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Design and Empirical Study of PSC Course Model Based on AI Program

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Abstract

With the development trends of reform and opening up, modernization of education, and globalization of the economy, the importance of teaching Mandarin proficiency test (PSC) has become increasingly significant. At the same time, the development of course models for Mandarin proficiency test systems assisted by computer networking, AI technology, and mobile applications has emerged. Existing offline and online course platforms suffer from issues such as unsuitability of form, poor interactivity, and lack of universality, which hinder the widespread implementation of PSC courses. In light of this, based on thorough investigation and research, this paper, taking the "Special Textbook for Mandarin Proficiency Test" as a blueprint, combined with Mandarin teaching theory, designed and developed a PSC course model based on AI programs. The learning effectiveness of this model was experimentally tested, and statistical research methods were used to compare and analyze the experimental data. The experimental data showed significant improvement, which was in line with the expected results.

Keywords: Online Platform; PSC; Teaching Model; Empirical Research

1 THE NECESSITY OF DESIGNING PSC COURSE MODELS

With the continuous development of society and the increasing frequency of interactions between countries and regions, there is a growing emphasis on promoting Mandarin proficiency. The National Language Commission stipulates in the "Decision on Carrying out Mandarin Proficiency Test Work" that "mastering and using Mandarin at a certain level is a necessary professional quality for personnel in various industries, especially teachers, broadcasters, program hosts, actors, and other professionals." (National Language and Script Work Committee, Putonghua Training and Testing Center, 2004) Therefore, it is necessary to conduct Mandarin proficiency tests for personnel in certain positions within a certain scope. Currently, Mandarin, as a nationwide language, has entered an unprecedented stage of rapid and orderly development in terms of teaching and promotion. "The PSC Testing Centers in China have generally implemented computer-assisted Mandarin proficiency test systems, marking the transition of Mandarin proficiency testing work into a more scientific, standardized, and normalized era." (Li & Yin, 2007) "The significant change in the form of Mandarin proficiency testing represents a leap in the modernization of testing methods." (Chen, 2013) With the development of intelligent terminal-assisted testing systems, Mandarin courses and self-learning platforms need to develop in accordance with the needs of the times. Therefore, the trend of designing PSC course models based on AI programs is increasingly evident.

PSC has received increasing recognition and attention from the entire society. "In recent years, it has become possible to use continuously developing information technology, the internet, and speech recognition technology to address the issues of Mandarin promotion." (Long & Chen, 2013) Among them, modern educational technology models based on the principle of interactive teaching are quite representative. Research on interactive language teaching has been conducted abroad, such as G. Wells and Wilga M. Rivers' theory of interactive teaching, which believes that "the interactivity of language is a cooperative activity that involves establishing relationships among the sender, receiver, and situational context of language use." (Wilga M. Rivers, 2000)(Wells et al., 1981) The effectiveness of the curriculum is currently a hot topic in language teaching. "Effectiveness talks about two aspects: whether the activities achieve results, and how the situation of achieving results is, whether there is a good match between the time and effort invested and the final output." (David Nunan, 2000) Currently, research on the effectiveness of interactive modes in PSC course training is in its infancy, but research and development on the interactive modes of remote training for PSC courses based on AI programs have not yet begun.

Based on the above, this paper proposes the design of a PSC course teaching model based on AI programs. With the support of network-based remote technology, it addresses the problems of limited coverage, short training time, single training content, and high training costs in traditional classrooms. In contrast, the PSC course model has the advantages of wide coverage, rich teaching resources, and rapid dissemination. It emphasizes multimedia assistance, comprehensiveness, and targeting. Learners can achieve resource sharing, learning exchange, and business discussions, etc., with bidirectional network service functions for teaching and learning.

