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Using Participatory Teaching in Hands-On Courses: Exploring the Influence of Teaching Cases on Learning Motivation

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Abstract: Industrial design is an applied discipline that combines aesthetics and engineering. Through hands-on activities, students can better understand shapes and details in model making. The literature shows that hands-on courses help enhance students' creativity, learning motivation, and interest. Model-making courses are one of the hands-on courses in industrial design programs. To enhance students' learning enthusiasm in the practical course of this study, we introduced a "participatory teaching method". To examine changes in students' learning motivation after the new teaching method was introduced, the researchers conducted mid-term and final questionnaires and collected feedback on the students' learning experiences. The results showed that the introduction of the participatory teaching method had a positive impact on students' learning motivation, as they could participate in the planning and evaluation of course content. These results can serve as a reference for future course planning.

Keywords: participatory teaching method; hands-on implementation; learning motivation; curriculum planning

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1. Introduction

Industrial design is an applied discipline that combines the two fields of aesthetics and engineering. Students can further master shape and details in model making through hands-on practice. The model-making course is one of the basic practical courses. The purpose of the course is to cultivate each student's ability to transform concepts into a three-dimensional design. The most obvious feature of the course is the hands-on process, and factors such as patience wear, academic pressure, and the factory environment in the implementation process affect the level of learning.

The implementation of traditional model-making courses is oriented towards 'learning objectives', with each objective representing a specific manual technique. Through 'repeated practice', the goal is to learn and become proficient in various manual skills. The exercises for each task are practiced progressively, starting from the basics, and gradually move toward more advanced techniques, with the ultimate goal of achieving the desired standard. Those who fail to meet the standard will redo the exercise to ensure that each learning objective is learned thoroughly. The content of traditional model-making courses is shown in Table 1.

As an instructor of model-making courses, the author has relied on years of teaching experience and classroom observations, as well as a SWOT analysis, to gain deeper insights into the reasons for students' low learning motivation. A summary of the current situation of model-making courses is presented in Table 2. In addition to the tedious and tiring nature of the course, which weakens students' interest in learning, the cost of course materials is also one of the factors that affect motivation.

There are many relevant literature references that can be used to improve the motivation of students in practical courses. Some studies focus on exploring how to change teaching methods to enhance student motivation, such as introducing problem-based learning, cooperative learning, or flipped classrooms [1]. Other studies have found that providing students with more opportunities to develop autonomy and rich learning resources can significantly increase their motivation and learning achievement. Through participatory teaching methods, students can actively participate in course planning and evaluation, which can effectively improve their learning motivation and achievement [2].

Table 1. The methods of execution and content of traditional model-making courses.

Stage	Content	Description
Course introduction and description (w1)	Explanation of Factory Safety and Management Regulations.	The course introduction and description stage (w1) includes an explanation of factory safety and management regulations. The purpose of this stage is to familiarize students with the working environment and explain the relevant class regulations. In this stage, the teacher will introduce the safety standards and requirements of the workplace to ensure the students' safety during practical activities. Additionally, the teacher will explain the class regulations, including time schedules, work requirements, and personal responsibilities, among others, to ensure that students have a clear understanding of the behavioral guidelines and expectations of the course. This introduction and familiarization stage provides students with a solid start, enabling them to develop a basic understanding of the course and adapt to it, thereby preparing them for subsequent learning activities.
Basic Skills (w2–w9)	- Explanation of Material Characteristics - Brief Introduction to Machine Operation	The stage of introducing mechanical operations (w2–w9) includes explaining the characteristics of various model materials and introducing related operating equipment. In this stage, the teacher explains the characteristics, advantages, and usage methods of different model materials, such as EK, PU, and other model materials. Additionally, the teacher introduces relevant operating equipment, such as hand tools, mechanical tools, cutting machines, etc., and explains their functions and correct usage methods. During this stage, students gradually learn about the characteristics and techniques of each model material. The teacher conducts demonstrations and showcases to help students understand the applicable scope and handling methods of each material. At the same time, students learn to use various operating equipment for related manual operations, including measurement, cutting, etc. The purpose of this stage is to provide students with a basic understanding of various model materials and operating equipment, laying the foundation for subsequent manual skill learning. Students will

