Journal of Positive School Psychology http://journalppw.com
2022, Vol. 6, No. 4, 6295 – 6307

Improving Student Creativity through Project-Based Learning: A Case Study of Integrating Innovation and Entrepreneurship Education within Product Design Courses

[1]Xiaolei Sun, [2]Eunyoung Kim

[1]Japan Advanced Institute of Science and Technology, Japan, kim@jaist.ac.jp
[2]Japan Advanced Institute of Science and Technology, Japan

Abstract

Innovation and entrepreneurship education is essential in the training of designer students; however, being an entrepreneur is often challenging for designers. To facilitate the integration of entrepreneurship training within professional product design education, we implemented a teaching reform practice through a project-based learning approach in order to provide students with entrepreneurial knowledge that would then enhance their innovative capabilities and creativity. In this case study, we describe current teaching practices, along with educators' ideas and processes for integrating entrepreneurship education into product design courses. Interviews conducted with students revealed that this teaching practice had a positive impact overall. Thus, the proposed teaching model and evaluation method based on the integration of entrepreneurship and product design education provide various insights for use within innovative teaching perspectives, as well as suggestions for product design educators.

Keywords: innovation and entrepreneurship education; product design; project-based learning; teaching practice.

INTRODUCTION

Over the last decade, enterprise sectors have widely recognized the need for innovation and creative problem-solving skills among entrepreneurs. Further, in recent years, higher education institutions have attempted to train students in hard skills, such as both cognitive knowledge and professional skills (Vogler et al., 2018), in addition to more soft skills, like problem-solving and teamwork (Casner-Lotto & Benner, 2006). These skill-related goals, however, are not easy to achieve in traditional learning environments wherein teachers are "the transmitters" of knowledge and students are "the receivers" of information (Alorda et al., 2011). Therefore, students often struggle to fully engage in these educational practices, leading to them developing a superficial understanding of disciplinary knowledge. Additionally, universities— particularly research universities— place greater emphasis on developing research skills rather than professional or transferable ones among students, consequently leading to a gap between what students learn at the university and what they need to know within the actual workplace (James & Holmes, 2012).

The primary function of product design is to engage in creative problem solving. A product designer develops artifacts and services through their understanding of human behavior and physical attributes, with them then utilizing brainstorming, ideation, sketching, model-making, and engineering skills to solve a given problem. Hence, to develop problem-solving skills among students who are majoring in

product design, they need to be given opportunities to work on real-world problems and be allowed to construct tangible knowledge in authentic professional contexts. Project-based learning (PBL) is an effective means with which to accomplish this goal. PBL is a form of inquiry-based education, wherein authentic problems and questions are used in real-world practices to inform education (Al-Balushi & Al-Aamri, 2014), which leads to meaningful learning (Wurdinger et al., 2007). PBL is a complex activity that focuses on complicated questions or problems. Participating students are then engaged in creative, problem-solving, decision-making, and research tasks. The goal of PBL is to provide students with a holistic and meaningful learning experience.

Product design is often considered complementary to entrepreneurial processes in various ways. Some scholars define innovation and entrepreneurship as discovering and evaluating opportunities for creating future goods and services (Venkataraman & Shane, 2000). Therefore, product design education is intrinsically linked to these basic notions. For graduates, design and entrepreneurship are necessary "transversal skills," in addition to other basic ones like creativity, innovation, critical thinking, teamwork, and communication skills (O'Sullivan et al., 2019). However, despite advancements within this industry, its education still does not regularly provide relevant real-world opportunities, meaning that product design students are often not well prepared for employment after graduation (Yang et al., 2005). Therefore, instilling complementary skills among students in these areas is essential to prepare them for the varied roles that they will inevitably play in the industry. Herein, the training goal of the product design major is to help students acquire knowledge about "innovation + design thinking + professional practice" in a way that meets the needs of social development and which promotes the integrated development of students' professional and innovative entrepreneurship skills (Liu & Zhao, 2021). The General Office of the State Council of China issued the "Implementation Opinions on Deepening the Reform of Innovation and Entrepreneurship Education in Colleges and Universities" on May 13, 2015, which then began deepening the reform of entrepreneurship education in colleges and universities. The Department of Jobs, Enterprise, and Innovation recognized the need for improved business skills among designers (Gaynor et al., 2018); therefore, to fulfill this specific need, educational institutions began to develop suitable programs and curricula. A similar skill deficit has also been identified, internationally, within the design sector (Design Council, 2005; Fleischmann, 2012). Thus, innovation and entrepreneurship education are popular topics in education and teaching reform at universities and colleges throughout the world. Nevertheless, integrating these topics and professional training into the curricula at tertiary institutions is challenging. Thus, training innovation and entrepreneurship skills are necessary for all undergraduate design programs. Guinness (2012) states that teaching entrepreneurship skills in design programs is equivalent to training these students in any other design-related skills because it effectively prepares them for the business world after graduation. However, only a few studies have explored the content and learning outcomes of innovation and entrepreneurship modules aimed at product design students. This lack is notable because higher education plays a vital role in integrating both innovation and entrepreneurship within the field of professional education, as well as in and cultivating these skills among future professionals.