2 RESEARCH ON PSC COURSE MODEL DESIGN

2.1 Survey on the Design Requirements of PSC Course Models

Survey Participants: Students and faculty from universities in Shanghai (Shanghai Normal University, Shanghai University of Finance and Economics, Shanghai University of Sport), totaling 126 individuals, including 71 females and 55 males. The age range is between 18 and 43 years old. Among them, 89 participants have never used Mandarin intelligent-assisted teaching platforms, while 37 have some understanding of them.

Survey Results: 93.41% of respondents believe that the learning process lacks systematic and orderly structure and requires the assistance of relevant teaching models. 92.5% of respondents believe that intelligent teaching models play a crucial role in learners' autonomous learning.

2.2 Object Analysis and Training Analysis

(1) Object Analysis

Object analysis and material analysis should be based on a thorough investigation and research of the target audience, guided by the principles of linguistic teaching, centered around the PSC course outline, and starting from the actual needs of students to design the course model. PSC course learners mainly consist of in-service teachers, students, civil servants, and individuals from various social sectors who have a demand for Mandarin proficiency. Their pronunciation is generally moderate to moderately substandard, and the learning duration is 20 days, making it a short-term training course.

(2) Analysis of Learners' Phonological Characteristics and Course Design

The experimental subjects come from different provinces across the country, with a majority from the Shanghai area. This paper compares the Shanghai learners with Mandarin phonetics, representing the largest group.

The pronunciation of initials and finals in Mandarin is crucial. Learners in this region mainly make two types of errors when pronouncing vowel sounds: they are confused by similar sounds, leading to mispronunciations, or they substitute local dialect sounds for the unique phonetic elements of Mandarin. For example, common errors include pronouncing "r" as "l," insufficient articulation of compound finals, and confusion between similar sounds (such as "ou-e," "u-uo," "ie-i," "ian-i," "an-ai," etc.). To address these issues and common patterns, an AI intelligent model has been designed to simulate specialized exercises for initials and finals and exercises with typical words. In the specialized exercises, correct pronunciation, articulation position, and methods are demonstrated to correct pronunciation errors. In the exercises with typical words, learners practice pronunciations linked to corresponding initials and finals. For instance, exercises for "n," "l," and "r" initials use words like " 牛 " (niú) and " 刘 " (liú), " 陋 " (lòu) and " 肉 " (ròu) as examples.

Mandarin has four tonal categories, denoted in a five-tone system: first tone (55), second tone (35), third tone (214), and fourth tone (51). The difficulty for Shanghai learners in Mandarin tone learning lies in distinguishing and accurately pronouncing the tone categories. Shanghai dialect generally falls into five tone categories, represented in a five-tone system as follows: first tone (53), second tone (35), third tone (13), fourth tone (55), and fifth tone (13). The underlined tones indicate entering tones, which are short and sharp. Based on this, an AI intelligent model simulates and designs a specialized tone training section aimed at correcting learners' mispronunciations. The model teaches the principles of pronunciation using the five-tone marking method, and demonstrates correct pronunciation methods through graphics, animation, and links to accurate pronunciations.

2.3 Course Content Design

(1) Theoretical Foundation of Course Content Design

The remote assistance of intelligent terminals is based on constructivist learning theory. Constructivist learning theory posits that learning is an active construction of knowledge meaning by learners through their interaction with learning content, based on their existing knowledge framework. This theoretical model explicitly recognizes learners as the subjects of learning and emphasizes learner-centered active knowledge construction suitable for learning activities in autonomous and networked environments. Constructivism emphasizes learners' social interactions, problem-solving in "real" environments, and the personal and stylistic construction of knowledge based on their experiences and backgrounds. It represents a curriculum form with contemporary characteristics, inheriting the excellent achievements of traditional education while reflecting the changes in modern educational trends.