		learn to choose appropriate materials and tools and understand how to use them correctly.
	- Reference Planes (Vertical, Horizontal) - Cube - Polyhedron - Single Curved Surface - Double Curved Surface - Surface Treatment (Polishing, Filling, Painting)	Basic manual skills are explained and demonstrated step by step, from shallow to deep. Each operation has its own standard requirements, and any work that does not meet the standards will need to be reperformed until it meets the standards. This stage mainly focuses on a single workpiece.
Advanced Techniques. (w10–w18)	- Tolerance Concept - Workpiece Fit (Two-piece, Multi-piece) - Application Practice	In the stage of multiple-workpiece fitting exercises, the objective of manual work is based on the assembly of two or more components. In the early stages, principles of geometric shape fitting, such as handles and alarm clocks, will be utilized. Through these exercises, students will learn how to fit different parts together, understanding their interrelationships and connection methods. As the learning progresses, students will gradually transition to practicing the assembly of everyday objects, such as kettles and toasters. These exercises will closely resemble real-life application scenarios, allowing students to apply their acquired handcrafting skills and knowledge to successfully complete complex component assembly tasks. The purpose of this stage is to enable students to apply their manual skills in practical contexts, further enhancing their proficiency level.

The literature also suggests that model-making courses can help students better understand design principles and spatial relationships, improving their design skills and promoting the development of industrial design professional abilities [3]. Therefore, enhancing students' motivation to learn these courses is crucial and is the main objective of this study.

Table 2. Model-making course SWOT analysis.

Strength	**Weakness**
Through the learning of model-making skills, one can effectively grasp the development of modeling and details, and at the same time understand the related concepts of subsequent manufacturing procedures and the application of material properties.	The tedious and exhausting learning process weakens students' interest in learning, and impatient students tend to give up halfway through learning, which in turn affects the development of basic design skills.
Opportunity	Threat
Improve learning motivation through curriculum-related adjustments, thereby enhancing learning effectiveness.	Course materials are expensive, and students are often reluctant to purchase materials for practice as they wish save money, which affects the depth of learning. The basic course of model making is only offered for one semester, and it is not easy to determine the depth of learning.

2. Literature Review

The key factor in the implementation of education is the students themselves, and the improvement of learning motivation and preparation for learning depends on the students' own mental state, cultural and educational background, as well as other factors. Emotional state and personality can also affect how they learn. Motivation is an internal drive that leads to changes in student behavior and results in the meeting of his/her needs [4].

The effectiveness of teaching is the core concern of every teacher in the process of carrying out education. However, the most important key factor lies in the students themselves. Scholars have explored the impact of student motivation, engagement, and self-regulated learning on academic achievement. The results showed that there is a positive correlation between student motivation, engagement, and academic achievement [5].

Learning motivation refers to the internal drive or motivation that prompts a learner to engage in learning activities. It encompasses the reasons and purposes for a person's learning, as well as their attitudes, interests, and expectations towards learning. The level of learning motivation can have a significant impact on the learning process and outcomes [6].

Learning motivation is a research topic in various fields, including educational psychology, developmental psychology, and cognitive psychology. Its theories and empirical research have received widespread attention and investigation. Some well-known theories of learning motivation include self-efficacy theory, self-determination theory, achievement goal orientation theory, and flow theory [7–11].

Learning motivation is very important, since it increases learners' efforts in pursuing a goal, and also determines the attitude that is directed toward the goal [12]; in that sense, the core of teaching execution is to effectively enhance students' learning motivation.

Multiple methods and tools are used to measure learning motivation, including questionnaires, interviews, observation, and behavioral testing. These methods involve both qualitative and quantitative research approaches to gain a deep understanding of students' motivational background and reasons [7–11].

In recent years, the participatory teaching method has been a commonly used teaching method in the field of education. The curriculum delivery method is discussed jointly by the teacher and the students, which results in a higher willingness among students to engage in self-directed learning during the course [13].

There are various methods of participatory teaching, including different contents and purposes. Common methods include brainstorming, workshops, role plays, etc., all of which have the spirit of participatory teaching. The core is to redefine the role of the teacher, encouraging a shift from teacher-led to student-led activity within the classroom, and then teachers and students jointly construct the overall situation and process of teaching, thus completing the learning function of education [4]. The thoughts students hold about the subjects they study will become part of their learning experience [14]. Participatory teaching allows students to "lead" the curriculum, shifting the responsibility for learning from the teacher to the students, which in turn promotes student participation and interaction [15].

In the process of teaching, the teaching skills and methods adopted by the teacher play an important key factor in the students' interest in learning, and the teaching method chosen by the teacher is based on factors such as the knowledge level of the students, learning motivation, and course objectives [16,17]; the participatory teaching mode can guide students to actively participate in the teaching process and improve the teaching effect of the experimental course, with students going from "passive indoctrination" to "active learning", which effectively improves each student's ability to actively explore, independently analyze, and deal with problems, and is conducive to cultivating an innovative education spirit and improving teaching quality [18]. Participatory teaching methods also have a profound impact on various levels of interaction, and can provide a well-

founded methodological framework for curriculum development and research on improving teaching strategies [19].

