Demand Analysis of Computer Aided Design Course for Industrial Design based on Evaluation Grid Method

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Abstract—Computer-aided design courses are increasingly important in industrial design education. In this context, this study uses the EGM technique of Miryoku Engineering Theory to extract different stakeholders' demand factors for CAD courses and visualize their cognitive structure; in addition, we use Quantitative Theory Type 1 to calculate these demand factors to get the influence weights between these factors. As a result, we found the original demand factors of 7 CAD courses, their sub-elements and importance, and the four subjective feelings these factors bring to participants. Through research, the conclusion of this paper can be used as a reference for the reform of computer-aided design curriculum.

Keywords—CAD course; Industrial Design; EGM; Quantification Theory Type I;

1 INTRODUCTION

Computer Aided Design (CAD) plays an important role in industrial design. Computer-aided industrial design has become a necessary means of modern product development [1]. In the teaching reform of industrial design, CAD course is also an important compulsory course. It is an effective tool for creative visualization and communication between teachers and students majoring in industrial design [2]. However, the current body of knowledge in CAD courses lags behind the demand for employment in the Design industry [3]. The teaching materials, including the course content and instructional approaches, are not adequately tailored to the cognitive abilities and learning characteristics of college students at this developmental stage. The current teaching practices may not fully align with the cognitive and psychological needs of students, potentially hindering their academic progress and overall learning outcomes. [4]. Evaluating the effectiveness and quality of a course is critical for both educators and researchers [5]. In addition, the needs of students as one of the basis for school curriculum development have important reference value [6]. The needs of learners are multi-level, including at least objective needs and subjective needs. The former is in terms of society, we generally call the former needs, the latter is for students, we call it wants. These two

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requirements are often inconsistent and can even be very different [7]. Human-based needs analysis involves subjective preferences. We use Miryoku Engineering theory to reveal the multi-level demand for industrial design computer-aided design courses from different stakeholders. This is a method developed by Japanese researchers J. Sanui and M. Inui to study people's preferences for products or services. In Miryoku Engineering, the Evaluation Grid Method (EGM) technique depicts the cognitive structure of participants in a hierarchical graph [8]. EGM diagrams can visualize the link between user needs and objective design factors [9]. In this study, the benefit of using Miryoku theory and EGM technique is that we take into account the psychological needs of the participants and extract the multi-layered needs and preferences of different stakeholders. Few researchers currently use this method for computer-aided design curriculum reform. In addition, this study uses Quantification Theory Type I to calculate the influence weight of the demand influencing factors extracted by EGM. QTT1 is a statistical analysis method that enables the inclusion of both quantitative and categorical independent variables in multiple regression analysis. This makes it possible to incorporate categorical and qualitative factors into the analysis, by either converting them into numerical scores or creating dummy variables. [5].

2 METHODS AND MATERIALS

First, according to the ranking data of industrial design universities in China, literature retrieval and questionnaire survey, 7 typical computer-aided design courses were selected as the interview samples for this research. Second, in order to understand the multi-level needs of different stakeholders for computer-aided design courses, we invited 12 industrial design graduates, current students and computer-aided design teachers from these schools, as well as 4 industrial design practitioners. a total of 16 people as interview participants for EGM. Third, we used the EGM method to conduct semi-structured interviews with these participants to obtain data on their needs for the CAD course, which reflected the participants' cognitive structure. They presented participants' original reasons (OEI), concrete reasons (CEI) and abstract reasons (AEI) separately. Finally, we used quantitative theory 1 to quantitatively analyze the qualitative data obtained from the interviews to obtain the importance Connection between these influencing factors.

3 RESULTS AND DISCUSSION

3.1 The Result of EGM

The final EGM chart of influence factors of computer aided Design course for Industrial Design is shown in Figure 1. The diagram shows that the influence factors of computer aided Design course contain 4 main abstract evaluation items (AEI) on the upper side of the diagram. 7 of the original evaluation items (OEI) were listed in the middle layer of the chart. There are 26 vertically arranged concrete evaluation items (CEI) on the right side of the table. The number after each item represents the mention times of that item, which is a combination of similar representations.