This study addresses the extant lack of research into innovation and entrepreneurship skills in product design education by constructing a project-based module. Herein, we describe the process of the teaching reform of the "Product design methods and process" offered by the Dalian University of Science and Technology. This course is part of their four-year art and design program curriculum. Product design methods and processes constitute the core materials of product design, meaning that they are essential for students majoring in this field. This course offers guidance on design theories

and topics to help students master the fundamentals of product design, design procedures, design methods, and performance methods. This course is titled "Designing Cultural and Creative Products for Dalian University of Science and Technology." Herein, students are required to complete the design and production of various creative products within eight weeks, as well as then carrying out the post-promotion and sales of their products. PBL was then applied to this eight-week course for third-year product design students. A total of 32 third-year Chinese students (20 men and 12 women) majoring in product design at the Dalian University of Science and Technology were enrolled herein. We divided these 32 students into eight groups, with four students in each one. Two classes were conducted per week, with each lasting four hours. Upon completion of the course, students received four course credits. During this period, educators provided face-to-face instruction. Furthermore, we explored potentially effective methods for integrating innovation and entrepreneurship into product design, as well as for enhancing students' creative abilities and entrepreneurial drive.

Innovation and entrepreneurship education in China

To gain an in-depth understanding into current innovation and entrepreneurship education, a symposium on this topic was held by the Chinese Association of Higher Education in 2007 (Gao & Cao, 2007). According to Wang, "university-wide" innovation and entrepreneurship education is divisible into four categories: general, embedded, professional, and vocational knowledge (Wang, 2015). However, scholars have since identified various contradictions (Yang & Alex, 2014) in Chinese entrepreneurship education. For example, the disciplinary position of tertiary institutions in terms of innovation and entrepreneurship education is illegible and varies greatly. Additionally, they are often associated with several problems, such as unsuitable course content systems or a lack of professional teachers (Zhou & Xu, 2012). Jiang et al. (2018) explored the varying challenges that separate professional education from that of innovation and entrepreneurship skills in colleges and universities (Jiang et al., 2018). In this regard, a learner-centered approach was introduced by Harkema and Schout (2008) in the field of innovation and entrepreneurship education, which enabled students to be the driver of their own learning. Cao and Shi (2016) stressed the need to update ideas and concepts around innovation and entrepreneurship education, construct scientific and rational course systems, enhance the integration of professional education, and establish an effective evaluation system. Thus, innovation and entrepreneurship education should not exist as separate modules to the wider curriculum but should be integrated within its original content. Implementing innovation and entrepreneurship education reforms in China is thus reasonable, urgent, and realistic. These reforms would then enhance the quality of China's higher education systems, improve the creative ability of undergraduates, and improve graduates employability and employment quality. As educators, we aim to complete product design courses by transferring and applying innovation and entrepreneurship theories and concepts.

Project-based learning

PBL is an inquiry-based instruction method that engages learners in knowledge construction through meaningful and real-world projects (Brundiers & Wiek, 2013). The six hallmarks of PBL, as identified by Krajcik and Shin (2014), including having a driving question, focusing on learning goals and promoting participation in instructional activities, collaboration among students, use of scaffolding technologies, and production of tangible results. Herein, creating artifacts to solve real-world problems is the most important of all these features, with this the differentiating PBL from other student-centered pedagogies, such as "problem-based learning" (Blumenfeld et al., 1991; Helle et al., 2006). The creation process herein requires learners to work in a cooperative manner as they apply and integrate knowledge and come up with solutions to real-world problems. Trainers and community members (e.g., clients) then serve as facilitators who provide learners with feedback and encouragement. The use of PBL

facilitates the development of learners' knowledge and practically skills. Implementing project-based learning can encourage students to become active participants in the learning process (Movahedzadeh et al., 2012). This problem-oriented teaching mode allows students to actively find solutions by using hands-on experience, which corroborates the aims of the product design program; that is, the provision of hands-on experience along with innovations and entrepreneurship classes, thereby emphasizing more practical knowledge.

