points are indicated or feedback is provided to learners (3-3), the numbers for L4 and L3 are 19 and 1 respectively, while none of the JLMs in L2 have accomplished these two aspects. The reason why FPI emphasizes the progressive difficulty in application and encourages the transformation of application methods and perspectives is that problems that are overly similar or simple are not conducive to learners' adjustment of their mental models and are not beneficial for the reconstruction and improvement of mental models. Similarly, exercises without feedback and guidance cannot better facilitate learning.

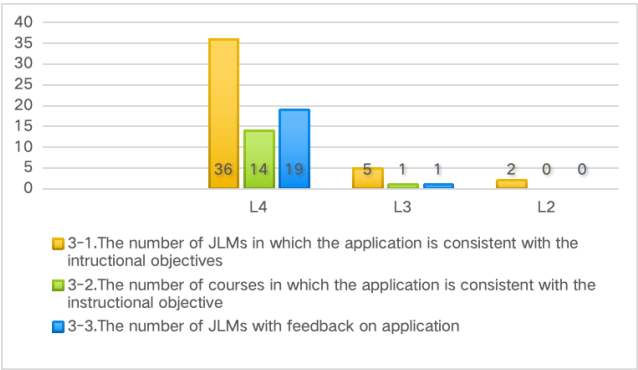

Fig. 4. Number of Application Realizations.

As shown in Fig. 5, although both L3 and L4 JLMs can focus on problem (1) to set their instructional content, there are 16 JLMs in L4, accounting for 44% of the grade, and 2 JLMs in L3, accounting for 40% of the grade, that set problems in a certain context (1-2). Context setting can make learning more purposeful. Repetitive, dull explanations and examples are difficult to make learners feel the sense of purpose in learning, while the language use scenarios can immediately endow knowledge points with their value in interpersonal communication and effectively enhance the purposefulness of learning. The more realistic and practical the scenario setting is, the better the effect will be. Among the 15 JLMs that can achieve this in L4, 15 focus on knowledge concepts, principles, mechanisms, or a series of gradually deepened questions (1-3) for teaching, while only one JLM in the other three grades dissects language knowledge and skills into

specific items based on the instructional objectives. Focusing on problems and gradually deepening them or presenting them from multiple angles in a complete argument not only helps learners improve their cognitive patterns but also meets the needs of learners of different learning levels, which is the main reason why L4 is superior in focusing on problems compared with the other levels.

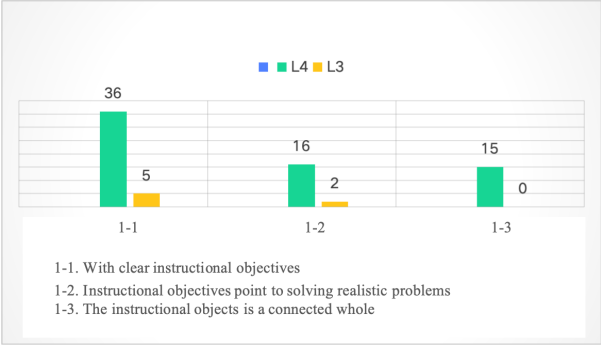

Fig. 5. Number of Problem-centered Realizations.

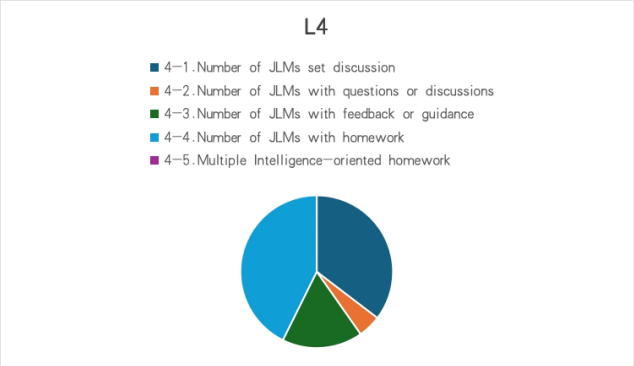

Fig. 6. Number of Integration Realizations.