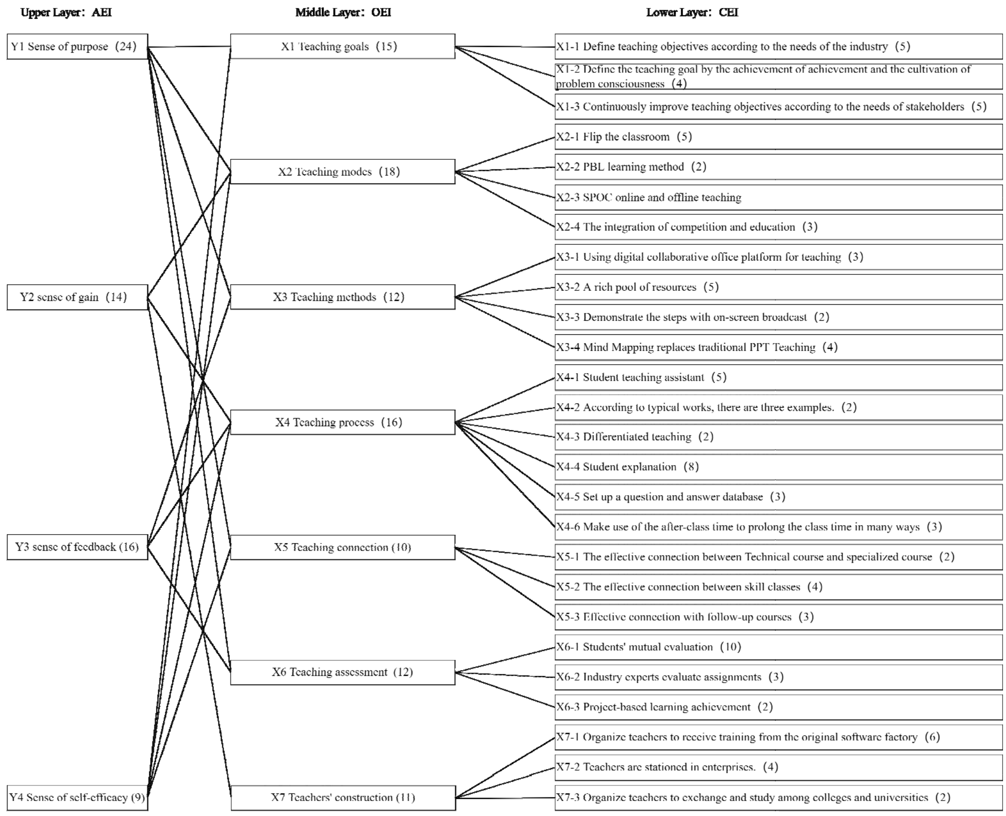

Fig 1. The EGM chart of influence factors of computer aided Design course for Industrial Design

3.2 Results of QTT-I

3.2.1 Determining the relative importance of the factors that impact the "Sense of purpose"

Through the hierarchical chart and results of Quantification Theory Type I, Table 1 indicates that Teaching goals, Teaching modes, Teaching methods and Teaching connection are original evaluation items which will bring interviewees with sense of purpose. Table 1 showed that the determination coefficient R2 was 0.714, indicating a strong correlation between the Sense of Purpose and the Computer Aided Design (CAD) course. Specifically, the Pearson Correlation Coefficient (PCC) values in Table 1 revealed that the factor with the highest correlation to the Sense of Purpose was Excellent Jury (X1), with a value of 0.756, suggesting a significant influence. Additionally, the Composite Score (CS) values in Table 1 demonstrated that Famous Master of Industrial Design (X1-1) had the strongest influence on Excellent Jury (X1).

TABLE 1. QTT1 Analysis Results for "Sense of purpose"

OEI	CEI	CS[a]	PCC[b]	Ranking
X1 Teaching goals	X1-1	2.340*	0.756	1
	X1-2	1.956		
	X1-3	0.745		
X2 Teaching modes	X2-1	0.540	0.706	2
	X2-2	1.773		
	X2-3	1.060		
	X2-4	1.845*		
X3 Teaching methods	X3-1	2.633*	0.675	4
	X3-2	0.533		
	X3-3	0.956		
	X3-4	0.265		
X5 Teaching connection	X5-1	1.225*	0.694	3
	X5-2	0.356		
	X5-3	0.865		
Constant		3.265		
R=0.845	R^2=0.714			

[a.] Category scores, [b.] Partial correlation coefficients. R Multiple correlation, R^2 Determination coefficient

3.2.2 Determining the relative importance of the factors that impact the "sense of gain"

Table 2 indicates that Teaching modes, Teaching process and Teachers' construction are original evaluation items which will bring interviewees with sense of gain. The correlation coefficient R2 from Table 1 was 0.759 (R2>0.7), indicating that the perception of gain had a good association with the computer aided Design course. As shown in Table 2, the highest value of 0.813 in PCC indicates that Teaching modes (X2) have the largest effect on perception of gain. CS values show that The integration of competition and education (X2-4) has the greatest influence on Teaching modes (X2-4).