Participatory teaching has a positive impact and progress on student learning, especially in terms of participation and self-efficacy [20]. Teachers also reflect on the teaching model and try to formulate new ways to contribute to the teaching process, since they have adopted participatory teaching. The conditions for supporting teachers include process support, trust, and an inclusive atmosphere [21].

Participatory courses do not exist just to pull students into the core of learning, but students actively become the active body of learning, and integrate learning plans according to the learning rhythm of themselves and fellow students [22]. Students must be responsible for the effectiveness of the educational methods they choose. Through learning in this way, students can effectively cooperate with each other to develop practical skills and help each other, forming a multi-faceted interactive learning mentality [22]. However, a large number of communication forms used in the teaching process have obvious benefits for cultural difference learning courses [23]; participatory learning courses are particularly significant for courses that need to be implemented in person, such as medical clinical courses, etc. [24,25]; participatory teaching methods can also optimize the MOOC education model [5].

Participatory teaching is applied in various fields of education [26]. In special education, participatory teaching methods are used for teaching autistic students, and effective results have been obtained [27].

In the field of multimedia, the game mode of real-world experience is also applied to deepen students' multi-faceted learning understanding [28]. In terms of art and design creation, the participation of students is strengthened by means of participatory learning [29].

In terms of learning for the elderly, for the cognitive learning of self-protection, the use of a teaching intervention strengthens the self-efficacy of students [30].

This teaching method is applied to civil servants' cross-domain coordination situational drill courses to enhance each student's ability to reflect and give feedback to each other [31].

The application of participatory teaching in the field of design education has been studied extensively [32–36], and the results have shown the numerous advantages of this teaching method. Participatory teaching can stimulate students' creative thinking and enhance their creativity and problem-solving abilities. It also fosters students' proactiveness and engagement in the design process, encouraging their active participation in design discussions, collaborative design proposal development, and practical implementation. Through participatory teaching, students gain rich practical experience and cultivate their professional skills. Furthermore, the research emphasizes the importance of close collaboration and mutual learning between teachers and students for effective implementation of a participatory design. Such collaboration provides students with a better learning environment and support while promoting their growth and development.

Practical courses are the foundation of professional development in design. According to the literature, participatory teaching methods have been widely applied in various educational fields, including design education, and have shown significant effectiveness in practice. However, their application in model-making courses is relatively limited. This study aims to introduce participatory teaching methods into model-making courses and compare them with traditional hands-on teaching methods to further understand their overall impact on teaching. The findings of this study can serve as a reference for design courses that primarily rely on hands-on execution methods.

3. Research Procedures and Methods

This study from the literature that the participatory teaching method has been one of the most commonly used teaching methods in the field of education in recent years. Through the participatory teaching model, teachers and students participate in the

decision making behind the creation of course content, which can enhance students' learning interest and learning persistence.

In addition, through the SWOT analysis of the course (shown in Table 2), it is also observed that the cost of course learning materials is also one of the factors that affect learning motivation; the learning resource planning will support students' purchase of materials through planning funds as one of the means to strengthen learning motivation.

Through the SWOT analysis methods (shown in Table 3), we can better understand the possible situation of the measures we have adopted, thus serving as a reference for follow-up planning.

Targeting the problem of weak learning motivation in practical courses, the learning motivation will be strengthened and improved through the PDCA mode. PDCA is the abbreviation for Plan–Do–Check–Act, a management methodology used for continuous improvement and quality management. It is a cycle model that achieves goals and improves organizational efficiency and effectiveness through continuous evaluation, adjustment, and improvement [37].

According to the spirit of participatory teaching, teachers and students participate together in the decision making behind the creation of course content, allowing students to have more autonomy in their learning. There are two main ways to implement this approach: the course content and assignment tasks are discussed and decided upon jointly by the teacher and students, and the course outcomes are assessed through joint participation and evaluation by the teacher and students. In terms of course evaluation, the mid-semester and end-of-semester feedback sheets will be used as the basis, and the end-of-semester learning experience will be used to gain further insights into students' post-learning perceptions.

Table 3. SWOT analysis of intervention methods.

