DESIGNING AI-ENHANCED TEACHING PRODUCTS FOR UNIVERSITY OMO CLASSROOMS

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ABSTRACT
The purpose of this paper is to study the current situation of the OMO (Online-Merge-Offline) teaching model in universities and propose solutions. Although there are numerous studies on the analysis and design of OMO learning environments, few have assessed their effectiveness from the perspective of enhancing design quality. Based on the Social Presence Theory and Quality Function Deployment method, the study identifies the pain points and needs of university students and teachers in the OMO model and conducts functional transformation of user needs in terms of offline terminals and online teaching platforms. The paper presents a set of OMO classroom AI-enhanced teaching interaction products that can improve teaching convenience, presence perception, and student engagement. These products aim to provide a reference for improving OMO teaching interaction quality and applying emerging technology in real-world scenarios.

Keywords: Online-merge-offline (OMO) classroom, AI-Enhanced interactive classroom products, Quality Function Deployment (QFD), KANO-model, social presence theory

1 INTRODUCTION
With the rapid development of information technology, the education industry is experiencing unprecedented changes. OMO (Online-Merge-Offline) teaching mode is playing an increasingly important role in the field of engineering and design education and updates the demand for educational interactive products. From the perspective of improving design quality, the purpose of this study is to provide an in-depth analysis of the status of the OMO teaching model and to explore how to optimize the design of instructional products through the integrated application of AIGC (Artificial Intelligence Generated Content) technology. Figure 1 shows the research framework and technical route of this paper.

During the research process, we started with the analysis of our design object, using QFD (Quality function deployment) and KANO-model which can help satisfy the requirements, reduce changes, and decrease the design period to identify the user needs. AIGC was used as a tool to help realize the goals and functional iterations while performing the PDCA(Plan–Do–Check–Act) cycle, and the final design outcome is an educational product that meets the needs of the OMO.

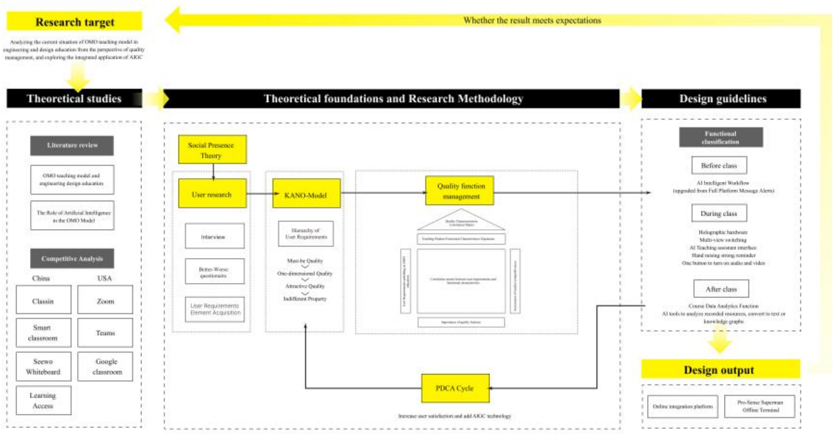

Figure 1. Research framework and technical approach

2 LITERATURE REVIEW

OMO teaching mode is student-centred, to open up various structures, levels and types of data in online and offline, virtual and real learning scenarios through technological means, to form a scene ecology of online and offline fusion, and to realize a new teaching pattern of personalized teaching and services [1]. Currently, OMO teaching and learning in universities are mainly carried out by online live platforms (such as *Zoom* [2], *Teams* [3], and *Classin* [4]), offline assistive products (such as *Smart Classrooms* [5], *Seewo Whiteboard* [6], and teaching support platforms (such as *Learning Link* [7] and *Google Classroom* [8]). However, OMO teaching paradigms in engineering and design education confront many problems, such as how to keep online and offline teaching content coherent and promote student interest and effectiveness from online learning. In addition, engineering and design education requires the teaching model to develop students' innovative and practical abilities as well as knowledge, which raises OMO model implementation requirements.

Technology advancements and hybrid teaching methods have led to the use of various products to support OMO teaching. Along with established tools like smart classrooms, cloud classrooms, and teaching apps, newer technologies such as virtual reality and digital twins are also being incorporated into hybrid teaching. Gu Yanhua et al. [9] investigated the application of virtual simulation technology in hybrid teaching using college courses as a case study. They developed a virtual simulation practice teaching system and demonstrated that virtual simulation teaching positively impacts teaching effectiveness through practical application. Chai Huifang et al. [10] developed a smart classroom framework with different layers and applied it to university settings to improve smart classrooms in the "post-epidemic era".