FPI supports the idea that deep learning requires learners to integrate new knowledge into their existing cognitive models, which ensures that the way in which this deep processing occurs is through collaboration between learners in solving problems or completing complex tasks. Learning is promoted when learners integrate their new knowledge into their everyday lives by being required to reflect on, discuss, or defend their new knowledge or skill via peer-collaboration and peer-critique. (Merrill, 2013, p. 44). In this study, the homework and discussion forums on MOOC platforms are counted as integration item. The data showed that all 11 platforms have assignment and discussion sections. Of the 83 JLMs, 62 have assigned homework, with the homework primarily designed to reinforce the language knowledge taught. The discussion sections are often initiated by the instructor, with individual students occasionally asking questions. Only a total of 4 JLMs have engaged in in-depth discussions in the discussion sections. Currently, MOOC platforms do not reflect team-based learning. As shown in Fig. 6, although 35 of the L4 JLMs have assigned homework to 97% of the JLMs in the level, and 29 of the JLMs have assigned discussion questions to 81% of the JLMs in the level, the homework assigned is relatively mechanical and lacks diversity or adequate use of linguistic intelligence, logical intelligence, and introspective intelligence, etc. and the discussions are unable to fully explore the issues.

4.3 Realization of individual items in JLMs at different E^3 levels

According to whether the JLM has achieved each sub-item of problem-centered, demonstration, application, integration four iteams, each sub-item to get 1 point. Comparing the average scores of the four sub-items, as shown in Fig. 7, the overall score of L4 is higher than that of the other levels. Among them, the completion degree is higher in the order of focusing on problems and applying new knowledge, integrating knowledge. The demonstration scores of the other three levels are relatively balanced, which means that the Japanese MOOC as a whole attaches the most importance to the demonstration part. Except for L4, the completion degrees of the other three levels are relatively close. Although there are JLMs that have not achieved focusing on problems and integrating knowledge, the average score of the JLMs that have been scored is not very different, and the lowest overall completion degree is the sub-item of applying new knowledge.

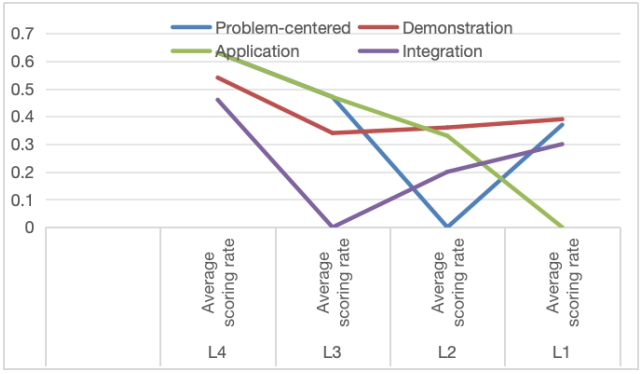

Fig. 7. The Realization of E^3.

4.4 Evidence concerning the E^3 of FPI in the foreign-language teaching approach

There are numerous methods and schools of foreign language teaching, which are beyond enumeration. Foreign language teaching approach is generally categorized into the era of methods, the era beyond methods, and the post-method era. The post-method era opposes foreign language teaching that is knowledge-centered or language-centered, emphasizes giving full consideration to the complex circumstances of foreign language teaching, underlines the significance of context, particularly factors such as social, political, and educational systems in foreign language teaching, and advocates context-based teaching and a series of macro strategies. It represents an advancement and reconstruction of teaching approach, with the ultimate goal of shaping a diverse, flexible, and free personal theory of teaching practice. In the post-method era, constructivism, is the psychological theory that has exerted a mainstream influence on foreign language teaching, which

shares a similar theoretical background with the first principles of integrating both cognitive and constructivist theories, particularly in its emphasis on addressing practical problems and gaining effective cognition through problem-solving, which enhances cognitive structure and has interoperability to foreign language teaching. Hereinafter, by comparing the e^3 evaluation results with representative foreign language teaching approaches, the consistency between the teaching strategies advocated by FPI and foreign language teaching approach is examined.

As shown in Figure 8, JLMs mainly use the grammar-translation method (G-T), the audiolingual approach (A), the situational approach (S), the communicative approach (Com), the cognitive approach (Cog), the task-based teaching approach (T), the direct method (D), and the production-oriented approach (POA). The most commonly used approach is the grammar-translation method, with 72 JLMs accounting for 87%. Of the 33 JLMs that use more than one teaching approach, account for 40%. Only 43 JLMs use one teaching approach, namely Task approach, direct method, and audiolingual approach. Seven JLMs do not clearly apply any teaching method. Although cognitive approach and audiolingual approach are somewhat contradictory, some JLMs use both methods in different teaching segments based on the teaching content.