We used the course "Product design methods and processes" as an example and attempted to integrate the relevant innovation and entrepreneurship content into it. PBL was utilized in our teaching process so that students were then able to learn independently. The eight student groups then took part in this course. Students worked together in the creation process by applying and integrating their knowledge in the constructing of solutions to real-world problems. Participants received feedback and encouragement from both trainers and community members. We also offered references and suggestions to educators for potential improvements to their innovation and entrepreneurship courses.

Materials and Methods

Curriculum reform implementation process

Adapting the syllabus and developing the integration of the course content. "Product design methods and process" is a core course within the learners' product design major, which involves training third-year college students in the integrating and application of basic professional knowledge. This course benefits students by helping them to develop comprehensive design skills and by providing them with systematic education on specific topics to help them solve practical problems. The United States has a relatively mature curriculum for entrepreneurship education, whereas China is relatively low on its testing and development herein (Yu, 2018). In the United States, the extensive course content of entrepreneurship education focuses on accounting, management, finance, and other topics. Some of the typical courses are titled "Investment and Risk," "Recognizing Opportunities," and "Entrepreneurship Studies." For our course, we combined theory and practice, with many parts of it being aligned with innovation and entrepreneurship education goals. We refined the syllabus by integrating innovation and entrepreneurship topics into this course and carefully selected each of the integration points. To integrate the course content of "Product design methods and process," we selected various topics, such as creative thinking, innovative models, entrepreneurial project selection, and entrepreneurial team building, from the innovation and entrepreneurship education course (Figure 1).

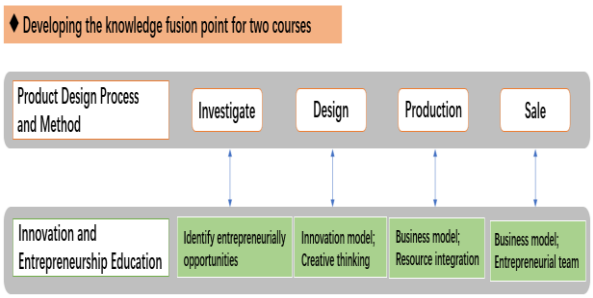

Figure 1 *Developing the knowledge integration points for the two courses.*

Additionally, the training objectives of the innovation and entrepreneurship course were integrated into the syllabus in order to instill an innovative spirit, entrepreneurial awareness, and related abilities among the students through educating them about creative thinking and enterprise creation. We also altered the course assessments and evaluation methods.

Optimizing teaching methods via the PBL model. We utilized the PBL model, which emphasizes the significance of students as the core focus in the pedological process, along with integrating the course knowledge points into real projects. Students were allowed to continuously explore complex issues during project research and enhancement, take advantage of their own initiative, and improve their ability to rationally acquire and apply knowledge. Taking the course "Product design methods and process" as an example, the steps

of the adopted teaching process were as follows:

 Project design

By combining the teaching plan of the courses, we designed a project to develop the cultural and creative product design skills of our students. A total of 32 students were divided into eight groups, with four in each group. The students then worked as a team to complete the following four tasks: preliminary research, product design, production, and sales. The project's design needed to be sufficiently challenging, with educators then having to integrate information about the knowledge points required by the students to within the project's explanation. Students would then encounter numerous problems during the various steps, such as in production, sales, mass-producing design solutions, and in controlling costs. The students were then required to constantly research new information, adjust their strategies, and improve their professional abilities and entrepreneurial skills to resolve real-world problems.

 Project plan

The implementation cycle of this project lasted eight weeks; thus, the students needed to plan their implementation schedule to ensure a successful completion. The teachers would then guide the students in establishing their project plans and schedules through examples given within the classroom and would help them complete the project planning process from design studies, design sketches, sample production, team division, process planning, presentation form, and sales model.