Intervention Method	Strength	Weakness	Opportunity	Threat
Participatory teaching model	High student participation	There may be a gap between the content of the homework and the teaching objectives	Understand the gap in teaching cognition between teachers and students	The weakening of the status of teaching
Learning resources provided	Students have a higher willingness to practice	Additional funds, not regular funds, may be short	Can understand the improvement rate of students' willingness to implement	Once the shortage of funds cannot be met, the willingness to learn will be weakened

3.1. Research Questions

This research aims to explore how to enhance the learning motivation of design practical courses through the implementation of new teaching approaches and examine whether these teaching approaches have a positive impact on students' learning outcomes.

3.1.1. P (Plan)

The implementation of traditional model-making courses is oriented towards 'learning objectives', with each objective representing a specific manual technique. Through 'repeated practice', the goal is to learn and become proficient in various manual skills. The exercises for each task are practiced progressively, starting from the basics and gradually moving towards more advanced techniques, with the ultimate goal of achieving the standard. Those who fail to meet the standard will redo the exercise to ensure that each learning objective is learned thoroughly. The content of the model-making course is divided into

basic and applied skills, with each semester of the 18-week course focusing on these two areas, as shown in Table 3.

The following phenomena exist in the current hand-made design courses:

- Curriculum execution factors: Hand-made skills need to repeat a single action for a long time, such as surface grinding, and also need to focus on the workpiece for a long time to avoid mistakes, such as with the size requirements of the workpiece, etc. Therefore, these courses require a lot of attention to study. Students generally think that the courses are too "hard" and their willingness to take courses is reflected by a low score.
- Material cost factors: Model material costs are generally not provided by schools for free. Due to cost issues, students are less willing to redo the courses, and often demonstrate the mentality of coping with what they already have to hand.

Then, a participatory teaching model is drawn up to strengthen students' learning motivation and provide model materials. The methods adopted are first listed in the blue ocean strategy ERRC action framework [38], as shown in Table 4.

Table 4. ERRC action framework for intervention methods.

SWOT	Strength	Weakness	Opportunity	Threat
Participatory teaching model	High student participation	There may be a gap between the content of the homework and the teaching objectives	Understand the gap in teaching cognition between teachers and students	The weakening of the status of teaching
	Raise	Reduce	Create	Eliminate
	Student engagement	Teaching dominance	Communication of teaching cognition between teachers and students	The gap in teaching cognition between teachers and students
Learning resources provided	Strength	Weakness	Opportunity	Threat
	Students have a higher willingness to practice	Additional funds, not regular funds, may be short	Can understand the improvement rate of students' willingness to implement	Once the shortage of funds cannot be met, the willingness to learn will be weakened
	Raise	Reduce	Create	Eliminate
	Implementation will	Once the funds are in short supply, it will affect the students' willingness to learn	Willingness to learn	Schoolwork avoidance

In response to the above problems, the adjustment of the first teaching method will be the main focus, while the second material cost factor will be based on the application for project subsidies.

However, in order to avoid waste of materials, course teaching assistants (TAs) will assist in controlling the collection of materials and establish a system for reusing leftover materials, strengthen the utilization rate of remaining materials, and cultivate students' attitudes toward not wasting.

The students participating in the course are first-year freshmen; the research field is the teaching site, and the model-making room is in the workshop.

This research is mainly carried out through the participatory teaching mode. Through the discussion between the teacher and the students to decide the topic of the production, the objects that the students are interested in are used as the modeled implementation projects to enhance the learning willingness of the participating students.

The new teaching method will be evaluated through the results of the quantitative evaluation forms and qualitative feedback forms. A rating scale using a five-point Likert

scale (SD, D, N, A, SA) will be employed, and the obtained data will be transformed into numerical values ranging from 1 to 5. Descriptive statistics, a one-sample *t* test, and a paired sample *t* test will be conducted using the SPSS statistical software to understand students' perspectives on the new teaching approach. Additionally, the end-of-term reflections and feedback will be integrated to assess the effectiveness of the new teaching method.

3.1.2. D (Do)

Implementation Procedures

In order to increase learning motivation, a participatory teaching method is introduced. The course is divided into three stages: the first stage, basic skills; the second stage, comprehensive practice; the third stage, application practice. Its curriculum content planning and implementation instructions are shown in Table 5.

Table 5. Course content planning and implementation instructions.