Meanwhile, AI technologies provide new ideas to solve the problems in the OMO teaching model. AIGC can generate personalized learning resources based on students' learning data to enhance the interactivity and relevance of online learning. For example, by analysing students' online learning behaviours and performance, AIGC can automatically recommend learning materials suitable for students' levels or generate targeted practice questions.

3 THEORETICAL FOUNDATIONS AND RESEARCH METHODS

3.1 Social Presence Theory

The social presence theory has its roots in the Community of Inquiry (CoI) model proposed by Garrison in 1999 [11]. The CoI model proposes a theoretical model for sustaining the teaching and learning experience in higher education as it moves into a computer-mediated environment and states that the teaching and learning experience is comprised of three essential elements: cognitive presence, social presence, and teaching presence.

3.2 Quality function deployment (QFD)

QFD is mainly composed of two major parts: Quality Deployment and Function Deployment. Within the framework of QFD, KANO-model was introduced to determine the impact of the presence or absence of different product features on the ultimate satisfaction of users. The Kano model is designed to understand the relationship between the performance of product features and the subjective perception of the user through a questionnaire. Through better-worse coefficient calculation, the quality characteristics of the product are classified into Must-be Quality, One-dimensional Quality, Attractive Quality, and Indifferent Quality. It is to differentiate the positioning of different features in the product and to be able to optimize the product iteration and upgrading based on this feature [12].

3.3 Quality Management PDCA Cycle

The PDCA cycle, also known as the Deming Cycle, is a management method for continuous improvement, which consists of four consecutive phases: Plan, Do, Check and Act. In this study, the PDCA cycle is mainly used to combine the development of modern technology to Cyclic the part of user satisfaction, to realize the iterative upgrading of functions.

4 NEEDS ANALYSIS

4.1 Interviews to Obtain User Requirements

In OMO education, teachers, online students, and offline students are the main users of teaching products and have different needs. This study conducts demand interviews with four teachers (3 females and one male, who have rich experience in teaching foreign languages in universities) and students (2 females and two males, who have experience in OMO learning) with different backgrounds. By analysing the content of the interviews, we initially obtained the users basic needs of the OMO teaching process.

4.2 Categorizing User Requirements Using the KANO-Model

A user satisfaction questionnaire based on user requirements elements was created and distributed to the target users. Based on the valid questionnaires (n=33), combined with expert interviews, users were asked about their satisfaction with the function from both positive and negative aspects. The Better-Worse coefficients of each function were obtained after calculating the data (see Figure 2 for the calculation method). A coordinate system is drawn with the absolute value of Worse as the horizontal axis and Better as the vertical axis. The coordinate system is partitioned with the intersection of the mean of the absolute value of Worse and the mean of Better (0.220, 0.445) to obtain the Better-Worse matrix [13] for the classification of the demand attributes, as shown in Figure 2. In the design of the subsequent products, the priority order Is ①Must-be Quality, ②One-dimensional Quality, ③Attractive Quality, ④Indifferent Quality.

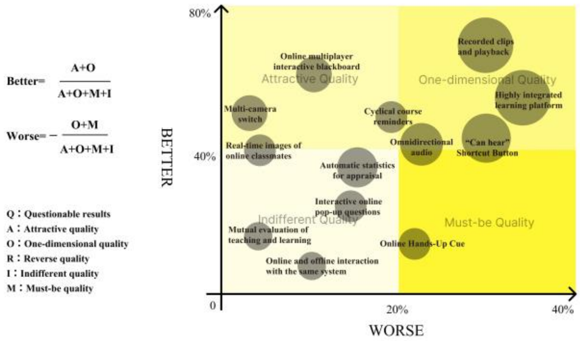

Figure 2. User needs distributed on KANO-Model

4.3 Functional characterization using QFD methods

After analysing the user requirements by KANO-Model, we got the categorization of the demand attributes and the satisfaction grading of the teachers and students in the OMO experience. According to the theory of social presence it decomposes and transforms the needs and gets the functional characteristics. Further, using the QFD method, we constructed a quality house. Through the quality house analysis, the functional matrix of the relationship between functional characteristics and user requirements is obtained (as shown in Figure 3). For example, one of the user's needs, the real-time image of an online classmate, has a strong correlation with a target score of 5 for the function-OMO holographic hardware.