 Project exploration

Because four links were available to complete this project, the students were tasked with collecting novel information to solve any problems encountered. At the investigation stage, students we taught how to identify entrepreneurial opportunities, understand entrepreneurial risks, master the methods of evaluating entrepreneurial projects, and build entrepreneurial teams. Students then learned to apply creative thinking and innovative methods in the development of projects in a way that addresses specific market needs during the design phase. In the production stage, the students mastered the use of various integrating resources and were tasked with controlling the production costs, as well as with developing entrepreneurial resource management skills to design their final products. In the final sales stage, the students carefully considered their choice of business model and became familiar with the process of financing a startup. They adjusted their plans based on the problems that they had encountered throughout the project. They also applied their newly gained knowledge of innovation and entrepreneurship throughout the entire product design and development process.

 Project display

According to Larmer and Mergendoller (2010), a final publicly available product, such as a presentation, is required within the scope of PBL. Students' final designs were presented in the form of course exhibitions, with any outstanding products then being produced and sold and which were then promoted as cultural products from the campus. This process allowed students to then sell their designs in the market. Our goal was to motivate and inspire confidence among them in order to improve their learning abilities and to help them realize that the public would recognize their work.

 Reflections on this evaluation

Educators and team members proposed revisions to the plan at each stage, with students then improving the project across its various iterations. In addition to the faculty involved in teaching this course, we invited various external experts (such as industrial designers, product managers, and sales experts) to judge the students' final work. Herein, our course adopted a more flexible method for the assessment of students' work. this assessment was based on the following two aspects: students' professional knowledge and their understanding of innovation and entrepreneurship. We evaluated each student's learning via five factors: learning process,

learning attitude, learning engagement, learning outcomes, and presentation skills. The students' learning process was evaluated according to their mastery and application of specific knowledge. Our evaluation of students' learning attitudes primarily relied on five of the eight evaluation criteria proposed by Sandra Colhando in 2020 on LinkedIn, namely: 1) Improved self-confidence & competence, 2) Keeping the brain healthy & sharp, 3) Changing one's hobbies into business ideas & collaborations, 4) Being less averse to risks, and 5) Being more adaptable to change. The assessment of students' learning engagement was based on give items mentioned in the ebook "It is Not Just About Fun: The essential guide to learner engagement," which includes the following: 1) Being active in their learning, 2) Being eager to participate, 3) Being willing to expend effort, 4) Being motivated, 5) Being inspired. Furthermore, many scholars have advocated incorporating novelty, usefulness, and elaboration for assessing idea creativity (Gabriel et al., 2016; Jagtap et al., 2015). Therefore, students' learning outcomes were evaluated using three aspects: novelty, usefulness, and product elaboration. The evaluation of students' presentation abilities typically focused on the effect of their product display, the logic of their presentation, and their ability to promote the product. Because the teachers were involved in the entire learning process, they were well aware of the students' educational situation. Hence, the evaluation proportion of the course teachers accounted for 70% of these criteria, whereas that of external experts accounted for 30%. External experts assessed the students on their final learning outcomes and presentation skills. This assessment aimed to improve students' comprehension abilities overall. Table 1 presents a detailed description of the course's composition and assessment methods.

Table 1 *Course composition and assessment methods*

Course composition	**The basic theory of product design + the basic theory of innovation and entrepreneurship**	
Evaluation proportions	**Internal course teachers (70%)**	**External experts (30%)**
Learning process (10%)	Mastery of specific knowledge (5%) Application of specific knowledge (5%)	
Learning attitude (20%)	Improved self-confidence & competence (4%) Keeping the brain healthy & sharp (4%) Changing hobbies into business ideas & collaborations (4%) Less averse to risks (4%) More adaptable to change (4%)	
Learning engagement (10%)	Active in their learning (2%) Eager to participate (2%) Willing to expend effort (2%) Motivated (2%) Inspired (2%)	
Learning outcomes (10%)	Novelty (5%) Usefulness (5%) Elaboration (5%)	Novelty (5%) Usefulness (5%) Elaboration (5%)
Presentation skills (30%)	The effect of the product display (5%) The logic of the presentation (5%) The ability to promote the product (5%)	The effect of the product display (5%) The logic of the presentation (5%) The ability to promote the product (5%)

Results

After completing the course, we conducted semi-structured random interviews with

representatives from the eight student groups to explore their perceptions of the course and to examine the effectiveness of this teaching method. To ensure inclusivity in our study outcomes, we interviewed four women (F1-F4) and four men (M1-M4) from all of the student participants. Informed consent was shown to each interviewee before the interview began. All interviewees were clearly informed of the purpose of the interview and signed the informed consent indicating their consent. The content of our interviews is transcribed and presented in Tables 2 and 3, respectively.

