Application of Outcome-Based Education Framework for the "Design Workshop" Course in Emerging Engineering Education

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***Abstract*—This Research to Practice Full Paper, implementing the outcome-based education (OBE) approach, introduces a new pedagogical framework in the "Design Workshop" course for undergraduate students, strengthening and improving student learning outcomes, and theoretical and practical abilities. "Emerging Engineering Education" (3E) requires a project-based learning method, transforming traditional knowledge-based education into an innovation-based education mode. However, lots of factors, such as project resources, sites, funds, cooperatives, and so on, limit the project-based learning of engineering majors (Architecture, Urban and Rural Planning, Landscape Architecture). Therefore, the establishment and improvement of the corresponding course system are essential. The "Design Workshop" course, offered by the School of Architecture at Tianjin University (TJU) takes specific projects as the carrier to integrate diverse knowledge, improve students' overall abilities, and offer a solution to the concerns mentioned above. The purpose of the article is to provide a framework for the "Design Workshop" courses, based on OBE. The course addresses the design and practice learning teaching method. The skills needed for graduation are determined based on industry demands. The task list and course teaching methods are adapted to the skills needed for graduation. The "Design Workshop" course is offered in the third year because the main prerequisite courses have already been completed, and the core competency refers to the most intensive knowledge and tasks, besides the students will have the flexibility to be engaged in the industry. The teaching experience emphasizes the importance of a multi-level course support mechanism and the systematic nature of each support component. It was found, that the educational system focuses on competency rather than the outcome, according to the abilities it can be. Students freely meet the actual project requirements and the specific design tasks as the standards, based on the design process and the final design outputs to derive the knowledge to be learned. The ability requirements and specific tasks determine the course system, giving rise to normative thinking. Taking everything into account, students can improve their abilities through "construction and building", "full life cycle support and management", "stakeholder coordination", and "activities and public occasions' preparation". Consequently, students will be more likely to adapt to the changing industry demands. Based on this, the establishment of the "Design Workshop" course framework provides an effective and new way to nurture emerging engineering undergraduate talents.**

Keywords—Outcome-Based Education; Design Workshop; Industry Demand; Ability; Course Framework

I. INTRODUCTION

In recent years, the growth of an innovative economy addresses a large number of innovative talents at universities. The quality and level of education have a direct impact on the innovation and international competitiveness of China's industry. The School of Architecture at Tianjin University (TJU) is also adjusting and changing in response to the major national demands. By setting the "Design Workshop" courses, TJU School of Architecture promotes a world-class engineering education system, nurturing talents in the architecture industry with international vision and innovation abilities [15][16].

"Workshop", as a teaching mode, originated from the Staatliche Bauhaus Academy in the Weimar Republic of Germany in the early 20th century (1919-1937), emphasizing the education of learners' comprehensive abilities of design and practice, and adopting the "factory apprenticeship system". The learners were able to gain practical experience and understanding of the real construction process, including the site, space, structure, and even a series of contents, such as construction standards, material prices, construction cost control, and post-project management, so as to have a systematic understanding of the entire life cycle [8], creating an interactive learning environment. In the early 1960s, Lawrence Halprin, an American landscape architect, proposed "workshops" as a way to provide people with different interest groups and communities to think, discuss, reach consensus, solve problems, and put forward the new RSVP (resource - score - valuation - performance) spiral theory of "workshop", which has a clear attribute of community participation. In recent years, construction courses have continued to emphasize physical space, while conducting significant research on public participation and the entire life cycle.

In China, the Ministry of Education proposed a development strategy for Higher Engineering Education, called "Emerging Engineering Education" (3E) ever since February 2017. In addition, "Fudan Consensus", "Tianda Action", and "Beijing Guide" have been put forward, and the "Notice of Carrying out Emerging Engineering Education Research and Practice", and the "Notice of Promoting Emerging Engineering Education Research and Practice Projects" have been announced [23]. This is a new approach to engineering undergraduate education, emphasizing research and practice, and cultivating innovative engineering

talents with sustainable abilities under the background of interdisciplinarity.