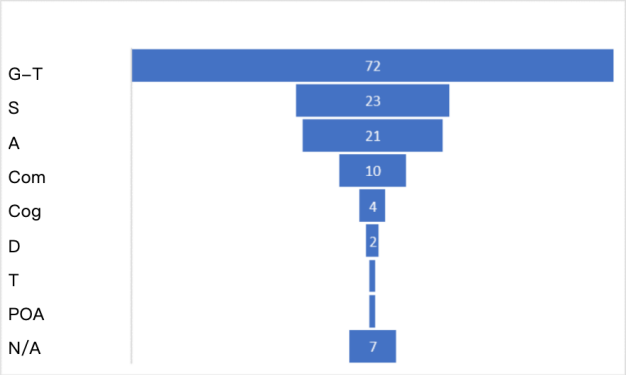

Fig. 8. The Utilization of Foreign Language teaching approaches.
(Represented by the Initial Letters of the teaching approaches in English)

Furthermore, by employing SPSS to conduct a chi-square verification of the relationship between e^3 of JLMs and the utilization of foreign language teaching approaches, the significant P-values for the comparison between the single translation teaching method and the composite teaching method, as well as the single teaching method and the composite teaching method, were 0.013 and 0.002 respectively. This indicates that teaching approaches have a significant influence on the e^3 levels of JLMs, and the composite teaching method is evidently more conducive to attaining higher e^3 ratings.

After conducting a model classification of the 33 JLMs that employ different teaching approaches in combination, they can be categorized into four types of composite instructional models: those dominated by the grammar-translation method, the cognitive approach, the situational approach, and the composite of the cognitive approach, the situational approach, and the communicative method. As depicted in Fig. 9, the e^3 teaching efficacy level ascends with the application of the single teaching method, the grammar-translation method-dominated model, the situational approach-dominated model, the cognitive approach-dominated model, and the composite model dominated by the cognitive approach, the situational approach, and the communicative method. There are 10 L4 JLMs that solely utilize the grammar-translation method, accounting for 24% of the JLMs within the same instructional model. Among the JLMs of the grammar-translation method-dominated model, there are 17 L4 JLMs, increasing the proportion within the same model to 63%. The instructional models dominated by the situational approach, the cognitive approach, or the communicative method alone or in combination have a 100% proportion of L4 JLMs.

Among various types of composite JLMs, the translation-dominated JLMs type focuse on enabling learners to understand the learning content through the interpretation of language elements in the native language. Even if these JLMs are designed with application sections, they rely more heavily on grammar exercises and translation between sentences and the target language to master language rules. Although some of these JLMs incorporate the situational or communicative methods, they mainly utilize a certain situation or present the learning content in communication rather than orienting towards the situation to inspire students' associative thinking and evoke content perception. Through the original language knowledge and social experience, and by judging the principles and significance of the new teaching content through the situation or communication scene, new knowledge is constructed, and the learned content is understood and mastered. Hence, the e^3 level of JLM's instructional strategy are not balanced, with as many as 10 are the L1 level. This stands in stark contrast to the L4 effect, efficiency & engaging of the situational, communicative, cognitive, or multiple composite-dominated types.

It is widely acknowledged that the essence of the situational approach lies in facilitating learners' natural acquisition of language through situational perception. The communicative approach shifts towards functional-notional aspects, by conferring practical significance upon language learning and concentrating learners on listening, speaking, and doing behind the meaning. The cognitive approach emphasizes the meaningful discovery, comprehension, mastery, and creative application of language knowledge such as phonetics, vocabulary, and grammar. Three approaches accentuate the authenticity, sociality, and significance of language acquisition. FPI contends that new knowledge should be demonstrated and applied in specific problems, and attention should be paid to multiple perspectives, multiple levels, and appropriate progressive difficulty levels in demonstration and application. It repudiates the "reproducible" problems because the challenge of the problems should align with the mental models' learners possess, which can effectively enable learners to adjust and reconstruct their existing mental models during the process of problem-solving and enhance their skill levels. It emphasizes that learners themselves are the subject of the learning process,