Table 2 *Feedback from four women interviewees*

Interviewee	Transcript
F1	"The course gave us a thorough understanding of product design procedures and methods and the entire product life cycle from production to sales. Additionally, we gained a great deal of knowledge about innovation and entrepreneurship, which provided us with many novel ideas for our future studies and has opened up more opportunities and possibilities for our future careers."
F2	"We worked together as teams throughout the course to solve all problems from the start of the product design to the end of the sales process. After discussing and cooperating with my partners, I came up with various creative ideas and innovative approaches."
F3	"I liked the experience of taking this course because when I got to participate in the design of an actual project, I no longer felt that my coursework was irrelevant. I became more active in the course and I also realized that the design we do has value."
F4	"The homework theme for this course is closely connected to our lives. We are quite familiar with this topic. Furthermore, I found it very interesting to design cultural and creative products for our school. I would appreciate it greatly if our design work could be adopted. I would love to participate in a similar course."

Table 3 *Feedback from four men interviewees*

Interviewee	Transcript
M1	"By taking this course, we learned more about the processes of product design and product marketing. At the final presentation of my design work, we also received a lot of feedback from external experts, instructors, and classmates, and we hope to continue improving our work in the future."
M2	"Our design product was selected as the campus cultural product that was promoted during this course. I am very proud and excited. We are very grateful to have been recognized by external experts, teachers, and our classmates. We all like the product design major and the experience helped us gain confidence in our future professional studies and also helped us in being certain in our career plans."
M3	"There is a big difference between this course and previous professional courses. We can now solve emerging problems with our teachers and classmates, allowing our work to be continually improved and refined rather than it being complete design work alone. The external experts also gave us advice from a marketing perspective. I think I have a more holistic understanding of the course, which will benefit my future professional studies."
M4	"By integrating the knowledge of product design with the knowledge of innovation and entrepreneurship, I got a taste of the teamwork atmosphere I'll encounter in the future workplace. Since this is the first time, I have finished an actual project at my university, I took every part of it very seriously, and I hope that a more extensive audience will recognize our final product design."

The quotes in Table 2 show that the students were trained in the procedures and methods for designing products for the whole process from design to post-sales. Additionally, the course incorporated innovative and entrepreneurial knowledge, which provided students with new perspectives for their career growth. Thus, we found that offering students additional knowledge about innovation and

entrepreneurship in product design classes will help them develop a new perspective and focus on potential future careers. The interviewee, coded as F2, also mentioned that they worked together with other students to solve each problem from the initial design stage to the sales process. They developed numerous appropriate creative solutions and innovative ideas by discussing and collaborating with their group partners during the learning process. Therefore, we believe that future teaching based on this method would be effective in reinforcing students' ability to collaborate and will encourage them to explore various feasible problem solution strategies through group cooperation. The interviews with the interviewees coded as F3 and F4 helped us understand how participation in real-world projects, especially those closely related to their personal lives, helped them to become more aware of their interest in the course and made them realize the value of their design work. These results suggest that more traditional virtual projects should be replaced by real-world ones in future courses. Furthermore, topic selection should be based on students' interests in order to encourage their active participation in real projects. Additionally, teachers should ensure that their students understand the design process and the significance of taking part in real-world projects in order to enhance their sense of participation.

Unlike the feedback from the four women interviewees, that from the four men interviewees reflects the positive influence of teachers and classmates on the completion of their design projects during the course. For example, M1 mentioned that he received extensive feedback from teachers, classmates, and external experts during their final exhibition and hoped to continue improving his design projects thereafter. Based on students' feedback, it becomes clear that their enthusiasm increased after they received these helpful suggestions. M3 also stated that he could continuously improve and iterate on his design projects because he was able to work cooperatively with teachers and classmates on the course to solve various emerging problems. Furthermore, he mentioned that the opinions of the external experts inspired him to consider problems from a more holistic perspective in his future endeavors. This type of interaction between teachers and students is extremely beneficial for the latter's future professional development, thereby promoting their creativity and a more comprehensive range of design ideas. Thus, we suggest that educators should closely supervise their students' learning progress and situations in the classroom. Furthermore, when students encounter problems, educators should encourage them to formulate solutions together with their peers and provide timely guidance to help them develop diverse solution strategies. In addition, external experts must be invited to participate in course presentations and evaluations as these would provide students with a broader design perspective. M4 pointed out that the course provided him with a chance to experience the atmosphere of teamwork that would occur in his future workplace. Hence, we found that this teamwork mode of assistance between teachers and students positively affects the latter's professional quality in terms of their future career development.