(2) Module Design

Based on the Mandarin Proficiency Test outline and teaching materials, and considering the training hours and the proficiency level of the trainees, the model is designed with the following six modules:

National Language and Writing Policies and Regulations Training Module: Emphasizing the introduction

of the "National Common Language and Writing Law" and the "Mandarin Proficiency Test Outline," and providing links to other regulations and documents. The platform completes page interactions with a well-structured navigation link, forming a multimedia training platform that integrates speech, text, animation, and other media formats. This module adopts the theory of "material-driven" teaching, focusing on the input of teaching materials, and selects targeted and timely regulations and policies from a variety of related regulations and policies to guide the training.

Introduction to Phonetics Module: Introducing phonetic theory, phonemes, and other phonetic elements, as well as the physiological and social attributes of phonetics, primarily presented through text, images, AI intelligence, and animation. According to the structural knowledge theory in constructivism, structural knowledge refers to fundamental concepts and principles abstracted from various situations that possess normative and internal logical systems. Phonetic summaries mainly focus on theoretical knowledge and belong to the category of structural knowledge. Therefore, in the simulation design process, attention should be paid to visualizing and dynamizing abstract phonetic knowledge and using rich materials to make it vivid and concrete.

Learning Module of Initials and Finals: Based on common pronunciation errors in the region (such as the omission of the initial "i" when pronouncing the "qi" rhyme, and the omission of the initial "u" when pronouncing the "he" rhyme), the module uses AI intelligent disassembly technology combined with correct pronunciation tongue position diagrams and audio, along with incorrect tongue position diagrams and audio for error comparison. This module is designed in conjunction with task-based teaching methods, with a series of specific exercises designed for teaching. Learners complete these activities using the target language, focusing more on the meaning of the language than on its form during the task completion process, thereby achieving the teaching goal of practice.

Tone Learning Module: Based on common issues in Mandarin learning regarding tones among learners in the region, this module involves pronunciation practice of different tone values in reading exercises. It is accompanied by animations and correct pronunciations for demonstration and guided reading, integrating audio, video, and images. Constructivism suggests that learning in context allows learners to assimilate current knowledge using experiences from existing cognitive structures. This module incorporates tone symbols, represented by five-degree marks, and combines abstract knowledge with specific visual scenarios through AI technology, achieving teaching objectives through interaction between individuals and visuals.

Reading Aloud Module: Demonstrating reading aloud through text, interactive dialogues, and accompanying audio of correct pronunciation, this module allows for pause and replay, facilitating repeated practice. The platform incorporates practice modules at appropriate intervals, such as tests on basic phonetic knowledge, pronunciation principles, and reading essentials Q&A, utilizing different methods for different knowledge points to create a conducive learning environment and enhance learning effectiveness. Contextual design in course content development primarily focuses on creating real and simulated task environments. After outlining the key points for reading, providing students with standard and authentic reading recordings as much as possible can enhance student interest in learning. When constructing the network teaching support environment, emphasis should be placed on developing interactive modules for students, allowing them to easily adjust speech rate, volume, pause points, etc., during oral practice.

Speaking Module: Based on topics and scope provided by the Mandarin Proficiency Test outline and in consideration of the test scenario, this module designs speaking outlines and templates, allowing learners to combine modules fully during the testing process and efficiently complete speaking tests within the allotted time. Constructivism emphasizes the learning of non-structural knowledge, which refers to knowledge formed in specific contexts, directly associated with those contexts, and informal and unregulated. The focus is on "implicit learning."(Zhang, 2000) In the design of this module, interaction design, function switching, module combination, and other means are utilized to achieve interaction between the model and learners, enabling learners to immerse themselves in the environment, master methods of creating modules suitable for themselves, and achieve "implicit learning" of non-structural knowledge.

The above six modules fully apply constructivist principles, achieving interaction between the model and

learners, focusing on learner-centeredness, reflecting personalized autonomous learning, driving learning through problem-centeredness, and creating a conducive atmosphere for language learning.

2.4 Teaching Model System Design

Teaching model design based on AI programs should be guided by intelligent terminal technology, combined with specific teaching objectives, content, methods, and objects, to reasonably select and design teaching media information, forming an organic integration between the two.