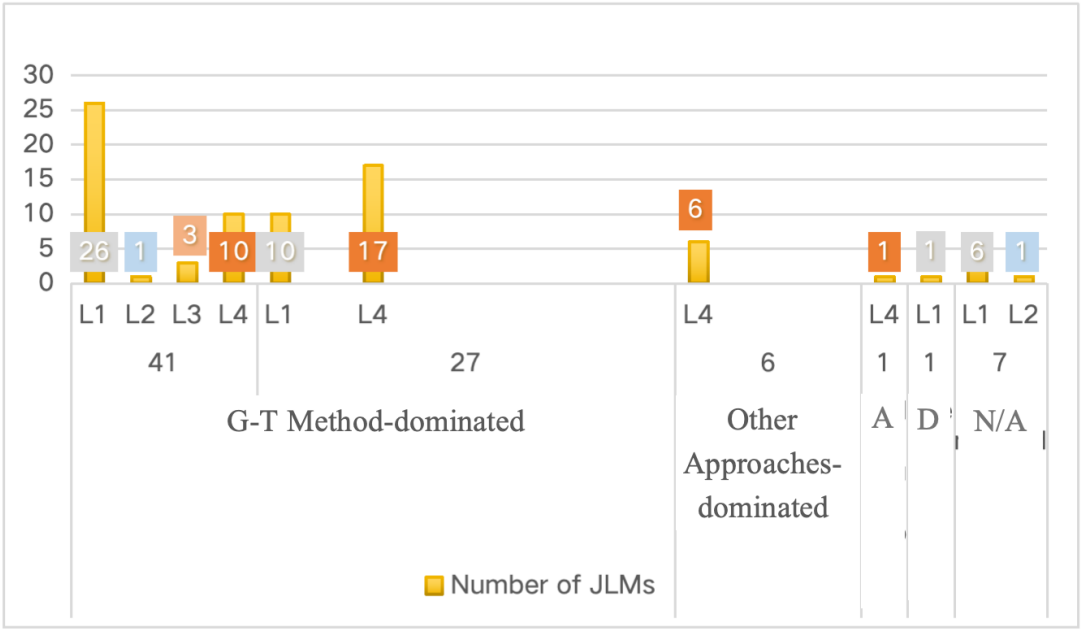

Fig. 9. Number of e^3 Levels corresponding to JLMs using different teaching approaches.

and learners must construct their own knowledge subjectively if they want to really establish their own cognitive structure and internalize knowledge into their own quality. Situational approach, communicative approach and cognitive approach are based on behaviorism, constructivism and cognitivist psychology respectively. FPI combines the strengths of cognitivist and constructivist theories, sharing many common elements with teaching approaches, so it can be verified by the validity of them. This highlights not only the importance of authenticity and social interaction in language teaching but also the critical role of cognitive activities such as understanding meaning, reasoning, and conscious thought in learning. If we recognize learning as an active and self-directed process, it becomes necessary to reflect this understanding in instructional design by integrating the contextualization of external knowledge, intrinsic motivation, and the internal reinforcement derived from the learning activities themselves.

5. Problems and solutions

5.1 Problems and deficiencies in JLMs

In JLMs using a blended teaching method, especially those with situational, cognitive, and communicative methods as the main teaching approaches for JLMs, the e^3 reached L4, indicating the consistency of these foreign language teaching approaches with the FPI in terms of teaching effectiveness, and also indicating that focusing on context and real-life communication problems to set language skills practice is effective in promoting interactive teaching and language skill acquisition.

The inspection of the FPI and foreign-language teaching approaches indicate that the main problems exposed by JLMs are as follows:

(1) The role of motivating learning with problem-solving and situations has not been brought into full play.

(2) In language teaching, there is a greater reliance on grammar explanations.

(3) The connection between old knowledge and new knowledge is insufficient, and there is a lack of matrix decomposition of knowledge in the language teaching system.

(4) The absence of multi-level and multi-perspective demonstrations and applications is notable, and human-computer interaction is insufficient.

(5) The work area and the discussion area are deficient in effective interaction; the assignment practices mainly consist of simple grammar consolidation and knowledge reproduction, with a relatively simplistic form. Learning reflection through methods such as peer discussion, peer assessment, and group tasks is absent.

Despite this, a considerable number of JLMs examined in this paper still focus on real-world problems and effectively integrate demonstration, application, and integration within the e^3 instructional design. The following is a brief description of proposition of instructional objectives and demonstration+application with problem-centered of two JLMs that have sufficient interaction representing L4.

5.2 Case one: Problem-centered to propose instructional objectives

The following shows the problem-centered instructional objectives presentation portion of the JLM titled “Practical Japanese (part 1)”, Unit 5, Conversation 1 of Daily Life on the (https: //www. icourse163. org) MOOC platform. This situational approach-led JLM shows its instructional objectives in the following way.

(1)Play a short animation video about daily life at the university as a reminder of what to study in this unit, as shown in Step 1 of Fig. 10. The video points out the overall

content of this course and indicates the learning key points: the expression of verb predicate sentences.

(2)Demonstrate the knowledge points of the learning objectives by asking questions, and highlight them in red, as shown in Step 2.

