Social and Affection: Design Procedures and Methods Curriculum Reform Based on Project-Based Learning

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Abstract. Project-based learning is one of the commonly used teaching methods for long-term engineering and design disciplines, which has far-reaching influence in international and domestic countries, and there have been many application practice cases so far. Based on the PjBL (Project-Based Learning) teaching method combined with the "demand" and "problem" oriented mechanism in OBE theory, this paper conducts teaching reform research on the "Design Procedure and Method" course of industrial design junior students of Wuyi University. By bringing three types of design questions, corporate, competition, and hobby, into the classroom, the project goals focus on the social dimension and affective domain. Finally, the effectiveness of pedagogical reform is evaluated in terms of student design output, aiming to improve student learning autonomy, participation, cooperation, and innovation. The conclusions show that: (1) increasing the examination of curriculum objectives at the social and affective levels is conducive to improving the connection and integration between the school and society, and improving the viscosity between students and learning; (2) The multi-dimensional of the project can better stimulate students' willingness to participate and learn independently.

Keywords: project-based learning, social and affection, industrial design

1 Intruction

In recent year, society 5.0 [1] and Industry 4.0 [2]have started gaining more attention, industrial design is beginning to focus on digital twins [3]、Sustainable design [4], [5]、Globalization and cultural diversity [6] etc.. In addition, the pandemic had led to the closure of some Chinese enterprises or faced structural transformation, the employment rate of graduates has gradually decreased, and design education has introduced innovation and entrepreneurship and social impact indicators, which has also forced a new reform of the curriculum. Fortunately, the PjBL teaching model puts learners in real-world problem situations, acquiring knowledge, developing skills, and solving problems by participating in real projects [7]. At the same time, this model can help

Y. Chen et al. (eds.), *Proceedings of the 2023 3rd International Conference on Modern Educational Technology and Social Sciences (ICMETSS 2023)*, Advances in Social Science, Education and Humanities Research 784,
https://doi.org/10.2991/978-2-38476-128-9_41

students understand the real design project in society, and apply multiple design methods to solve problems of design development [8]，in order to allow students to adapt to the needs of the job after graduation and adapt to the social rhythm in advance.

Therefore, this paper is based on the PjBL teaching model, and follows the teaching idea of OBE (Outcome-based Education）[7] introduced by Wuyi University since 2017. we discuss and reform the teaching approaches about the "Design Procedures and Methods" course of industrial design that is a core course for professional transition. Through the form of reverse design course objectives and combine both social and emotional dimensions are to determine the learning objectives, teaching content, assessment and continuous improvement of the course.

2 Literature Review

2.1 PjBL (Project-based learning)

Project-based learning emphasizes that students acquire knowledge and skills through practical participation in practical projects. It focuses more on students' active participation, teamwork, and ability to solve practical problems than traditional theoretical classroom teaching [7]. In the field of industrial design, project-based learning can simulate the real design process, allowing students to experience the whole process of design in real operation.

Many articles prove that PjBL improves students' critical abilities, creativity, communication skill and thinking skills[9]. In the 21st century, PjBL can help students develop many soft skills related to work and employment in the classroom, such as：teamwork, project management, communication skills, interpersonal skills and problem-solving skills [10]. There were also studies [11], [12] that combined teaching methods of PjBL and STEM has been shown to promote student productivity, generate meaningful learning, and influence students' positive attitudes towards future career pursuits, and it may improve students` lives and society. In addition, Diana [12] combed through relevant PjBL data from 2017 to 2021 and showed: PjBL can improve student learning outcomes in science learning and train students in problem solving (critical thinking). We can see that PjBL has an oppositive influence on student learning.

2.2 Social dimension

The social dimension of this paper is based primarily on social constructivism, a theory proposed by Lev Vygotsky in 1968. He claims that thought develops from society to the individual and not the other way and that cognitive growth occurs first on a social level, and then it can occur within the individual. To make sense of others and construct knowledge on such a social level allow learners to relate themselves to circumstances. Instructional models based on this perspective highlight the need for collaboration among learners and with practitioners in the society [13], [14]. Furthermore, Applefield JM, Huber R & Moallem M [15] introduced the importance of collaborative social in-

teraction and context in social or dialectic constructivism. The meaningful learning occurs when individuals are engaged in social activities such as interaction and collaboration.