Stage	Content	Description
Preparation (one week)	Syllabus Description	The teacher explains the teaching purpose and learning objectives of the course as well as the course content and pace of the preliminary planning, discusses with students the course objectives, and sets the learning assessment methods and standards. After discussing it with the teachers and students, the evaluation content and methods for the curriculum were established as described in 2-2.
The first stage (5 weeks)	Basic Skills Walkthrough	The first stage is the learning of basic skills. The teacher demonstrates the operation and stipulates the relevant learning content in the course execution, so as to cultivate the basic model-making skills. This stage lasts for six weeks, mainly to cultivate each student's basic production ability; the relevant learning content and development are led by the teacher. At this stage, students did not participate in the planning of the course, and a one-way teaching method was still used. The implementation content mainly focused on basic skills such as making reference planes, grinding, and template application.
The second stage (6 weeks)	Comprehensive Practice	The second stage is comprehensive practice. At this point, students have already had six weeks of experience in model-making courses and have mastered basic handmade skills. Entering the second stage, the implementation of the curriculum mainly focuses on comprehensive skills such as surface, assembly, and tolerance concepts. In this stage, students propose their own views and expectations based on the teacher's course learning objectives, and then jointly revise the course plan. This is a two-way participatory teaching method where teachers and students discuss the course format and exercise types for this stage and revise them based on the discussion results. The resulting consensus includes: 1. The exercise format should be a complete product, not just a simple geometric shape, which will be more interesting. 2. During class, students can discuss and assist each other, and not be restricted to practicing in fixed locations. 3. The number of exercises and the pace of class can be discussed for adjustment after a period of course time.

		The above consensus, reached through teacher–student discussions, serves as the learning content for the comprehensive practice of the second stage. Guided by the learning objectives, students jointly determine the form of handmade practice through discussions, and students can choose the type of exercise they like to carry out within the model-making courses.
The third stage (6 weeks)	Application Practice	The third stage is application practice. Entering the third stage (6 weeks), the content of the course implementation is mainly for the purpose of application, and daily products will be used, such as toasters, printers, coffee machines, etc. The students discussed together the production question types that they expected to implement. Before deciding on the question types, the teacher explained to the students the execution procedures and key points of each question type according to the difficulty of each question type. Under the limitation of teaching time, they informed the students of the question types that were too difficult or too simple, and suggested corrections so as to maintain the consistency of the difficulty level of the students' self-defined questions. In the end, the students confirmed the consensus of the majority as the learning content of the third stage of comprehensive exercises. Similarly, at this stage, students can independently choose their preferred question types when performing hand-made courses.
Final stage	Evaluation and Feedback	Students participating in the model-making course must complete 10 works during the semester. Through the comparison of the final grade and the grade of the previous semester, the learning effect of the course can be observed. In addition, in order to further understand the effect of the students' learning, two inspection mechanisms are adopted. One is the quantitative method, with the students filling in the learning questionnaires at the middle and the end of the semester; the second is the qualitative method, with the students submitting their learning experience at the end of the semester; based on the quantitative information and qualitative self-learning review, we can further understand the pros and cons of the course implementation method, which will be used as the basis for the adjustment of the course teaching method in the next school year.

Learning Assessment Methods

The previous evaluation method for the model-making course consisted of 10 themes over an 18-week semester. The evaluation was based on an 80:20 ratio, with 80% of the total grade coming from homework scores and 20% from attendance, which reflected students' learning attitudes.

The new course evaluation method follows a participatory learning model where the teacher discusses the course objectives with students during the first class of the semester and establishes the grading system accordingly. The teacher's evaluation score, which previously accounted for 80% of the total grade, is now only 50%, and 40% of the grades come from peer evaluation. The remaining 10% still comes from attendance, resulting in a total of 100 points.

3.1.3. C (Check)

Satisfaction Survey Form

To collect feedback from students, the learning feedback sheet consists of mid-term and end-of-term questionnaires. The questionnaire utilizes a five-point Likert scale (SD, D, N, A, SA) as the rating scale, and the obtained data are to be transformed into numerical values ranging from 1 to 5. In this scale, 5 represents Strongly Agree, while 1 represents Strongly Disagree.

The mid-term questionnaire covers several areas, such as whether the course content meets the requirements, if the course implementation method is appropriate, if the course implementation progress is satisfactory, if the homework evaluation method is clear, and if the number of homework assignments is appropriate.

The final questionnaire is similar to the mid-term questionnaire but includes an additional item on overall learning satisfaction.

Learning Experience at the End of the Term

At the end of the semester, students are required to submit a learning experience of at least 300 words to record their impressions of and suggestions for the training model-making course. Afterwards, the learners' experiences can be summarized, and quantitative data can be used to evaluate the course delivery method's strengths and weaknesses.