The internal design of AI programs incorporates various forms of multimedia, allowing anatomical cross-sections of the human body to be clearly displayed in a three-dimensional, vivid, and intuitive manner, enabling learners to quickly transition from perceptual to rational understanding of pronunciation organs. "Using 3D animation and simulation graphics technology to enlarge and slow down key parts, showcasing the activity mechanisms, motion states, and direction of airflow of each organ from different sides, directions, and angles,"(Peng, 2008) allows learners to transform imagination into imagery, abstraction into specificity, and combine text with images and sound, facilitating accurate grasp of the structure and movement of each organ in the pronunciation system.

(1) Selection of Media Information

The media resources of the intelligent model include the following aspects: a Text—The single-syllable words, polysyllabic words, and short passages for reading in this model are all based on the requirements of the Mandarin Proficiency Test outline. b Linear Media—Transforming knowledge difficulties into visual representations, clarifying pronunciation principles, and completing the transformation from theory to practice. c Streaming Media—Playing recordings of test works demonstrated by announcers; playing the pronunciation of vocabulary items for students to reinforce through repetition. dAudio Media—Recording one's voice and comparing it with demonstration materials to help learners correct deficiencies. e Combined Streams—Allowing learners to hear sounds while understanding the movement of pronunciation organs such as lips, teeth, tongue, and palate during pronunciation.

(2) Development Tool Selection

Currently, the intelligent model utilizes PaddlePaddle, a deep learning platform, which is used to create interactive programs integrating various forms, contents, styles, and interactive streaming media. PaddlePaddle is an intelligent development and creation tool with superconductive applications. It can integrate proprietary symbols that cannot be recognized or embedded by ordinary software, and the operation process only requires calling icons to control the flow of the program. PaddlePaddle has the following characteristics:

a It adopts highly optimized parallel computing technology, enabling rapid model training and inference, and achieving better performance.

b It supports multiple programming languages and hardware platforms, providing a rich library of deep learning models and tools to meet the needs of different users.

c It incorporates various security features such as data privacy protection and model confidentiality to ensure the security of user data and models.

d It can be used in natural language processing tasks such as text classification, sentiment analysis, and machine translation.

e Learning Management System (LMS) Knowledge Objects.

f One-Button Publishing to Learning Management Systems.

Based on these characteristics, we use PaddlePaddle to complete model production and fully leverage its advantages.

3 DEVELOPMENT OF PSC COURSE MODEL

3.1 Background Design

The background design mainly relies on the model framework provided by AI intelligent programs and is specifically designed according to different course content and teaching methods. Leveraging the high-quality templates provided by PaddlePaddle, specific teaching requirements are processed and produced. The design of the teaching model should strive for clear sections, concise navigation, clear lines, and reasonable color coordination, utilizing the advantages of multimedia integration on the web to stimulate learners' interest in learning.

3.2 System Integration

As shown in Figure 1, the model is divided into three major levels: the overall cover, the cover of each section, and the content of each section. Each section includes sub-contents and corresponding exercises.