Overall, social constructivism as a learning theory and its implications on teaching methods, students' learning motivation and the entire teaching/learning process. And it is a collaborative form of learning based on interaction, discussion and knowledge sharing among students. The teacher's role is to employ teaching methods that that are learner centred and collaborative in nature [16]. In 2022, Sun [17] through a case study based on project-based learning and integrate entrepreneurship education into all stages of the product design course curriculum. Also, it provides innovative teaching perspectives and suggestions for relevant educators. This teaching method also enhances students' enthusiasm for the course and their sense of social responsibility if their works are successfully sold and recognized by an external audience.

2.3 Affective domain

Many industrial design curriculum reforms focus more on students' knowledge, skills, and abilities, but less on students' affective aspects. Chen integrates artificial intelligence systems into teaching administration, teaching and learning, which will generate more and more data to provide a clearer picture of the teaching process, resulting in more accurate information recommendations, customized and personalized learning materials according to students' needs and abilities[18]. And A. F Zakaria uses cases to illustrate the positive impact of data technology in design education, and the practicality of skill modules was proposed [19].

Affective states have been accepted as important factors for succeeding and persisting in learning and achievement situations[20]. Moreover, positive activating affect correlates positively with motivational determinants of learning such as interest [21], intrinsic motivation [22], or learning enhancing achievement goal orientations[23]. In the classic Bloom classification of teaching objectives, it is divided into cognitive domain, from knowledge, comprehension, comprehension, analysis, synthesis to evaluation [24]. Another article initiated a Smart Product Service System (Smart-PSS) design project and used online industrial design studio [25].

However，affective domain is also gradually being valued . Affective domains as in Bloom's taxonomy focuses more on attitudes and values, which consists of stages including (a) receiving phenomenon, (b) responding to the phenomenon, (c) valuing, (d) organizing, and then (e) internalizing values [26]. Ashley's article seeks to give practical examples of how teachers can promote the development of students' affective learning using two cooperative learning structures: Student team assessment divisions (STAD) and jigsaw classroom. This study attempts to combine entrepreneurial Massive Open Online Courses (MOOCs) and blended curriculum design for affective learning [27]. Besides, Gao studied the affective domain including measures such as students' interest, engagement, attitude, and motivation for STEM contents and practices and career aspiration for STEM professions [28].

Therefore, this article explores two questions: (1) How is the social dimension implemented in PjBL teaching methods? (2) What are the effects of positive affection on students' learning?

3 Curriculum reform implementation

3.1 Project selection

The industrial design major of Wuyi University has established good relations and cooperation with enterprises all year round, and most of the teachers also have their own enterprise and project resources, which is more conducive to the establishment of project-based teaching methods in the classroom. However, for professional settings, "Design Procedures and Methods" belongs to the first-term courses, the pre-course involves modeling design, computer-aided technology, hand-drawn expression, ergonomics, and the post-course is mainly the major course of the professional triage module of the junior year. Therefore, before the course, the teacher needs to act as a planner and manager, and select the appropriate project to introduce into the classroom in advance.

Generally, the collection of project topics is carried out from three aspects: First, establish horizontal cooperation with enterprises and give practical topics. This approach requires first measuring the level of teachers and students —— prior knowledge, problem-solving skills, project domain scope, project funding, patent ownership and enforcement cycles, etc. Then, led by the course instructor, the school and the company reach relevant written cooperation. In addition, if the school already have a joint project that requirements and responsible of student take park in the course. Course teachers can negotiate content needed， project fund and labor cost distribution in advance. This type allows students to adapt to social requirements; Second, , international and domestic competitions are also a good source of project evaluation for design professionals, and most of the relevant design competitions in recent years include two categories, concept and product, such as Red Dot and IF. The competition topics and judging criteria have established a relatively mature system, which can better provide students with normative requirements and guidance, and also drive students' sense of participation and achievement. Third, for the first two items, most of them are biased towards fixed project topics, which will make it difficult to cover students' diverse dement, thereby affecting the progress of courses and students' interests. In this case, the teacher will screen again, generally from the international and domestic design trends, or the development field of other colleges and universities, or the professional direction and local needs of their own colleges. Such as social design, service design, sustainable design, emotional design and other novel topics. It is important to note that the diversity, cutting-edge, challenge, and difficulty levels of the field need to match the abilities and preferences of the students in their major, and it is also necessary to make a closer connection with the students as much as possible, which can lead to a sense of disconnection. This kind of project requires the teacher to spend a lot of time in advance to contact and understand, including the professional curriculum system, the course objectives, the student's prior knowledge, the scope of ability, local conditions, and the student's likes and hobbies, which will be a challenge.