3.1.4. A (Act)

This study adopts an action research approach in conjunction with the PDCA (Plan–Do–Check–Act) mode. The course is divided into three stages—basic skills, comprehensive practice, and applied practice—based on the learning objectives. Participatory teaching methods are employed, where teachers and students collaboratively discuss aspects such as learning content, execution methods, assignment formats, and evaluation methods. Due to limitations in classroom equipment and space, a total of 30 freshmen were involved in the course. Using a five-point Likert scale, mid-term and final evaluations were conducted to gather students' opinions on the new teaching approach. The collected data are then transformed into numerical values ranging from 1 to 5 and analyzed using statistical software to determine if there are statistically significant findings.

4. Research Results

The whole semester of the model-making course lasts eighteen weeks, and there are 30 students participating in the course. During this semester, each student must complete 10 works (some works are shown in Figure 1).

Basic Skills Walkthrough Comprehensive Practice Application Practice

Figure 1. Model-making course implementation results.

The "Model-Making Course" is a required subject for freshmen in their first semester of college. The duration of the course is one semester. Although the students in the previous and current semesters are different, they are all newly enrolled freshmen with no prior professional training in model making. The learners have similar backgrounds. Therefore, we can compare the grades of students who participated in the traditional model-making course in the previous academic year with the semester grades of students who were

introduced to participatory teaching in the new academic year, in order to understand the impact of the new teaching approach on learning effectiveness.

After one semester of participatory teaching, we found that the average final grade of the students was 81.5, which showed improvement compared to the average grade of 78.3 in the previous academic year under traditional teaching methods. According to Table 6, the standard deviation of the participatory teaching effect is low, indicating that participatory teaching has a positive impact on improving students' learning effectiveness.

Table 6. Comparison of academic performance between before and after semesters.

Semester	N	Minimum Value	Maximum Value	Mean	Standard Deviation
Participatory Learning grades have not been imported	30	69.8	80.7	78.3	0.7344
Import Participatory Learning grades	30	75.8	85.4	81.5	0.4285
Valid N (list-wise)	30				

In addition, to further understand the learning effect of the students, at the mid-term and final stages, the students filled out the learning questionnaire and handed in their learning experience at the end of the term. The questionnaire data for the mid-term is indicated in Table 7.

Table 7. Descriptive statistics for mid-term questionnaire data.

Mid-Term Questionnaire Content	SD N/(%)	D N/(%)	N N/(%)	A N/(%)	SA N/(%)	Mean	Standard Deviation
The course content meets the requirements	0/0	4/13.3	12/40	14/46.6	0/0	3.33	0.71
The course is carried out in an appropriate manner	0/0	2/6.6	14/46.6	13/43.3	1/3.3	3.43	0.67
The pace of course execution is appropriate	0/0	11/36.6	7/23.3	12/40	0/0	3.03	0.88
Assignment assessment method is clear	0/0	0/0	6/20	22/73.3	2/6.6	3.86	0.50
Appropriate amount of work	0/0	14/46.6	16/53.3	0/0	0/0	2.53	0.50

Based on the mid-term questionnaire data, the average scores for students' opinions on the course's progress ranged from 2.53 to 3.86. From the perspective of standard deviation, students' opinions on the course's progress are relatively scattered, while the two items related to the clarity of the assignment assessment method and whether the workload is too heavy are more consistent. To further clarify the test results, a one-sample *t* test was conducted to determine whether there was statistical significance. The test criterion was set as 3, with 3 indicating a neutral opinion on the scale. If the test results were statistically significant (H0: $\mu = 3$, H1: $\mu > 3$), it would imply that students had a positive view of the course. As shown in Table 8, all items were significant except for the third one, indicating that students' opinions on the course's progress were not clear.

Table 8. One-sample *t* test for mid-term questionnaire data (H0: $\mu = 3$, H1: $\mu > 3$).

Mid-Term Questionnaire Content	Mean	Standard Deviation	t	df	Sig. (2-Tailed)
The course content meets the requirements	3.33	0.71	2.567	29	0.016
The course is carried out in an appropriate manner	3.43	0.67	3.496	29	0.002
The pace of course execution is appropriate	3.03	0.88	0.205	29	0.839
Assignment assessment method is clear	3.86	0.50	9.355	29	0.000
Appropriate amount of work	2.53	0.50	−5.037	29	0.000

Refer to the information presented in the mid-term questionnaire, because the mid-term is the ninth week, and the first six weeks are the first stage of basic skills practice. This stage is still led by the teacher. Based on the goal of the course, there is an overall consideration of the progress of the course implementation, so it will not be changed for the time being, and the original curriculum planning content will still be maintained.