In 2016, China officially joined the "Washington Agreement", becoming the 18th full member and realizing the integration of China's engineering education and the progress of the engineering education quality certification system towards international substantial equivalence, providing a good opportunity to deepen the reform of engineering education, OBE as the core concept of education in the "Washington Agreement" [9][6]. Outcome-based education (OBE) is an educational concept, that mostly refers to an output-driven education system for developing high-quality and innovative industrial engineering specialists [24]. The outcome is supposed to be the objectives of teaching design. In contrast, the traditional construction education system focuses on teaching building and construction, but ignores the entire project life-cycle process, weakens stakeholder participation, lacks activity planning and industrial development, and is obviously insufficient to promote innovation, teamwork, social responsibility, and ability to create social value [18]. The term "workshop", on the other hand, refers to collaboration, experience, participation, group discussion, and adoption of different levels of knowledge in interactive learning and practical teaching. The learners actively participate in communication and discussion, investigation and analysis, a series of processes together, proposing solutions, as well as negotiating how to drive the project into success via the project implementation plan. From this point of view, the paper combined the OBE concept with the project-based learning method, implemented it in design courses, analyzed the effects, and tried to achieve an outcome that is in line with the objectives of the course.

A. Industrial New Demand

Architecture mainly studies the construction, coordination, management, and optimization of urban and rural living environments with the ideas and concepts of sustainable development [10]. In addition to planning and design, construction and management, supervision, etc., which are emphasized in the field of physical space, it is also engaged in the management of government urban planning and building department and is increasingly required to create social value and assume social responsibility through planning and design. At present, the new demands of the industry are reflected in practitioners' quality, teamwork ability, problem-solving, and innovation ability, which mainly include self-quality, self-awareness, courage, teamwork, good organization, leadership, and execution, analysis, solution of complex issues in a creative way, multidisciplinary innovative thinking. For design workshops and construction instruction, "commitment" has a significant impact on the students' characters, contributing to self-confidence and the corresponding "self-encouragement", "courage", "self-reliance", "persistence", "collaboration", and "service" [4].

B. Undergraduate Skills Meeting Industrial New Demand for Graduation

The training program focuses on professional knowledge: the basic knowledge of natural sciences, social sciences, and art as a platform for professional learning. In the past, "workshop" education emphasized design, development, and construction skills: the selection and use of appropriate planning and design methods, techniques, and materials to solve problems in response to social needs and be able to consider factors such as practicality, aesthetics, safety, health, comfort, resource, and environmental protection. In recent years, project-based learning has placed more emphasis on problem analysis skills, based on data and information mining, the application of modern simulation technologies, digital analysis tools, and material construction experiments, with the ability to analyze, simulate and optimize; teamwork skills, the ability to assume the role of team members or leaders in a multidisciplinary context; public engagement skills, the ability to effectively communicate and interact with the public, including communication and exchange in cross-cultural context; project management and practice skills, understanding and mastering engineering management principles and economic decision-making methods and be able to apply the skills in a multidisciplinary environment.

II. The Concept of OBE

OBE first appeared in the United States and Australia [6][9]. According to the definition provided by Spady, OBE means "Clearly focusing and organizing everything in an educational system around what is essential for all students to be able to do successfully at the end of their learning experiences". OBE aims at increasing students' learning abilities to achieve a visible and clear goal. OBE's 3 main principles are clarity of focus, high expectations, and design down. Outcomes are primarily about what students can do when they graduate (skills and practice), rather than know. The graduates should have the necessary knowledge and skills to face the industry development, and be qualified and employable. In OBE teaching, system, framework, time, and standards are all clearly defined [1][5]. OBE is a student-centered educational approach [5], that allows more students to participate in teaching and learning activities and practice.

In the above context, the process of determining the OBE training program takes the following steps: 1) Define the training objectives, industry demands, and graduation requirements, 2) Decide the outcomes, and set the abilities, 3) Deal with stakeholders, 4) Design the course， including teaching plan and syllabus, 5) Assessment. Students freely meet the actual project requirements as the standard, and the specific design tasks as the assessment standard, based on the design process and the final design outputs. The ability requirements and specific tasks by determining the course system give rise to normative thinking.

III. The "Design Workshop" Course Development in the Context of 3E

The engineering education system faces new demands of economic development, thus fostering talents with the abilities to adapt to the economic, technological, and social changes is a big challenge. In recent years, "Emerging Engineering Education" (3E) is offered, a new approach to promote engineering education, that requires the project-based learning method. The project-based learning emphasizes "building and construction". The whole process introduces a collaborative thinking mode based on "design-build (construction)" integration. Clearly, the changing industry has a solid framework of outcomes, so to organize a responsive and effective learning environment, the OBE approach is applied, that is to develop a set of outcomes and establish conditions to enable students to achieve [1] the resilient outcomes.