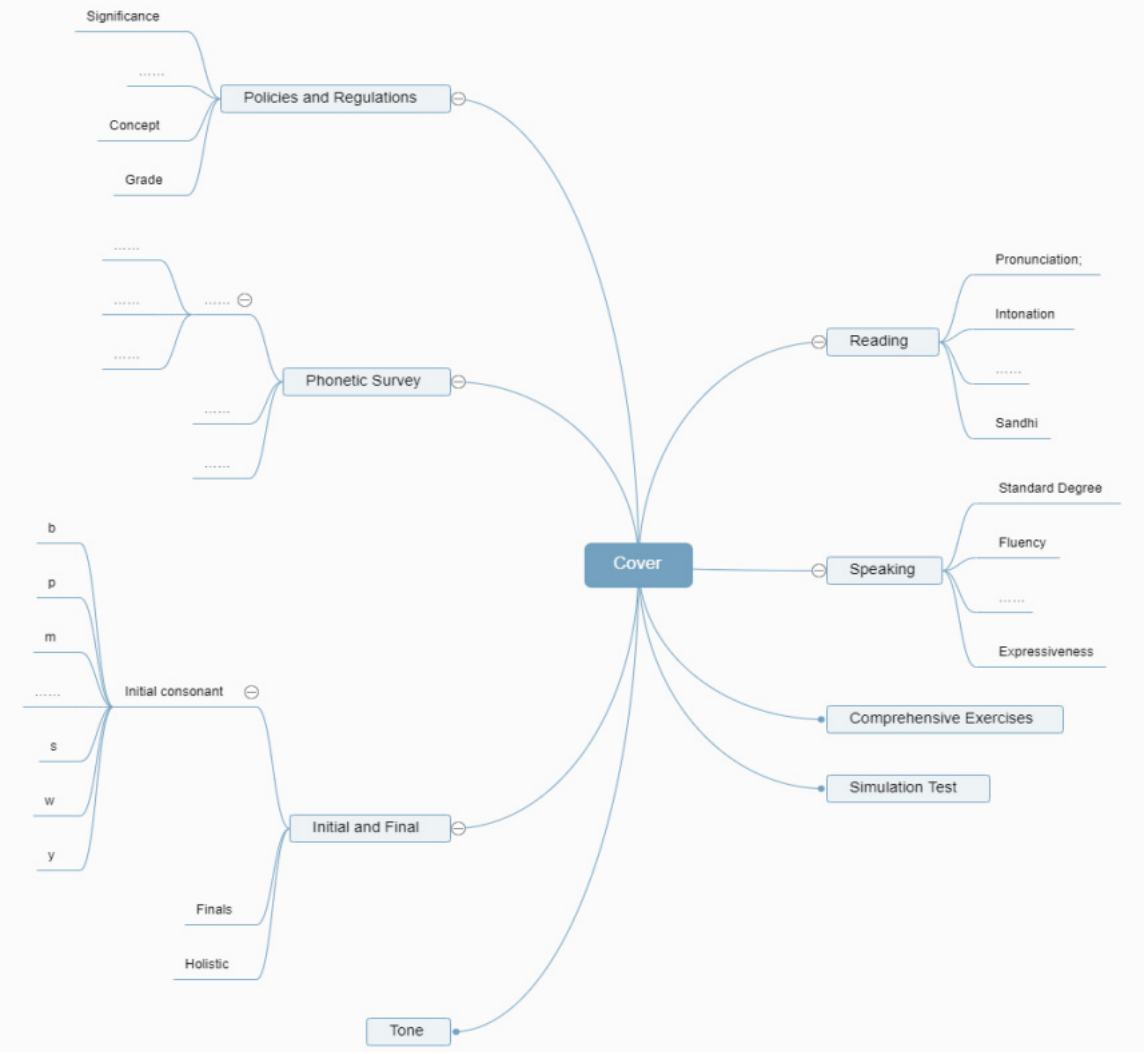

Figure 1 Model Structure Diagram

3.3 Navigation Design

The significance of navigation design lies in guiding users of AI intelligent models to perform specific practical operations quickly and accurately, achieving barrier-free operation, and enabling free navigation between various course information to enhance learning efficiency. This design both leverages the powerful

interactive functionality of intelligent media and facilitates rapid cognition by learners. The clear and concise navigation design in the model provides learners with a clear learning path.

The design of the main interface navigation is coordinated with the overall model design. The main interface navigation displays the six major learning modules and two auxiliary modules of the teaching model, along with their corresponding module names. Clicking on a module name will take the user to the corresponding module cover.