In 2022, the course sets five course objectives based on two dimensions of knowledge and ability: (1) master basic innovative and creative thinking methods and effectively apply them to solving complex design problems; (2) Capture market opportunities for complex design problems, grasp product design trends and user needs; (3) Be able to propose scientific and marketable design solutions to solve complex design problems; (4) have the aesthetic literacy required to solve complex design problems; (5) Familiar with the complete process of product design, and develop basic design project management and design decision-making skills.

The author echoes the course objectives of the relevant project topics, but adds the social layer and the emotional layer, which are mainly divided into four levels, the knowledge the ability, the social and the affection (Table 1). First, knowledge is mainly judged based on prior knowledge, which means that the project can cover 50%-80% of students' knowledge, if less will cause the project to be uncontrollable, students are more difficult to complete, will frustrate their self-confidence. Second, the ability level includes collaboration (80%-100%), creativity (80%-100%), challenge (20-50%) and critical (20%-50%), which is relatively high due to the fact that project execution is dominated by teams and the particularity of the design profession requires high creativity. However, challenging and critical competence cannot be set too high for the school's students, which may reduce initiative and thinking ability. At the social level, the project must solve the current problem, and the necessity of the local nature is not the greatest. The facilities can be coordinated and solved as much as possible in the course of the project, but the most basic must meet 70% to make the students' design projects more landed and better corrected and modified, and the students themselves also need to exert their own initiative, such as dealing with communication problems in different fields, research problems, etc. At the effective level, it can be understood that most teachers mainly choose topics with mandatory rules after interviews, and it is difficult for students to participate in topic selection, resulting in insufficient students' execution and frequent interruptions of process projects. Therefore, the multi-dimensional and multi-field selection of topics at this level can meet the preferences of different students, in order to stimulate students' interest in solving problems and maximizing student value and project value.

Table 1. Weight for project selection

Four levels	Segment goals	Weight（%）
Knowledge level	Knowledge	50%-80%
Ability level	Collaboration	80%-100%
	creativity	80%-100%
	Challenge	20%-50%
	Critical	20%-50%
Social level	Contemporaneity	100%
	local	20%-50%
	Facilities and environments	70%-90%
Affective level	Interests and vcalue	70%-100%

3.2 Project process

Project-based teaching is mainly based on teamwork, dividing students into small groups to implement projects. The group size is best 4-5 people, and students work together in the group, because too small a number of people will lead to too much workload for a single project, and it will also lead to the difficulty of assigning scores, causing students in the group to complain. Too many students can participate effectively, and in most cases individual students will be left behind. Secondly, inform the background of the topic selection of the relevant project, as well as the difficulty and challenges faced, so that students can have psychological expectations and self-assessment of risks. In addition, the number of projects must be more than the number of groups is the best, the most suitable is twice as much, and there is no requirement for the repetition of the project topic, because this can be distinguished by different problem goals and different solution directions derived from the subsequent group brainstorming. Subsequently, after each group has selected the project topic, the class brainstorming is carried out, and students can share different perspectives and skills, combined with the problem tree and KJ method to find the identified problem points to be solved. For example, for sustainable projects, one group ultimately wants to solve in the direction of sustainable material design, and the other group may solve it from the perspective of service design.

The course project-based teaching process is carried out in stages in combination with the teaching content method of the design program, mainly using the classroom mode, with six stages of "project topic selection, problem discovery, research and implementation, design positioning, solution, product display and report" for project implementation and intervention, after each stage, phased evaluation and feedback are required, and the group needs to reflect and share. This helps students learn lessons, identify areas for improvement, and learn from the experiences of other groups. During this period, teachers act as professional coaches, project coordinators, motivators and facilitators, evaluators of knowledge and skills [29] and calmers of emotions, developing students' ability to communicate and collaborate, also in line with the context of teamwork in real design.