A. Course Objectives

It is necessary to clarify the connection between OBE, the course, the educational objectives, and training goals. As shown in Figure 1, overall coordination, integrated simulation, material construction experiments, and public participation are all competencies required in the 3rd year. It is difficult for theoretical and practical design courses to integrate relevant knowledge and complete the corresponding tasks. Accordingly, the most efficient way to develop the relevant skills is to offer the "Design Workshop" course in the 3rd year. The course is designed to meet the following 3 sub-goals: 1) Knowledge and skill objectives (base): master the integrated simulation techniques and material construction experimental methods; be able to organize public participation and cross-cultural communication. 2) Process and methodology objectives (carrier): conduct training in analysis, evaluation, and decision making under the guidance of teachers; learn by taking the project as a platform, master communication skills with stakeholders; complete material cognition through linkage with manufacturers and material identification and classification. 3) Experience and attitude objectives (the base for course optimization): evaluate the learning outcomes, based on the student's preferences and attitudes towards the process or results, including recognition, experience, and internalization.

B. Course Model

The OBE design course organization model differs from the traditional design course model. It is outcome-oriented and forms a course model according to a specific process. The specific process can also be partially adjusted in line with the different characteristics of the project, such as teaching content, teaching methods, teaching management tools, and teaching assessment principles of the course. The basis of the course model is the student experience and teaching effectiveness. The model reflects not only the organizational structure of the course and the teaching process but also the different relationships between the course and relevant fields.

Based on the statistical analysis of construction courses in domestic and international architecture schools, the construction courses are offered at undergraduate to postgraduate levels and are divided into the following categories: 1) a basic architectural design teaching set in the first year, with a course cycle of one month or less, four weeks before the beginning of the school year; 2) an optional design unit, which is arranged in the architectural design improvement phase (3rd and 4th years); 3) a graduate project, the course duration is more than 3 months; and 4) summer camp, taking the students to the countryside during summer holidays to experience construction in the rural studio [2].

Teaching experience at TJU shows that it is suitable to arrange the "Design Workshop" course in the architectural design improvement phase (3rd-year undergraduate), as all the prerequisite classes and tasks are already completed at that period. The courses require multi-level support and emphasize the systematic nature of each support component. The support component consists of the overall design process, periodical tasks, and corresponding knowledge points. Students freely meet the actual project requirements as the standard, and the specific design tasks as the assessment standard, based on the design process and the final design outputs to derive the knowledge to be learned, as shown in Figure 1.

The outcome of the "Design Workshop" course is rooted in both urban and rural settlements, where the designers and consumers cooperate more smoothly to create products that are adapted to the demands of society. At this point, the application of new technologies in classrooms is becoming more common, especially in online classrooms. Simultaneously, digital and parametric design has been widely used in architecture, landscape architecture, and other design industries. Moreover, virtual reality technology (VR), building information model (BIM), artificial intelligence (AI), and big data have a great impact on the course model, so that the way of thinking, construction process, and setup methods are gently changing. "BIM+VR" technology is mainly used for visual information integration involving design teams and consumers, material manufacturers, government and related associations , etc. The network platform is applied throughout the whole process of teaching, creating a learning community.

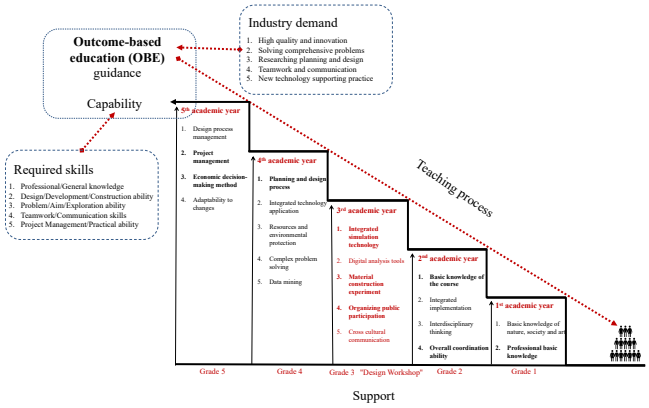

Fig. 1. OBE concept and support in the teaching process

C. Course Resources

The "Design Workshop" course resources include teaching materials, textbooks, visual aids (e.g., pictures, videos, films), facilities, and other relevant teaching tools. The teaching atmosphere is crucial for enhancing the quality learning process, which requires multimedia classrooms, a flexible learning environment, and also on-the-spot teaching. The team consists of a group of designers, supervisors, instructors, non-design participants, government-related institutions, clients and consumers, and a construction team. Compared with traditional design courses, the design workshops have high requirements for construction platforms (practice base, etc.). When selecting a learning environment, the following factors should be considered. In terms of combining the project with the course, which aims at choosing a specific spot for practice learning. In terms of course arrangement, the course is set 4 weeks before the beginning of the fall semester (usually in August). The course meets the needs of design and building without conflicting with other courses. In terms of project funding, placement agreements should be signed for onsite practice-based learning. The contract within the trust is to guarantee the corresponding transportation and accommodation expenses of remote areas (Dangchang in Gansu, Xiamutang in Jiangxi, Louna in Guizhou, Siyang in Jiangsu, Longdongbao in Sichuan, etc.).