TABLE 2. QTT1 results for "sense of gain"

OEI	CEI	CS[a]	PCC[b]	Ranking
X2 Teaching modes	X2-1	0.325	0.813	1
	X2-2	1.362		
	X2-3	0.375		
	X2-4	2.365*		
X4 Teaching process	X4-1	0.485	0.521	2
	X4-2	0.369		

	X4-3	1.060*		
	X4-4	0.236		
	X4-5	0.489		
	X4-6	0.478		
X7 Teachers' construction	X7-1	0.869*	0.448	3
	X7-2	0.785		
	X7-3	0.632		
Constant		3.158		
R=0.871	R^2=0.759			

3.2.3 Determining the relative importance of the factors that impact the "sense of feedback"

Table 3 indicates that Teaching methods, Teaching process, and Teaching assessment are original evaluation items which will bring interviewees with sense of feedback. The correlation coefficient R2 from Table 1 was 0.787 (R2>0.7), indicating that the perception of feedback had a good correlation with the computer assisted Design course. As shown in Table 3, the highest value of 846 in PCC indicates that Teaching assessment (X6) has the most effect on perception of feedback. CS values suggest that Industry experts evaluate assignments has the biggest impact on Teaching assessment (X6).

TABLE 3. QTT1 results for "sense of feedback"

OEI	CEI	CS[a]	PCC[b]	Ranking
X3 Teaching methods	X3-1	1.065*	0.762	2
	X3-2	0.265		
	X3-3	0.678		
	X3-4	0.621		
X4 Teaching process	X4-1	0.632	0.592	3
	X4-2	0.165		
	X4-3	1.495*		
	X4-4	0.635		
	X4-5	0.485		
	X4-6	0.368		
X6 Teaching assessment	X6-1	0.658	0.846	1
	X6-2	2.365*		
	X6-3	1.378		
Constant		3.023		
R=0.887	R^2=0.787			

3.2.4 Determining the relative importance of the factors that impact the "Sense of self-efficacy"

Table 4 indicates that Teaching goals, Teaching modes, Teaching process and Teaching connection are original evaluation items which will bring interviewees with sense of self-efficacy. Table 1's determination coefficient R2 was 0.702 (R2>0.7), which indicated a strong association between the sense of self-efficacy and the computer-aided Design course. Table 4 shows that the Teaching process (X4) has the biggest impact on sense of self-efficacy, with the highest value of 0.896. CS values show that Differentiated teaching (X4-3) has the biggest impact on Teaching process (X4).

TABLE 4. QTT1 results for "Sense of self-efficacy"

OEI	CEI	CS[a]	PCC[b]	Ranking
X1 Teaching goals	X1-1	0.742	0.692	3
	X1-2	0.885*		
	X1-3	0.632		
X2 Teaching modes	X2-1	0.680	0.784	2
	X2-2	0.658		
	X2-3	0.362		
	X2-4	1.396*		
X4 Teaching process	X4-1	0.368	0.896	1
	X4-2	0.365		
	X4-3	2.851*		
	X4-4	1.632		
	X4-5	0.689		
	X4-6	0.984		
X5 Teaching connection	X5-1	0.399	0.602	4
	X5-2	0.462*		
	X5-3	0.365		
Constant		3.256		
R=0.838	R^2=0.702			

4 CONCLUSION

The results of this study show that the requirement elements of computer-aided design courses and the specific sub-elements of these elements can be effectively analyzed through EGM. The advantage of using EGM is that the research results reflect the cognitive structure of the experimental participants, thus better reflecting the underlying logic of these needs. In addition, the influence weights between these demand factors can be calculated by quantitative theory 1.

These results can provide specific directions for the teaching reform of CAD courses in industrial design majors. How the teaching team can meet these diverse needs in the teaching process can be discussed in depth in future research.

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