(3)Replay the video and summarize the verb phrases, highlighting the "masu" form in red, as shown in Step 3.

(4)Outline the instruction objectives subskills "masu" and summarize the main points, as shown in Step 4.

(5)Decompose the learning key points of the sub-skills of the "masu" form once more into affirmative, negative, and interrogative forms, as in Step 5.

In this display of the learning objectives, real situations and problems are incorporated, and itemized explanations are carried out through questioning and summarization. The video is not only a generalization of the instructional objectives but also multiple manifestations of the instructional content.

5.3 Case two: How to avoid demonstrating new knowledge in a grammar-translation manner and carry out progressive and interactive applications layer by layer

This case is the conversation part of "Steps in Japanese for Beginners1 Part1" lesson 03, dialog 03.1 on edX (https: //learning. edx. org/), which is the cognitive approach, the situationalapproach, the communicative approach-led model. The content of the screenshot is the phases of demonstration and application by problem-centered.

The content is based on the specific scene of lunch and revolves around how to use adjectives to describe traits. After the learner learned vocabulary and grammar, the JLM enters the conversation session. The learning of demonstrating new knowledge and its application based on the real-life scene of the question "Karaku nai desu yo" and can be decomposed into six steps.

(1)Listen, following the conversation in the scene without prompts, as shown in Step 1 of Fig. 11.

(2)Understand prompts with Japanese subtitles, indicating the main points of learning, as shown in Step 2.

(3)Speak, do language output exercises for key points as the application: watch the subtitle prompt to the role-playing dialog lines, as shown in Step 3.

(4)Remove the subtitle prompts for the parts that contain grammar rules, allow the learner to try to speak by him- or herself, and then show the complete content, as shown in Step 4.

(5)Remove the subtitles of the whole sentence and allow the learner to repeat the sentence, as shown in Step 5.

(6)With no prompt, show the conversation again and allow the learner to check and confirm, as shown in Step 6.

This JLM enables learners to learn how to express "taste" through the demonstration and key prompts of the same learning video and repeats the "application" in stages from easy to difficult. It confirms grammatical points (the affirmative and negative forms of adjectives) in application and enables learners to cognitively understand the expression rules in real-life scenarios and achieve a transfer of knowledge from cognition to skills through a demonstration-demonstration section-demonstration of the entire scenario.

The teacher never appears in the demonstration in this video; rather, it is guided by narration and subtitles to lower or increase the difficulty, mainly through the repeated prompting of the key points in the scene to help the learner complete the cognitive process.

5.4 The empirical revelations of the cases

The two teaching cases presented by the composite teaching strategies such as the situational approach, cognitive approach, and communicative approach are all dominated by the real communicative situations of language and a distinct problem consciousness, conducting demonstrations in various sub-items or multiple perspectives. They organize the application of language skills from easy to difficult, enhance human-computer interaction through questioning and application exercises, and achieve the highest level of teaching effectiveness at e^3. Briefly, both cases have deep and effective design and implementation of demonstration and application, focusing on human-computer interaction and the construction of cognitive structure in gradual situational practice. Among them, Case Two places greater emphasis on the multi-angled nature of language use in different occasions, occupations, and age groups, far exceeding the realization rate of approximately 25% of this indicator in the other 82 JLMs, and better embodies the sociality and communicativeness as the essence of language.

6. Conclusions

Through empirical evidence, this paper finds that although we are in the midst of the transformation to digital intelligence in the digital age, the ID of JLMs are still difficult to completely get rid of behaviorism in knowledge transfer. They lack sufficient focus on problem-based demonstrations and the application of language skills in instructional design, as well as an adequate emphasis on fostering learners' awareness of their proactivity and capabilities during the learning process. Moocs are aimed at groups with different levels of learning needs, learning levels and intelligence characteristics. To this end, learners are regarded as the subjects of learning, combined with the characteristics of foreign language acquisition, and based on instructional design theories, on the one hand, we should focus on improving the design and quality of problem-oriented skill practice and peer interactive learning, and establish a good interaction between learners and between learners and teachers. On the other hand, by creating such a learning process, to support learners building the ability and subjectivity of acquiring knowledge subjectively. Digital intelligence education presents unprecedented challenges to platform technology, teachers, and learners. Perhaps when digital courses have developed to the stage of AI, leveraging technologies such as Natural Language Processing (NLP), Machine Learning, Deep Learning, Knowledge Graphs and Semantic Networks, Data Mining and Learning Analytics, as well as Human-Computer Interaction (HCI), AI can automatically generate course frameworks and highly adaptive