D. Assessment and Outcome Requirements

The OBE theory puts forward 12 criteria for outcome-oriented learning, which include engineering knowledge, problem analysis, design development solutions, research, application of modern tools, engineering, social, environmental, and sustainable development, professional

norms, individuals and teams, communication, project management, life cycle learning, and other 12 aspects, according to which the assessment criteria are set [9]. In order to increase efficiency, the students are grouped into 6 teams, including program, publicity, finance, material, structure, and construction teams. Students in each team are taught specific skills, they are allowed to work collaboratively to ensure the smooth progress of the teaching tasks. Table I shows the outcome requirements students should gain in the context of teams and study weeks.

TABLE I. OUTCOME REQUIREMENTS OF THE "DESIGN WORKSHOP" COURSE

Teaming	**Outcome requirements**		
	Phase I cognition (1 week)	***Phase 2 action (1 week)***	***Phase 3 results (2 weeks)***
Program team	Complete the design and construction plan	Design and building process, stakeholder coordination	Building outcome evaluation
Publicity team	Develop a work plan and carry out publicity via various channels	Project work diary, video materials, multimedia results	Post, short video shoot, acceptance report
Finance team	Work plan and project calculation	Budget reports, project expenditure details	Construction cost reports' submission
Material team	Material analysis, material and structure, material and details	Determine material selection plan, material experiment, manufacturer docking	Node design and material utilization diagram
Structure team	Structure selection	Material analysis and mechanical calculation of structures	Structural solutions
Construction team	Construction drawing, construction process development	Site construction organization, construction safety, construction tools	Construction management system development, construction process simulation

Assessment and evaluation (excellent, good, qualified, unqualified) methods and grades take into account the student's usual performance, course practice and design, onsite construction, operation, and maintenance management program, and activity planning. The assessment and evaluation of the traditional "Design Workshop" course for TJU undergraduates usually account for 100% of the total. Usual performance is 40% of all points, including overall abilities of coordination, simulation, analysis, building materials, construction practice, and public participation. The project outcome and the final defense account for 60%. The system consists of 3 sub-scales: 1) theoretical knowledge (15%); 2) academic reports on frontier issues (15%); 3) project outcome (70%). The evaluation is completed by the internal and external university evaluation committee members.

As for the OBE-oriented assessment and evaluation, the 100-point grading system is applied. Table II shows the OBE-oriented grading system of the "Design Workshop" course.

TABLE II. TRADITIONAL AND OBE-ORIENTED COURSE ASSESSMENT

Assessment method	**Learning objectives**	**Assessment results (%)**	
		Traditional mode	***OBE mode***
Usual performance	1) Knowledge and skill objectives (base) 2) Process and methodology objectives (carrier)	40%	80%
Final exam	3) Experience and attitude objectives (the base for course optimization)	60%	20%
Total		100%	100%

The assessment is conducted according to the depth of the skills and knowledge students gained. Usual performance is 80% of all points. The project outcome and the final exam account for 20%. If the usual performance and final exam are both completed, the student will receive a full mark (100 points), however, if there is no usual performance, the student will receive only the mark for the final exam, according to the design project outcomes. The focus is on building and construction (20%), life cycle management (20%), stakeholder collaboration (20%), event planning, and industrial development (20%), design, and final defense (20%). The purpose of the assessment is to evaluate the student's knowledge and abilities gained during the courses [5].

IV. THE FRAMEWORK OF THE "DESIGN WORKSHOP" COURSE BASED ON OBE

A. Course Information

The undergraduate "Design Workshop" course at TJU School of Architecture is an innovative and entrepreneurial practice-based (selective) course, that is suitable for students majoring in Architecture, Urban and Rural Planning, Landscape Architecture, and Environmental Design. The "Design Workshop" course promotes the integration of technical courses and design courses, combining design, technical (construction course held in the classroom), and practical courses (practice platform, funding). Credit hours are 32, and credits are 2, the overall course is 32 hours, and there is no suitable teaching material so far.