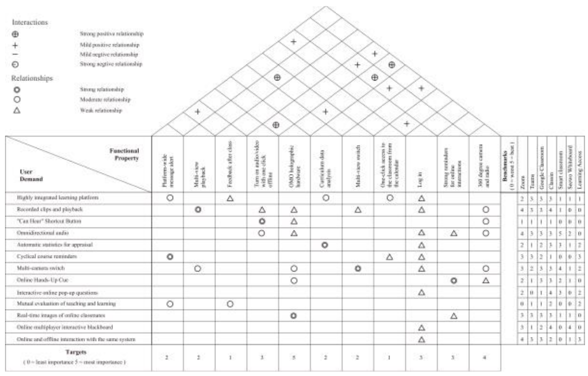

Figure 3. OMO Quality House Modelling

The results of this study provide a reference for the main functions of teaching product design in the subsequent OMO teaching model. Platform-wide message alert、Multi-view playback、 Turning on audio/video with one click offline, OMO holographic hardware, Curriculum data analysis, Multi-view switch, and Strong reminders for online interactions, which are strongly related to user needs will be focused on in the subsequent design. At the same time, the other functions will not be innovated based on simple design.

5 INTELLIGENT DESIGNING OF AI-ENHANCED PRODUCTS

5.1 Constructing Product Design Objectives

We first sorted out the general OMO class process and drew a flowchart from the perspectives of three participants: online students, offline students, and teachers; from the three aspects of time: before, during, and after class (un-highlighted part of Figure 4).

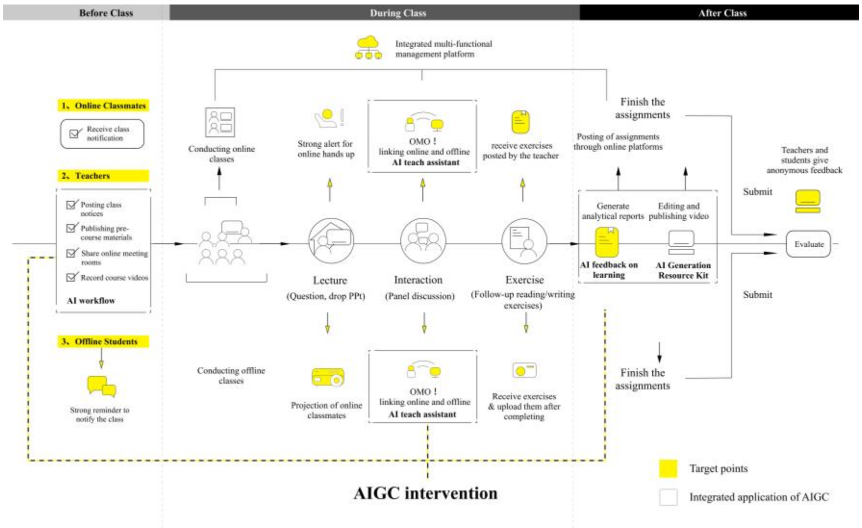

Figure 4. OMO Teaching Model Complete Objective Process

Then, the research team designed a specific kit for OMO class, named OMO! Pro-Sense Superman OMOPSS）. It consists of an offline companion terminal and an accompanying online integration platform. The design objectives of this kit for different subjects in the OMO classroom are mainly shown in Table 1. These objectives were then implemented into specific aspects of the OMO classroom (shown in the highlighted part of Figure 4).

Table 1. Summary of functional design objectives

Target Group	Goal	Solution
Teacher	Balance the difference in their focus on online/offline classmates	Real-time holography, presenting images of online classmates
		Distance design, individual control terminals
		Strong reminders for online student questions
Online student	Make it an immersive classroom experience	Self-adjusting omnidirectional camera
		Personalize the perspective of your lessons.
Offline student	Reduce the difficulty of their interactions with their online classmates	Real-time holography to facilitate group discussions
		Monolithic matching to move the corresponding terminal on demand

5.2 PDCA Cycle for Function Iteration

After arriving at a preliminary list of features, the research team re-examined the reasonableness of each feature and iteratively upgraded it by using the PDCA cycle method to combine AI technology with some of the features (See Figure 4 for details of the Integrated application of AIGC).

5.3 Proximity-based offline terminal design

From Garrison et al. (2000) who proposed the online community of inquiry model [11], it is known that the main methods to enhance the sense of presence in the OMO classroom are: course design and organization, facilitation of discussion, and direct instruction, etc. These methods are dependent on the individual teacher's pedagogical skills. But in terms of generalizability, enhancing the presence of online students from the perspectives of sight, sound, and touch, so that the distance between the classroom's member units is perceived, thus increasing the possibility of interaction.

The OMOPSS offline terminal (Figure 5) is controlled by online students, and it tries to use technological means to stereoscopically the images of online students in the offline space. Its underlying use logic is that each terminal can be paired with an online classmate in the offline teacher's classroom space. It should be emphasized that, because the current holographic projection technology is not yet able to fully achieve media-free stereoscopic imaging, it is possible to add the required media projection screen based on this program when considering landing.