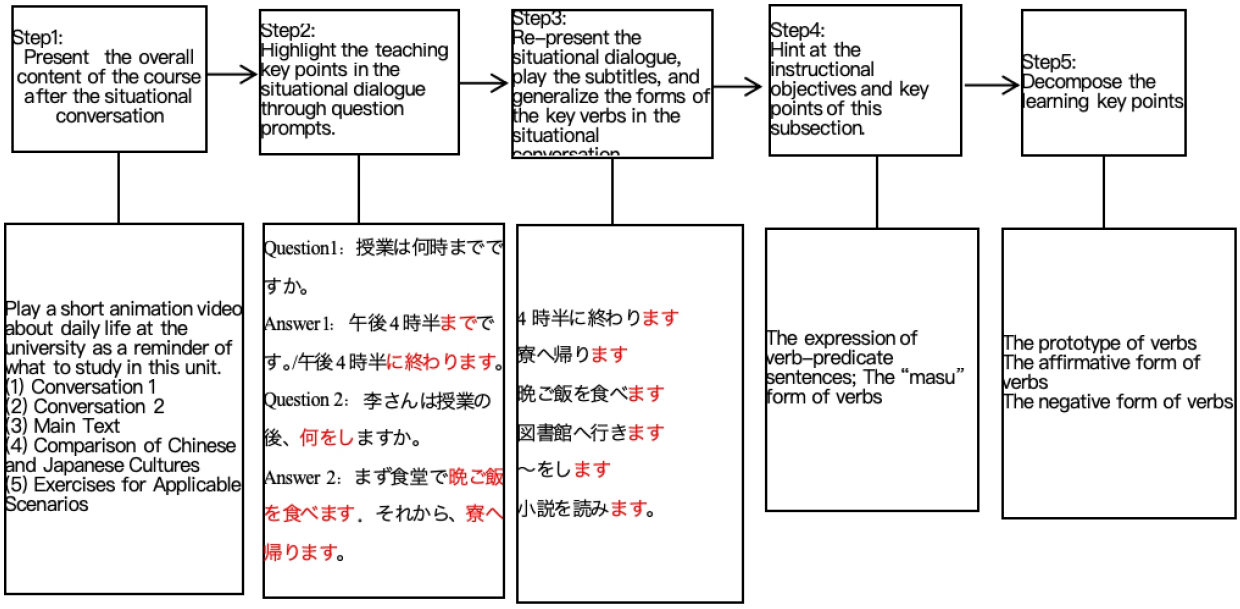

Fig. 10. Problem-centered Instructional Objective Decomposition.

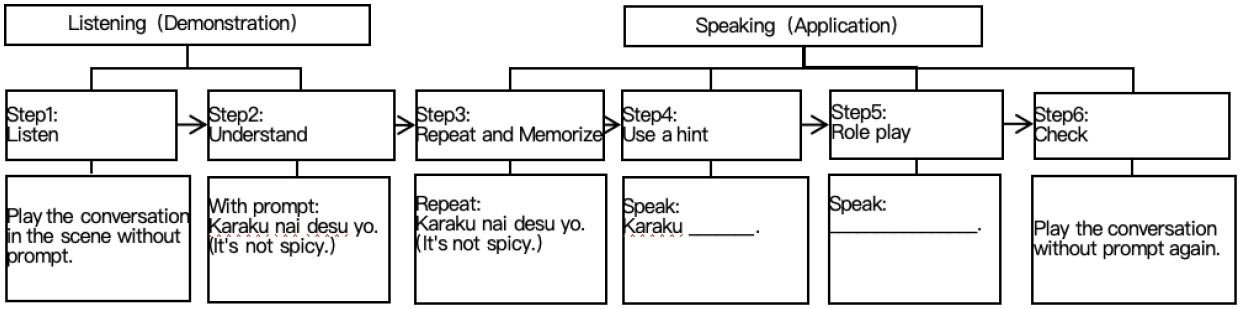

Fig. 11. Unification of composite foreign-language teaching approaches and demonstration & application.

teaching content, offering learners optimized and dynamic learning support. Nevertheless, a learner-centered instructional approach and ID theory remain indispensable prerequisites for its realization. This is not only aligns with the inspiration provided by the FPI proposed by Merrill, the father of automated instructional design, but also may provide useful ideas for AI-driven transformation of digital intelligence courses.

Conflict of interest

The authors declare no competing interest.

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