B. Course Target

As a new foothold for design teaching, the "Design Workshop" course allows students to experience the process from design to construction through the identification of the multi-level complete cycle of the project and nurtures students' "new" innovative design thinking and understanding of the corporate social responsibility (CSR) in the construction industry. TJU School of Architecture, as the course target, has carried out practice-based construction courses and teaching programs supported by "Construction Competition" platforms, such as 2016 "Zhuhuan" in Louna, 2017 "Huashe Cinema" in Deyang, 2018 "Fluorescent Xiamutang" and "Xiamutang Dance" in Xiamutang, and 2019 "Children's Restaurant" in Xiamutang [18]. Table III shows the results of the OBE approach implementation in the "Design Workshop" course at TJU in recent years.

TABLE III. DEVELOPMENT PROCESS OF THE "DESIGN WORKSHOP" COURSE AT TIANJIN UNIVERSITY

Project name	**Study mode in Tianjin University**				
	Year	***Picture***	***Site***	***Supervisor***	***Design team***
German Pavilion	2011		Barcelona	Song Kun, Hu Yike	Zhang Yepeng, Wang Yiyu, Huang Qiao, Hu Hongrui, Chai Wenpu, Congnan, Deng He, You Xin, Wang Qing, Liu Dongwei, Wang Xi, Yanik, Liu Huixin, Wu Hao, Zhang Tianxiang, Zhang Qianyi, Liu Bo, Han Liguo, Zhang Wenbo, Liang Junying, Lin Zheng
Bamboo Region	2016		Louna Village, Dingxiao Town, Xingyi City, Guizhou Province	Hu Yike	Wang Xuerui, Zhu Zichao, Gao Yue, Shen Chensi, Shi Dongwei, Shen Zian, Wang Liwen, Wu Shaoji, Xu Yuan, Deng Jian, Tang Keyan, Wang Xu, Zhang Erke
Bamboo Dome	2017		Anji Village, Huzhou City, Zhejiang Province	Yuan Yiqian, Hu Yike	Wang Xuerui, Bei Yining, Wang Chang, Li Zhi, Cong Yining, Deng Jian, Tang Keyan, Wang Xu, Zhang Erke, Wu Jinze, Liu Jinwen, Hu Huiyin, Jiang Xuefeng, Xu Zhilei, Yan Shihang
Huashe Cinema	2017		Louna Village, Ding Xiao Town, Xingyi City, Guizhou Province	Wang Jianghua, Hu Yike Off campus Instructor: Wang Zhenfei	Zhen Liang, Sun Yaqi, Cao Baiqing, Liu Yuanyuan, Yang Shaoxin, Zhang Min, Zhang Xiyuan, Zhou Jie
Dancing Tree	2018		Xiamutang Village, Wan'an County, Ji'an City, Jiangxi Province	Hu Yike, Xin Shanchao Technical Instructor: Xu Zhen	Yu Bo, Wang Yixuan, Zhen Liang, Gao Yuanben, Zhu Yiran, Huang Siye, Wu Xi, Xu Ningjia, Xu Lin, Xu Zhilei, Liu Zhijuan, Wang Suwei
Xiamutang Firefly	2018		Xiamutang Village, Wan'an County, Ji'an City, Jiangxi Province	Wang Fei, Hu Yike, Xin Shanchao, Zhang Yilu (Teaching Assistant)	Syracuse University-Wei Minglu, Sun Furui Tianjin University-Xie Jingrong, Zhang Shuming, Xu Xuejian, Hu Jie, Zhou Xinyue, Zhu Wenyuan, Yan Shihang, Jiang Xuefeng, Liu Jinwen, Deng Jian, Zhang Erke
Dancing in the Forest	2018		Beijing	Wang Hongcheng, Hu Yike	Guo Ru, Deng Jian, Zhang Erke, Tang Keyan, Wang Xu, Cong Yining, Yang Ning, Cao Yeqi, Sun Yawei, Zhang Ying, Chen Lijun, Wang xuerui, Li Yinong
Walls	2019		Xiamutang Village, Jiangxi Province	Yang Wei, Hu Yike, Wang Zhigang, Sun Delong	Walls, AHO-TJU international construction course, Louna architect Bookstore © CBC Ma Peiquan, Liu Yuan, Cheng Jing, Liang Yuxuan, Li Ziang
Wind Nest	2019		Beijing	Wang Hongcheng, Hu Yike	Chen Lijun, Deng Jian, Sun Yawei, Zhang Erke, Guo Ru, Liu Runtong, Zhang Hao, Zhang Jiale
Curtain Roll	2020		Beijing	Wang Hongcheng, Hu Yike	Guo Ru, Liu Yaxin, Zhao Yue, Li Zhi, Liang Ning, Gan Yutian, Ma Tianhe, Sun Shuoqi
Touch the Neon	2021		Chengdu	Wang Hongcheng, Hu Yike	Guo Ru, Liu Yaxin, Zhao Yue, Li Zhi, Liang Ning, Gan Yutian, Ma Tianhe, Sun Shuoqi