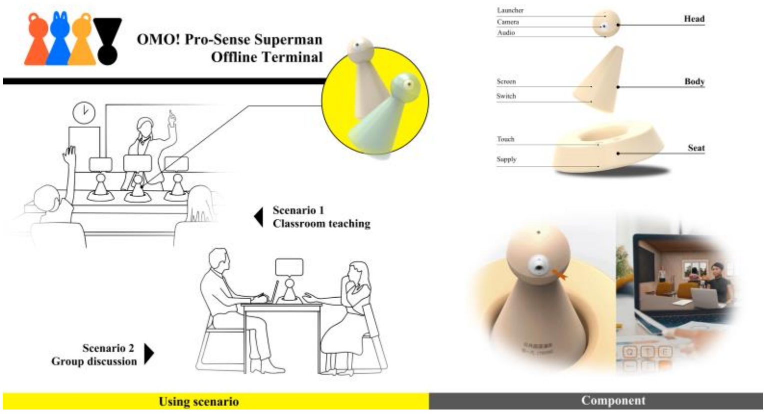

Figure 5. OMOPSS *Design*

In offline spaces equipped with OMOPSS terminals, teachers can place offline terminal in the front row of the classroom and wait for online matching. After successful pairing, online students can control the camera of the OMOPSS to follow and adjust the viewpoint (as shown in Figure 6). This will greatly enhance the presence of online students in the offline space and increase the possibility of interaction between online and offline students.

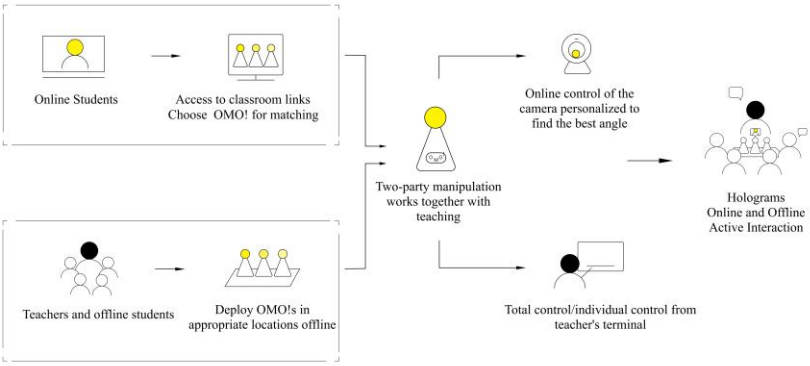

Figure 6. How to use the OMOPSS

5.4 Online Integrated Platform Design

Based on the functional settings of offline terminals, the research team accompanies the design of the online integration platform (Figure 7). The most important function of the platform is to help online students control the offline terminal devices and to assist the classroom in better online and offline interactions. To continuously maintain the learning status and enthusiasm of online students, the students' overall classroom performance will be evaluated by AI tools, and appropriate suggestions will be given. This approach helps students improve their learning methods and continues to promote the progress of the course and the student's personal progress.

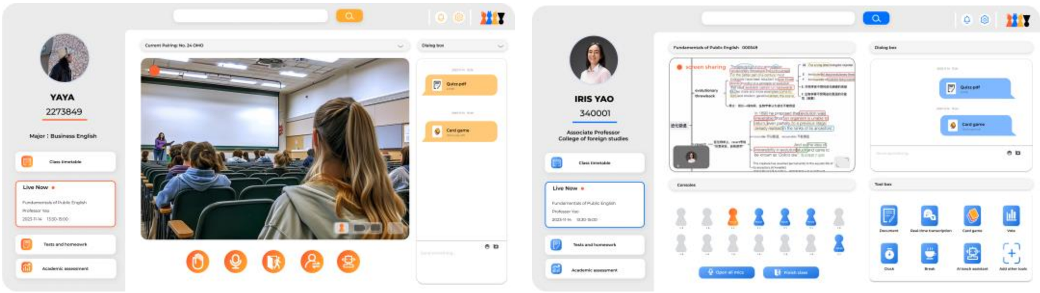

Figure 7. Student homepage of the OMO! Online platform

6 CONCLUSIONS

Based on the online presence and improving design quality, this paper finds the user demand points through the KANO-model and derive them into the QFD user demand satisfaction indexes and determine the product characteristics that need to be focused on the design.

The research results can help teachers improve their focus on the online learner groups under the OMO teaching mode, strengthen the connection between offline and online learners, and promote the equality of offline and online learner groups participating in teaching activities in OMO teaching. At the same time, the research results explore new AIGC application scenarios by adding AI technology and upgrading functions, which are still insufficient but focused, so that the research results are basically in line with the research objectives. The results are a useful attempt to innovate software and hardware products under the OMO teaching mode.

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