The design projects of the group represented by M2 were ultimately chosen as the campus cultural products. The interviewee mentioned that this course boosted the confidence of all his team members, particularly in terms of their perspectives of their future studies. The course also helped students narrow down their career direction. Therefore, educators should assist students in deciding on their future education directions, pay more attention to their learning processes, and provide appropriate affirmations and suggestions. Educators should also devise incentive mechanisms or encourage students to participate in design competitions to increase latter's enthusiasm and confidence in the learning process.

Discussion

According to our analyses of our participating students' feedback, we propose the following future teaching strategies and suggestions:

 Incorporate innovation and entrepreneurial knowledge into all stages of the product design course curriculum.

As educators, we should be well versed in the knowledge of innovation and entrepreneurship as these are both skills that are required at different stages of the product development process. For example, in the early stages of product development, students should master the project management and research techniques that an entrepreneur would typically know. In the middle stage of the product design process, students should consider the perspective of entrepreneurs in terms of controlling the budget as a part of the production process and in understanding the communication skills needed between entrepreneurs and various departments involved in the production process. Finally, in the latter stages of the product design process, students should be familiar with product marketing channels and acquire various marketing skills and other relative knowledge. Herein, students would be guided to design products from a more reasonable and comprehensive perspective by integrating their newfound knowledge around innovation, entrepreneurship, and the product design processes that would then help them to develop various new perspectives and focus on their potential future careers.

 Strengthening students' teamwork through simulations of the entrepreneurial team operation model.

Teachers and students are able to take part in a discovery process through classroom collaboration (Wentworth & Davis, 2002). We recommend that students' ability to work together in teams should be reinforced and that they should be encouraged to explore feasible solutions for solving problems through group cooperation. Future education courses should focus primarily on discovering appropriate teaching methods that would help students to experience a real entrepreneurial team mode of operation, utilize their own individual characteristics, and fulfill their tasks in a way that would then improve the final output. Additionally, educators should serve as members of each team. Herein, educators would assist students in identifying solutions and provide them with timely guidance to help students develop different solution approaches to the problems that they encounter. Teamwork between teachers and students can then improve the professional quality of the latter's career development. Moreover, external experts' opinions also play a crucial role in students' career development. Therefore, the inclusion of external experts for evaluating students' design works and providing them with design suggestions can positively affect the development of their design ideas.

 Making the course assignments realistic and feasible

Going forward, educators should consider replacing virtual projects with real-world ones based on their interests. Each project task should appeal to students and be of social value. Students should fully understand the purpose and importance of these real-life projects from its beginning stages, in addition to being encouraged by educators to create and promote their design works. In this context, students would be encouraged to gain a sense of social responsibility and enthusiasm in participating when their works are successfully sold and receive attention and recognition from an external audience.

 Promoting design education through the organization of design competitions

It would benefit educators to encourage students to actively participate in design competitions. These competitions assess whether designers are able to properly integrate the essential product design elements, such as function, ergonomics, operation, and psychology, into each of their designs. The experience of participating in international design competitions not only fosters students' skills in product design but also allows them to learn about the latest international trends in the design field. The use of design competitions as a teaching method for undergraduates is a highly practical approach. Furthermore, winning international awards would help students during their undergraduate studies to

achieve better job prospects, to study abroad, and to obtain higher grades in their postgraduate entrance examinations. Many award-winning students will also then have a stronger initiative to improve their design requirements in their subsequent design studies, which will enhance the learning atmosphere in their class and will have a positive impact on the overall teaching effect.

 Strengthening the process of supervising students' learning

Educators should closely monitor the entire learning process of their students. We recommend that educators pay more attention to students' learning and serve as assistants to them in the educational process. Educators need to play a key role in helping students learn during the production and sales of their works, particularly in the later stages. Furthermore, teachers need to be effective aids for students and provide them with valuable guidance in a way that not only provides knowledge but also negotiate it with students in dialogic interactions wherein they share and revise ideas (Al-Rahmi & Zeki, 2017; Nystrand & Gamoran, 1991).