C. *Primary Coverage of the Course*

Among the 8 main skills required for undergraduates, design workshops take up half of the tasks: coordination, integrated simulation, practice, material identification and classification, and organization of public participation skills. The learners should relate their knowledge to new tasks, making the process more productive. From the perspective of the overall planning and coordination ability, workflow, communication, and coordination are needed. It requires a thorough understanding of project management, coordination, stakeholder communication, supervision, and assessment mechanisms implementation. The students gain a better understanding, as they practice.

As regards integrated simulation ability, the construction training of analysis-synthesis-evaluation models is needed, including objective analysis to support decision making and subjective evaluation of optimization schemes. In terms of material identification and classification ability, it is crucial to carry out training in selecting-processing-organizing materials, together with material cognition, innovation, and processing. Regarding organizational skills of public participation, public participation-based management, and decision-making training are needed, including project, planning, planning-notification mechanisms, project decision-making and resource utilization, program selection, and management countermeasures, as shown in Figure 2.

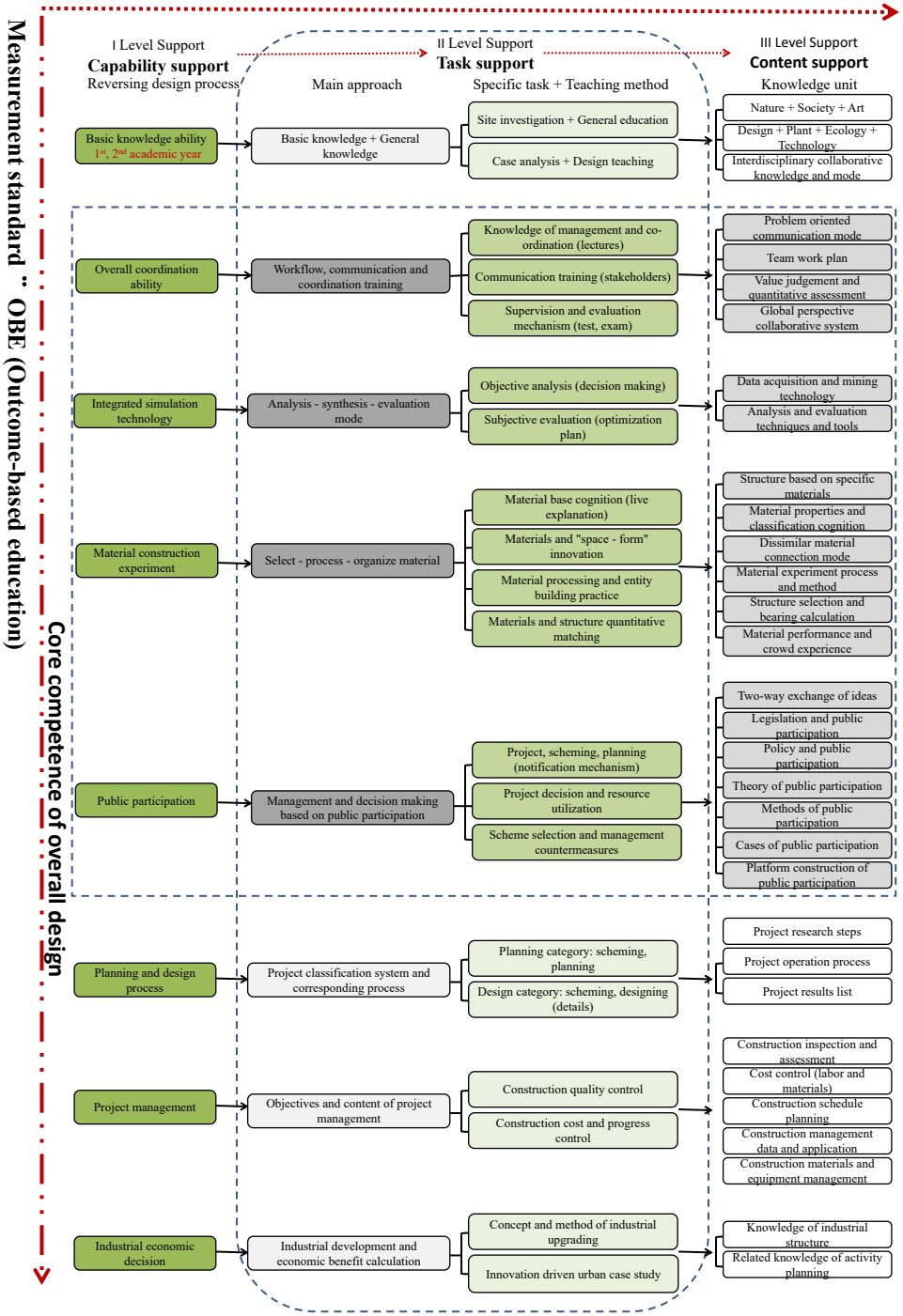

Fig. 2. Design teaching support and the "Design Workshop" course content system

D. Course Framework