The seventh week to the ninth week of the midterm is the second stage. Students begin to participate in curriculum planning. Under the consideration of the course progress, the teacher further discusses with the students the requirements for correcting the amount of homework in order to respond to the questionnaire feedback requirements.

The content of the final questionnaire is mainly based on the content of the mid-term questionnaire to increase the overall learning satisfaction items. The results of the end-of-term questionnaire survey are shown in Table 9.

Table 9. Descriptive statistics for the end-of-term questionnaire data.

End-of-Term Questionnaire Content	SD N / (%)	D N / (%)	N N / (%)	A N / (%)	SA N / (%)	Mean	Standard Deviation
The overall course content meets the requirements	0/0	3/10	10/33.3	17/56.6	0/0	3.46	0.68
Appropriate manner in which the overall course is carried out	0/0	5/16.6	13/43.3	11/36.6	1/3.3	3.26	0.78
The progress of the overall course execution is appropriate	0/0	8/26.6	11/36.6	11/36.6	0/0	3.10	0.80
The overall work assessment method is clear	0/0	0/0	5/16.6	21/70	4/13.3	3.96	0.55
Appropriate amount of overall work	0/0	8/26.6	14/46.6	8/26.6	0/0	3.00	0.74
Satisfaction with overall course study	0/0	2/6.6	12/40	16/53.3	0/0	3.46	0.62

Based on the data from the end-of-term questionnaire, the average values range from 3.00 to 3.96, which is higher than the values from the mid-term questionnaire. From the perspective of standard deviation, compared to the mid-term feedback, there has not been much change in the perception of course progress, and the opinions are still relatively scattered. However, there has been a slight change in the perception of excessive workload.

To further test the results, a one-sample *t* test was conducted to determine if there was statistical significance. The test criterion was set as 3, with 3 indicating a neutral opinion on the scale. If the test results were statistically significant, it would imply that students had a positive view of the course. As shown in Table 10, only the first and fourth items are significant (H0: $\mu = 3$, H1: $\mu > 3$). This means that students provided positive feedback on the course content and assessment methods, which is consistent with the implementation approach of introducing participatory teaching.

Table 10. One-sample *t* test for end-of-term questionnaire data (H0: $\mu = 3$, H1: $\mu > 3$).

End-of-Term Questionnaire Content	Mean	Standard Deviation	t	df	Sig. (2-Tailed)
The overall course content meets the requirements	3.46	0.68	3.751	29	0.001
Appropriate manner in which the overall course is carried out	3.26	0.78	1.861	29	0.073
The progress of the overall course execution is appropriate	3.10	0.80	0.682	29	0.501
The overall work assessment method is clear	3.96	0.55	9.522	29	0.000

Appropriate amount of overall work	3.00	0.74	0.000	29	1.000
Satisfaction with overall course study	3.46	0.62	4.065	29	0.000

To further understand students' perceptions throughout the semester, a paired-sample *t* test was conducted to examine the differences between students' self-evaluations at the mid-term and the end of the term (H0: μ= 3, H1: μ ≠ 3). As shown in Table 11, the first four items did not reach statistical significance, indicating no significant differences. However, the fifth item regarding the appropriateness of the workload received positive feedback. In other words, through the participation and discussion during the learning process, timely adjustments to the course content proved meaningful to the students.

Table 11. Paired-sample *t* test (H0: μ= 3, H1: μ ≠ 3).

Paired Sample		Mean	Standard Deviation	t	df	Sig. (2-Tailed)
Pair1	The course content meets the requirements	3.33	0.71	−0.941	29	0.354
	The overall course content meets the requirements	3.46	0.68			
Pair2	The course is carried out in an appropriate manner	3.43	0.67	1.409	29	0.169
	Appropriate manner in which the overall course is carried out	3.26	0.78			
Pair3	The pace of course execution is appropriate	3.03	0.88	−0.387	29	0.702
	The progress of the overall course execution is appropriate	3.10	0.80			
Pair4	Assignment assessment method is clear	3.86	0.50	−1.000	29	0.326
	The overall work assessment method is clear	3.96	0.55			
Pair5	Appropriate amount of work	2.53	0.50	−3.294	29	0.003
	Appropriate amount of overall work	3.00	0.74			

At the end of the semester, students are asked to submit a learning experience report that exceeds 300 words. To better understand the students' learning impressions, the report is subjected to analysis in which recurring keywords are identified and sorted based on their frequency of occurrence. Similar or repeated phrases and sentences are also highlighted and tallied. This information is then used to compile a list of the top ten most frequently occurring keywords, which are ranked according to frequency and presented in Table 12. The resulting analysis provides valuable insights into the students' learning experiences.