3.3 Evaluation system

Establish a diversified assessment method with learning outcomes as the core, and introduce a four-way evaluation mechanism of student self-evaluation, group mutual evaluation, enterprise tutor and course tutor, with a proportion of 10%, 10%, 40% and 40%. At the same time, a phased project operation evaluation is set up, and the usual attendance performance is integrated into the proportion of the stage, and additional points (up to 10 points) are set up, and the incentive mechanism for the winning of the enterprise project is given additional points and labor fees; For winning international and domestic design competitions, additional points will be given according to the level of the winning works, patent application and work output. Teachers make quantitative scales at the final marking, and integrate students' participation, students' progress, students' enthusiasm, students' learning values, etc. into the evaluation details, so as to

form a more scientific, comprehensive and objective evaluation and assessment system, which will also be conducive to the dynamic adjustment of teaching content and continuous improvement of the curriculum (Table 2).

Table 2. Evaluation System for the Course of " Design Procedures and Methods "

Number	Course objectives	Assessment content	Evaluation basis			Grade Ratio (%)
			Pre-project (research report)	Mid-project (design positioning)	End of the project(Design presentation and presentation)	
1	Objective 1: Master basic innovative creative thinking methods and apply them effectively to solving complex design problems.	Understand the basic process and method knowledge of product design, be familiar with different types of product design, and master and effectively apply various creative thinking methods.	30	5	0	35
2	Objective 2: Capture innovation opportunities to solve complex design problems, and grasp design trends and directions.	For a specific product design problem, master and effectively apply product investigation and analysis methods to effectively complete the product design opportunity capture	0	10	0	10
3	Objective 3: To be able to propose scientific and marketable design solutions that solve complex design problems.	The rationality of design positioning, the degree to which the design works fit the design positioning, and the comprehensive evaluation of the appearance quality, functional performance and social impact of the design works	0	5	20	25
4	Objective 4: Acquire the aesthetic literacy needed to solve complex design problems.	Product ratio, balance, visual impact, differentiation, and evaluation that meets the	0	0	10	10

		aesthetic needs of target users				
5	Objective 5: Familiarize yourself with the complete process of product design and develop basic design project management and design decision-making skills.	The mastery of design evaluation and decision-making methods, as well as the appropriateness of application, and the effect of design evaluation and decision-making training	0	0	20	20
Total			30	20	50	100

3.4 Project outputs

Through this course, industrial design students can gain more practical design experience and develop innovative thinking and problem-solving skills. Not only will they be familiar with the design process, but they will also be able to understand market requirements and user experience in practice, and be well prepared for future industrial design work.

After 3 years, the course has certain exploration results, built 4 school-enterprise internship bases, 8 school-enterprise horizontal cooperation projects, won a total of 2 innovation and entrepreneurship competition awards, students have won a total of 80,000 entrepreneurial funds, 2 Red Dot awards, 1 IF award, more than 10 domestic competitions award, 1 product utility patent, 7 appearance patents, and 8 landing products for business incubation.

Among the follow-up return students, the students' satisfaction with the course was 93%, and most of the students said goodbye to the habit of directly drawing sketches in the past. They recognized the importance of preliminary research and project-based learning, and the correlation of the project design logic. However, there are two things that need to be improved: First, after the course, students can have continuous guidance for participating in the competition or product landing after class. Second, it is necessary to refine the division of labor in the group and give corresponding points, otherwise individual students will be indiscriminately charged.

4 Conclusion

The project-based learning "Design Procedures and Methods" curriculum reform provides industrial design students with a richer and more practical educational experience. By participating in real projects, students can gain more in-depth learning and exercise opportunities, cultivate comprehensive quality and practical ability, and lay a solid foundation for future industrial design careers. At the same time, after increasing the

social and emotional levels of project topic selection target points, the project output is more impressive, which also indirectly proves the effectiveness of the teaching method.

Acknowledgment

Wuyi University Undergraduate High-quality Curriculum Construction and Innovation and Entrepreneurship Education Construction Reform Project: Curriculum Reform of Design Procedures and Methods. Fund number: KC2022065. Time: 2022.