The focus of this section is to establish the course framework, which meets the following stages: 1) building and construction, 2) entire life cycle management, 3) stakeholder collaboration, and 4) activity planning and industrial development. The focus is on the collaborative mode rather than the series system, as shown in Figure 3. The full life cycle management, or BLM (Building Life cycle Management), enables students to consider the whole process of construction and development, investment, planning, designing, constructing, and operating [3], that is integrated management. Teachers essentially develop the construction teaching process, regulations, and rules, guide students' design, coordinate relevant leaders and experts, and constantly check the work.

In general, the coordination process is a coordination process among the designers, governments and institutions, material processing manufacturers, customers and users, and construction teams. The specific methods of coordination are getting to know the participants, leaders, and unit heads, summarizing the problems, ensuring flexibility in coordinating issues, contract management, and setting working hours and assessment sessions. Contract management is to ensure the expenses and quality of the project while establishing a fair, responsible, and right-based cooperative environment. Construction coordination aims to pursue project quality and progress, as well as costs and risk reduction.

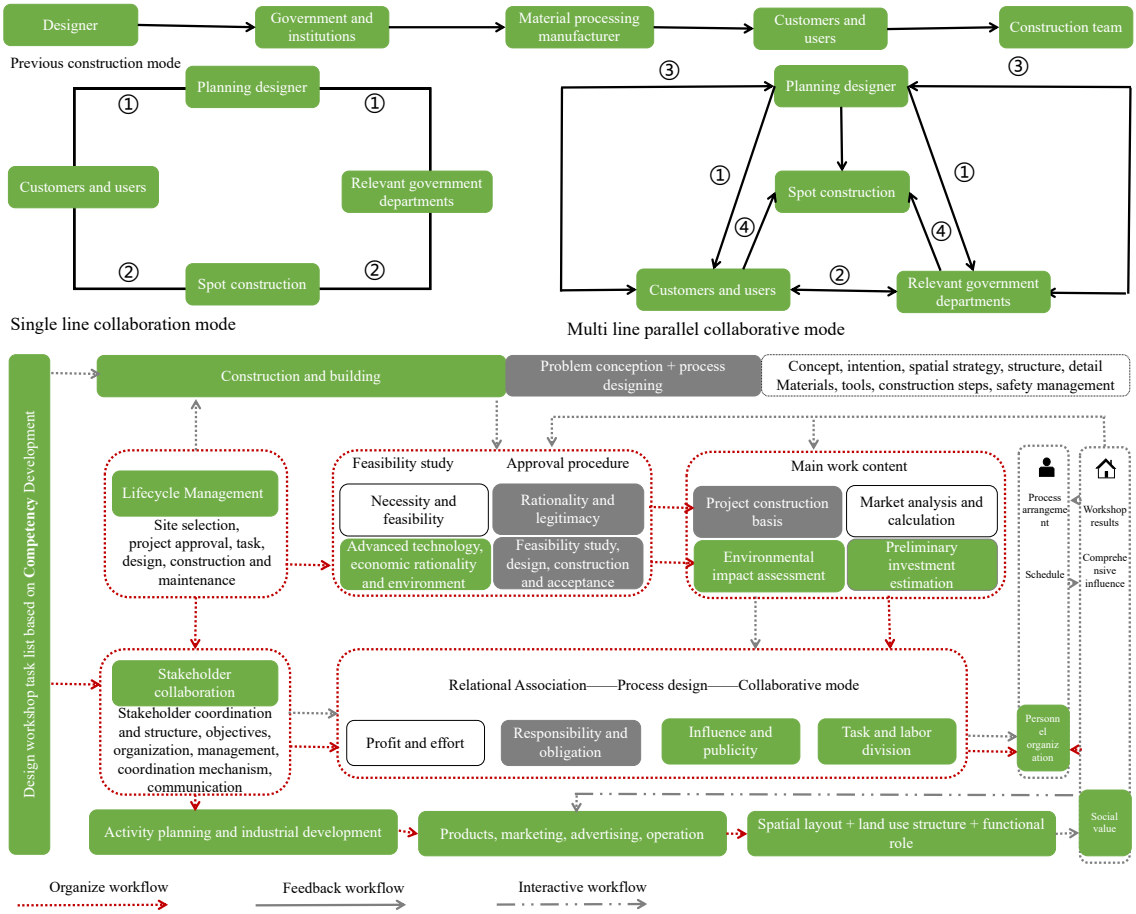

Fig. 3. Course framework

The framework can drive learners to think in an extensive way and advance the process of the project.