4 PRACTICE VERIFICATION

The effectiveness of the course model is assessed based on its impact on learners' performance. We conducted a 20-day experimental test on students enrolled in the Putonghua Proficiency Test (PSC) class. After the completion of the teaching content, we conducted computer-assisted Putonghua proficiency tests (machine tests) following the standard PSC examination process to understand the impact of the course model on learners' performance.

4.1 Performance Test Analysis

(1) Test Subjects: 120 students majoring in general humanities, science and engineering, and arts and sports-related disciplines at Shanghai University of Sport were randomly divided into two groups: an experimental group and a control group, with 60 students in each group.

(2) Testing Method: All learners in the experimental and control groups underwent a 20-day Putonghua proficiency test teaching. The control group used traditional classroom teaching and post-class independent review, while the experimental group introduced AI-intelligent PSC course models into teaching and engaged in independent learning using intelligent models after class. After the teaching phase, a unified PSC test (machine test) was conducted on both groups of students, and statistical analysis was performed on the data using methods such as t-tests.

Table 1 Descriptive Analysis of Overall Performance: Group Statistics

	Group	N	Mean	Std.Deviation	Std.ErrorMean	Pass Rate（≥60）	Excellence Rate（>80）
Score	Experience Group	60	89.168	3.4249	0.6850	100%	100%
	Control Group	60	85.468	3.7748	0.7550	100%	84%

Table 1 visually displays the mean, standard deviation, standard error, pass rate, and excellence rate for both the experimental and control groups.

With 60 participants in each group, the analysis reveals that the experimental group's mean of 89.168 is higher than the control group's mean of 85.468. The standard deviation indicates that the experimental group exhibits better stability than the control group. The size of the standard error reflects the magnitude of the sampling error, with smaller values indicating better accuracy. In this case, the experimental group's standard error of 0.6850 is smaller than the control group's 0.7550, indicating that the experimental group has a smaller sampling error, suggesting better overall performance. Both groups achieved a pass rate of 100%. It's worth noting that the PSC exam differs from typical tests; under standard testing procedures, most candidates achieve a passing grade or higher, resulting in a relatively stable distribution of scores within a certain range. However, strict proficiency requirements exist for higher score ranges. Therefore, the 100% pass rate in both groups reflects a normal score distribution pattern. The excellence rate in Table 1 is 100% for the experimental group and 84% for the control group, indicating a significant superiority of the experimental group over the control group.

Table 2 Independent Samples Test

	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	.144	.706	3.630	48	.001	3.7000	1.0194	1.6504	5.7496
Equal variances not assumed			3.630	47.553	.001	3.7000	1.0194	1.6499	5.7501

Levene's Test is a robust method for testing homogeneity of variances. The results above show that F=0.144, P>0.05, indicating homogeneity of variances. For data satisfying both homogeneity of variances and normality, t-tests can be used to compare differences between the two groups, as shown in Table 2. The t-value is 3.630, P<0.01, indicating rejection of H0 and acceptance of H1 at the 0.01 level, suggesting that the score difference between the experimental and control groups is statistically significant. Additionally, the mean difference between the two groups is 3.7 points, with a 95% confidence interval for the population difference of [1.65, 5.75], indicating a maximum population difference of 5.75 points. Based on this data, it can be concluded that there is a significant difference in performance between the two groups, implying that the PSC intelligent course model has a significant effect on improving scores.

4.2 Analysis of Module Scores

The modules consist of reading monosyllabic words, reading polysyllabic words, reading texts, and thematic speaking. The test is designed to be completed in approximately 13 minutes. The exam closely follows the textbook content and evaluates learners' proficiency in Mandarin phonetics, vocabulary, and grammar, demonstrating good reliability and validity.