Table 12. Keywords for organizing learning experience (red for keyword).

Sort	Words	Times
1	I am so tired of taking the model-making class	38
2	Make a complete product and feel a sense of accomplishment	30
3	The process of doing it by hand is very fun and interesting	29
4	My whole body is dirty and uncomfortable in class	24
5	There is a lot of homework in the molding class, and the pressure is great	20
6	The pace of the course is very fast, and I have been worried that I will not be able to keep up during the course	18
7	I have been doing badly and have to redo	15
8	I spend a lot of time in the molding class, and often have to come to the factory and stay up late	10

9	To learn design, do you have to make models? Now it is not all about drawing with a computer	8
10	The steps of making are very important; think carefully before executing	7

Based on the students' end-of-term reflections, an overall perspective on the model-making course can be derived. The keywords that appeared frequently include a sense of fatigue from repetitive practice in class and dissatisfaction with cleanliness. These observations reflect typical views of the model-making course when compared to traditional lecture-based courses. The second observation indicates that during the comprehensive practice stage, students believe that the exercise format should be a complete product rather than simple geometric shapes, as it would be more engaging. This suggests that students' participation in discussions and collaborative decision making during class indeed helps enhance their learning motivation. Furthermore, the content of the reflections reveals that discussions and adjustments with classmates during the teaching phase are still necessary regarding the quantity of course assignments and the pace of course execution to enhance students' interest in learning.

5. Discussion and Conclusions

Hands-on practice is the foundation of design education as it helps students better understand design principles and spatial relationships, enhances their design abilities, and fosters the development of their professional design skills [3]. The biggest challenge of practical courses is that students need to invest a significant amount of time and effort into practice, which can impact their learning motivation. Therefore, improving students' enthusiasm for hands-on practice is an important instructional goal. The literature suggests that participatory teaching methods have been widely applied in various educational fields and have shown positive effects in terms of enhancing both learning motivation and outcomes [2]. This study introduces participatory teaching approaches to enhance learning motivation, focusing on first-year students in an industrial design program enrolled in a model-making course. Students participate in discussions and decision-making processes regarding course content, implementation methods, assessment approaches, and further explore the impact of student engagement in the course on their learning motivation and outcomes.

Here are four of the study's main outcomes.

1. Regarding the participatory teaching method, students are involved in the decision-making process regarding the course content. This approach can foster a positive learning attitude, increase course participation, and motivate students to actively seek out course-related information. In terms of learning effectiveness, there was an improvement in grades compared to the previous academic year under traditional teaching methods (as shown in Table 5). Based on the students' self-assessment results at the midterm and final evaluations, positive feedback was received in terms of the course content meeting their needs, clear assessment methods for assignments, and overall satisfaction with the course (as shown in Tables 6–9). However, when comparing the self-assessment results between the midterm and final evaluations, only the aspect of appropriate assignment quantity showed a difference (as shown in Table 10). Overall, adopting this new teaching method has positive implications for learning effectiveness and motivation.
2. Based on students' end-of-term reflections (as shown in Table 11), an overall perspective on the model-making course can be derived. The keywords that frequently appeared include a sense of fatigue from repetitive practice in class and dissatisfaction with cleanliness. These observations reflect typical views of the model-making course. Additionally, the content of the reflections also indicates that students' participation in discussions and collaborative decision making during class indeed helps enhance their learning motivation. Furthermore, it is suggested that discussions and

adjustments with classmates during the teaching phase are still necessary, including the quantity of course assignments and the pace of course execution, in order to enhance students' interest in learning.

3. As mentioned in the previous literature, the spirit of participatory teaching lies in the inclusion of students' ideas and opinions on the course, thereby forming a process of actual participation to stimulate students' learning motivation [1]. Therefore, in the future for the course preparation stage, there can be more opportunities for interaction with students, such as allowing them to discuss the relevance of model-making projects to daily life, guiding them to think about the purpose of making models and the reasons for understanding the use of these products, or adding a scoring mechanism to increase group motivation, thus triggering students' interest in learning.
4. In the observation of the teaching environment, it has been noted that the introduction of the participatory teaching model can easily induce a sense of "inertia" in some students' learning, along with the occurrence of "bargaining" between students and teachers through collective means. Students expect to choose "simple" questions to work on or request a lowering of the evaluation standards to "pass," which can undermine the overall teaching quality and the achievement of learning objectives.

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