1) Observation and research: observation-discovery-solution, research based on current construction economic and social knowledge, according to the selected design theme.

2) Analogical thinking: combine processes and methods with case studies, and learn to build a new system by analogy.

3) Proposal design: propose innovative project ideas based on the above-mentioned aspects, such as environment, materials, program, business model, economic condition, and so on. In general, it needs to harmonize the relationship between humans, nature, space, and industry, while establishing normative thinking. The construction of engineering projects goes through the following process: construction preparation, startup, construction, installation, completion acceptance, delivery, and the control of construction quality, which is filtered into construction preparation control (pre-control), construction process control (mid-control), and completion acceptance control (post-control) [13].

V. Limitations and Problems

The findings from the paper help to understand the main process and approach of the "Design Workshop" course, however, there are still some limitations and concerns that can have a significant impact on conducting and completing the training program. For example, the lack of a visual learning environment is one of the limitations of the course. It is difficult to show the construction process in the classrooms visually, which is usually displayed through visual tools so that everyone can reach a consensus. The stakeholder

coordination is completed independently by a member of the team, which is to ensure that the information is transmitted to the whole team nondestructively, leading to the omission and misunderstanding of design information, the design team, the consumer, and the builder. The network platform is gradually solving this problem, but there is still a lot of room for improvement. In case of the lack of a reliable database of material manufacturer information, the building team can only rely on the network data, market research data, and relevant experience to select the materials, which is inefficient. Moreover, the impact of weather conditions, epidemics, and other uncertain factors should be considered, which can result in a serious delay in the progress of the project [18].

In general, most problems can be solved through accurate course design, but there are still some that can't be solved with the support of the current system.

1) Process legalization: How to legalize the construction drawings (signed and affixed seals by qualified units) and the construction process (how students can be licensed for conducting the onsite work). A solid and promising cooperation mechanism with design and construction institutions needs to be established therefor.

2) Strengthening safety awareness: How to support course team members and coordinate the various departments and personnel to ensure safety, how to conduct safety checks, and use the insurance system in a reasonable way.

3) Technology limitations: Students control the entire process of the project. There are still a lot of ways to incorporate large-scale, sophisticated, and complex projects into the course. However, it has become exceptionally of great consequence how to work with the relevant technical professionals to increase the participation of the students.

4) Platform limitations: Lack of construction teaching at this stage is constrained by various elements such as interdisciplinary, inter-regional, and inter-organizational constraints, which create a large number of problems, such as lack of building experience and site investigation, difficulty in coping with weather changes, and misplaced material selection, leading to a temporary modification of the construction plan during the construction process, which has a serious impact on the overall progress of construction [18].

5) Solving economic concerns: From the perspective of the entire education system, there are no special funds and corresponding systems to support design workshops yet. Currently, it is temporarily solved through private channels (fundraising from design institutions or alumni), but this is not sustainable. It is suggested that the relevant authorities can announce new policies to promote the construction of new engineering, new agriculture, new medicine, and new arts.

VI. Conclusions

In conclusion, the design workshops are being incorporated into the course system in universities to integrate teaching content, use engineering cases to breakthrough classroom teaching, eliminate the barriers of separation and governance of practical teaching, and establish a classroom-practice integration system. In this process, the establishment of a case base, the selection of a practice base, the implementation of course funds, the introduction of new technologies, and the construction of new platforms are all very significant. The design shall be meaningful for creating social value, education shall bear its social responsibilities, and the whole society shall provide the necessary support for the education system.

In this paper, a new teaching method for the development of engineering education is proposed. The "Design Workshop" course is offered to future engineers, adopted to combine education with industry, under the background of 3E. Taking TJU School of architecture as the research target, the paper analysis the "Design Workshop" courses and puts forward an OBE course framework. The research shows, that OBE can greatly advance learning effectiveness, especially in 3E implementation. This course is of great significance to the engineering students and professors, however, the course still has a few flaws, that must be addressed, such as a survey to assess learner and educator satisfaction.

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