Reference

1. A. G. Kravets, A. A. Bolshakov, and M. Shcherbakov, Eds., "Society 5.0: Human-Centered Society Challenges and Solutions," vol. 416, 2022, doi: 10.1007/978-3-030-95112-2.
2. S. Ing Tay et al., "An Overview of Industry 4.0: Definition, Components, and Government Initiatives," Article in Journal of Advanced Research in Dynamical and Control Systems, vol. 12, 2018, Accessed: Jul. 02, 2023. [Online]. Available: https://www.researchgate.net/publication/332440369
3. M. Liu, S. Fang, H. Dong, and C. Xu, "Review of digital twin about concepts, technologies, and industrial applications," J Manuf Syst, vol. 58, pp. 346–361, Jan. 2021, doi: 10.1016/J.JMSY.2020.06.017.
4. C. G. Machado, M. P. Winroth, and E. H. D. Ribeiro da Silva, "Sustainable manufacturing in Industry 4.0: an emerging research agenda," https://doi.org/10.1080/00207543.2019.1652777, vol. 58, no. 5, pp. 1462–1484, Mar. 2019, doi: 10.1080/00207543.2019.1652777.
5. R. A. Ramirez-Mendoza et al., "Incorporating the sustainable development goals in engineering education," International Journal on Interactive Design and Manufacturing (IJIDeM), vol. 14, pp. 739–745, 2008, doi: 10.1007/s12008-020-00661-0.
6. Gui Bonsiepe, Design, Cultura e Sociedade. Editora Blucher, 2020. Accessed: Aug. 14, 2023. [Online]. Available: https://books.google.com.my/books?id=UvDRDwAAQBAJ&dq=culture+design&lr=&authuser=1&source=gbs_navlinks_s
7. G. Solomon, "Project-Based Learning: a Primer," 2003, Accessed: Aug. 14, 2023. [Online]. Available: http://www.techlearning.com/db_area/archives/TL/2003/01/project.php
8. A. van Boeijen, J. Daalhuizen, J. Zijlstra, R. van der Schoor, and Technische Universiteit Delft. Faculteit van het Industrieel Ontwerpen, Delft Design Guide: Design Strategies and Methods. 2014. Accessed: Aug. 14, 2023. [Online]. Available: https://orbit.dtu.dk/en/publications/delft-design-guide-design-strategies-and-methods
9. Z. Zulyusri, I. Elfira, L. Lufri, and T. A. Santosa, "Literature Study: Utilization of the PjBL Model in Science Education to Improve Creativity and Critical Thinking Skills," Jurnal Penelitian Pendidikan IPA, vol. 9, no. 1, pp. 133–143, Jan. 2023, doi: 10.29303/JPPIPA.V9I1.2555.
10. F. Musa, N. Mufti, R. A. Latiff, and M. M. Amin, "Project-based Learning (PjBL): Inculcating Soft Skills in 21st Century Workplace," Procedia Soc Behav Sci, vol. 59, pp. 565–573, Oct. 2012, doi: 10.1016/j.sbspro.2012.09.315.
11. K. H. Tseng, C. C. Chang, S. J. Lou, and W. P. Chen, "Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment," Int J Technol Des Educ, vol. 23, no. 1, pp. 87–102, Feb. 2013, doi: 10.1007/s10798-011-9160-x.