Table 3 score distribution of each module

	Name	Percent	Time	Experience Group	Control Group	Core points of module evaluation
1	Monosyllabic word	10%	≤3.5 min	88.31%	85.59%	Standard degree of initial consonants, finals and tones of monosyllabic syllables
2	Polysyllabic words	20%	≤2.5 min	87.28%	84.03%	Including 1 and the standard degree of tone sandhi, neutral tone and ER
3	Paragraph reading	30%	≤4.0 min	83.20%	78.31%	Including 1.2 and focus on continuous tone change, pause, intonation and fluency
4	Propositional speech	40%	≥3 min	81.31%	74.64%	It includes 1.2.3, and the level of speaking Putonghua without the help of words. It focuses on the degree of phonetic standard, vocabulary,grammar and fluency

Table 3 shows the average scores of students in the experimental group and the control group in each module. In the four modules mentioned, Modules 1 and 2 primarily assess Mandarin phonetics, including initials, finals, tones, and tone changes. There is a slight difference in the average scores between the experimental and control groups. In Modules 3 and 4, there is a significant difference in scores between the control group and the experimental group, as these two testing sections tend to evaluate learners' overall language proficiency. Students in the experimental group utilize the PSC course model in both regular teaching activities and

self-directed learning, providing a more systematic and standardized language learning environment. Particularly in the thematic speaking section, the difference in scores between the two groups is most significant, indicating that the intelligent course model has a positive effect on improving learners' language expression and communication skills. The experimental group outperforms the control group in all testing sections on average, demonstrating the positive role of the course model throughout the learning process.

4.3 Questionnaire Analysis

The questionnaire consists of two main parts: the first part collects some personal background information of the participants, such as age, name, gender, educational background, etc. The second part focuses on the participants' learning experiences and their suggestions for improving the model.

(1) Participants' Interest and Motivation in Engaging with the Teaching Model

In terms of participants' interest in engaging with the AI intelligent Mandarin training course model design practice research, it is evident that participants generally have a high level of interest in this teaching activity. Specifically, 50% of the participants indicated being "very interested," while 35% indicated being "quite interested." Additionally, 90% of the participants expressed a desire to continue with this teaching activity. This indicates that this activity not only helps to stimulate learners' interest in learning but also encourages them to stay motivated. Practical experience has shown that the success of integrating AI technology with traditional courses depends on whether it can stimulate students' interest in learning.

(2) Participants' Communication and Psychological States

From the survey, we found that 94% of the learners feel that compared to traditional courses, their feelings of anxiety have significantly decreased. The AI-based course model has made them feel more relaxed psychologically, leading to a noticeable increase in their willingness to speak and an improvement in their confidence. This undoubtedly stimulates students' interest in learning.

(3) Evaluation of Course Model Design

The evaluation results of the course model design by the participants mainly include: the degree of integration between the model and the course content, with 95% of the students expressing satisfaction; the interface design of the model, with 90% of the learners considering it culturally rich, capable of driving teaching through culture, and the design highlighting elements of Chinese culture is in line with the learners' needs; the convenience of the model's link paths, with 91% of the learners stating it is easy to use and operate; and the evaluation of media information, such as image quality and audio clarity.

(4) Improvement of Skills

The fundamental purpose of designing a course model is to improve learners' abilities. Through the survey, it was found that among students who used this course model for learning, 42% and 49% respectively reported a "significant improvement" and "certain improvement" in their Mandarin proficiency. This survey indicates that the model has a certain complementary effect on traditional course teaching and can help students improve their language proficiency and usage skills. The survey results also show that 69% of students believe that the model has helped improve their reading proficiency. Mandarin proficiency teaching is a comprehensive endeavor, encompassing various abilities. This model, to some extent, meets these requirements.

5 CONCLUSION

This paper has made preliminary exploratory attempts at the design of the PSC course model based on application programs, achieving the comprehensive application of various course strategies. After the tests and empirical studies mentioned above, we will make revisions and improvements based on feedback to achieve better results. However, it should be noted that the application-based course model is essentially a tool and a teaching method, and the leading role of teachers still plays a decisive role in the effectiveness of Mandarin teaching. Therefore, understanding the role and positioning of online course models is a prerequisite for utilizing intelligent media effectively and should be given attention.

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