12. N. Diana, Yohannes, and Y. Sukma, "The effectiveness of implementing project-based learning (PjBL) model in STEM education: A literature review," J Phys Conf Ser, vol. 1882, no. 1, p. 012146, 2021, doi: 10.1088/1742-6596/1882/1/012146.
13. J. Lave and E. Wenger, "Situated learning: Legitimate peripheral participation," Situated Learning, Sep. 1991, doi: 10.1017/CBO9780511815355.
14. M. Mcmahon, "Social Constructivism and the World Wide Web-A Paradigm for Learning Assessing Executive Functions and Problem-Solving in Primary School Students View project," 1997. [Online]. Available: https://www.researchgate.net/publication/243618245
15. J. Applefield, R. Huber, and M. Moallem, "Constructivism in Theory and Practice: Toward a Better Understanding," The High School Journal, 2001, doi: 10.2307/40364404.
16. V. Idaresit Akpan, U. Angela Igwe, I. Blessing Ijeoma Mpamah, and C. Onyinyechi Okoro, "SOCIAL CONSTRUCTIVISM: IMPLICATIONS ON TEACHING AND LEARNING," British Journal of Education, vol. 8, pp. 49–56, 2020.
17. X. Sun and E. Kim, "Improving Student Creativity through Project-Based Learning: A Case Study of Integrating Innovation and Entrepreneurship Education within Product Design Courses," Journal of Positive School Psychology , vol. 2022, no. 4, pp. 6295 – 6307–6295 – 6307, May 2022, Accessed: Aug. 19, 2023. [Online]. Available: http://mail.journalppw.com/index.php/jpsp/article/view/4525
18. L. Chen, P. Chen, and Z. Lin, "Artificial Intelligence in Education: A Review," IEEE Access, Apr. 2020, doi: 10.1109/ACCESS.2020.2988510.
19. A. F. Zakaria and S. C. Johnson Lim, "Data Analytics Skill Development for Design Education: A Case Study in Optimal Product-Service Bundle Design," Think Skills Creat, vol. 46, p. 101191, Dec. 2022, doi: 10.1016/J.TSC.2022.101191.
20. R. Pekrun, T. Goetz, W. Titz, and R. P. Perry, "Academic Emotions in Students' Self-Regulated Learning and Achievement: A Program of Qualitative and Quantitative Research," https://doi.org/10.1207/S15326985EP3702_4, vol. 37, no. 2, pp. 91–105, 2010, doi: 10.1207/S15326985EP3702_4.
21. L. Pekrun, Reinhard; Linnenbrink-Garcia, "Handbook of Emotions in Education," 2014, Accessed: Aug. 18, 2023. [Online]. Available: https://books.google.com/books/about/International_Handbook_of_Emotions_in_Ed.html?id=8_UjAwAAQBAJ
22. A. M. Isen, K. A. Daubman, and G. P. Nowicki, "Positive Affect Facilitates Creative Problem Solving," J Pers Soc Psychol, vol. 52, no. 6, pp. 1122–1131, 1987, doi: 10.1037/0022-3514.52.6.1122.
23. C. Huang, "Achievement Goals and Achievement Emotions: A Meta-analysis," Educ Psychol Rev, vol. 23, no. 3, pp. 359–388, Sep. 2011, doi: 10.1007/S10648-011-9155-X/TABLES/11.
24. L. W. Anderson et al., "A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives," Feb. 2021, Accessed: Aug. 20, 2023. [Online]. Available: http://dspace.vnbrims.org:13000/xmlui/handle/123456789/4570
25. B. Tuncer Manzakoglu and R. Dimli Oraklibel, "A Design Management and Design Thinking Approach for Developing Smart Product Service System Design: Projects from Online Industrial Design Studio," Journal of Design Studio, no. 1, pp. 107–116, Jul. 2021, doi: 10.46474/jds.933488.
26. D. R. Krathwohl and B. S. Bloom, "Taxonomy of educational objectives: the classification of educational goals, Volume 2," Taxonomy of educational objectives: The classification of educational goals, 1st ed., p. 196, 1964, Accessed: Aug. 20, 2023. [Online]. Available: https://books.google.com/books/about/Taxonomy_of_Educational_Objectives.html?id=Uh92wgEACAAJ

27. A. Casey and J. Fernandez-Rio, “Cooperative Learning and the Affective Domain,” https://doi.org/10.1080/07303084.2019.1559671, vol. 90, no. 3, pp. 12–17, Mar. 2019, doi: 10.1080/07303084.2019.1559671.
28. X. Gao, P. Li, J. Shen, and H. Sun, “Reviewing assessment of student learning in interdisciplinary STEM education,” Int J STEM Educ, vol. 7, no. 1, pp. 1–14, Dec. 2020, doi: 10.1186/S40594-020-00225-4/FIGURES/5.
29. W. Hung, “Problem Design in PBL,” The Wiley Handbook of Problem-Based Learning, pp. 249–272, Apr. 2019, doi: 10.1002/9781119173243.CH11.