Conclusions

In this study, we integrated innovation and entrepreneurial education within a professional product design course. We employed the PBL method to integrate entrepreneurial knowledge into this design course to enhance students' creativity and entrepreneurial capabilities. Furthermore, we examined and described current teaching practices, along with educators' ideas and processes for integrating entrepreneurship education into product design courses. An interview with students further revealed that this teaching mode positively impacted them. Our findings therefore advocates for the organic integration of entrepreneurship education into product design courses. We also implemented a teaching reform practice for entrepreneurial education and product design course integration based on PBL. Based on this, we proposed both a teaching model and evaluation method based on the integration of entrepreneurship education with product design, thereby providing innovative teaching perspectives and suggestions for relevant educators.

Based on the feedback received from students after the course, we concluded that the integration of innovation and entrepreneurship education into professional courses would allow for learners to focus effectively on their future career development by helping them better understand the entire process of product design, from the initial design stages to market launch, which then encourages them to consider future product design decisions that are appropriate for the market development stage. Additionally, the PBL method enables students to experience the operational mode of a real-world entrepreneurial team. We found that 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. Our teaching method of instilling cooperation between teachers and students also encouraged the latter to develop more innovative ideas for product design.

Moreover, students reported that they discovered novel methods for solving problems through the teamwork and discussions. Thus, we believe that teaching through the use of teamwork between educators and students would cultivate the latter's entrepreneurial capabilities and enhance their innovative awareness. It also confirms previous ideas about PBL as proposed by various scholars, such as Condliffe et al. (2017), who claimed that this method fosters students' creativity and that the resulting thinking skills improve their communication and collaboration abilities and facilitate self-directed learning.

Limitations and Future Research

Further research on this specific teaching process and project content design is highly warranted. Our study presented a preliminary exploration and practice of its developed teaching model. To effectively improve students' innovation and entrepreneurial

abilities, continually exploring and practicing the integration of innovation and entrepreneurship education according to the disciplinary characteristics of product design majors is vital for educators. As such, we intend to verify and improve the effectiveness of our teaching methods in future studies.

Reference

[1] Al-Balushi, S. M., & Al-Aamri, S. S. (2014). The effect of environmental science projects on students' environmental knowledge and science attitudes. International Research in Geographical and Environmental Education, 23(3), 213-227. https://doi.org/10.1080/10382046.2014.927167

[2] Al-Rahmi, W. M., & Zeki, A. M. (2017). A model of using social media for collaborative learning to enhance learners' performance on learning. Journal of King Saud University-Computer and Information Sciences, 29(4), 526-535. https://doi.org/10.1016/j.jksuci.2016.09.002

[3] Alorda, B., Suenaga, K., & Pons, P. (2011). Design and evaluation of a microprocessor course combining three cooperative methods: SDLA, PjBL and CnBL. Computers & Education, 57(3), 1876-1884. https://doi.org/10.1016/j.compedu.2011.04.004

[4] Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. Educational Psychologist, 26(3-4), 369-398. https://doi.org/10.1080/00461520.1991.9653139

[5] Brundiers, K., & Wiek, A. (2013). Do we teach what we preach? An international comparison of problem-and project-based learning courses in sustainability. Sustainability, 5(4), 1725-1746. https://doi.org/10.3390/su5041725

[6] Cao, F., & Shi, W. (2016, December 2-4). The Path Choice of China's Innovation and Entrepreneurship Mode of Universities and Colleges Based on the Enlightenment of America Babson Commercial College.Advances in Social Science, Education and Humanities Research 2016 3rd International Conference on Education, Language, Art and Inter-cultural Communication (ICELAIC 2016), Xiamen, China.

[7] Casner-Lotto, J., & Benner, M. W. (2006). Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century U.S. workforce (0823708888). https://files.eric.ed.gov/fulltext/ED519465.pdf

[8] Condliffe, B., Quint, J., Visher, M. G., Bangser, M. R., Drohojowska, S., Saco, L., & Nelson, E. (2017). Project-based learning: A Literature Review. http://files.eric.ed.gov/fulltext/ED578933.pdf

[9] Design Council. (2005). The Business of Design: Design Industry Research 2005. In. London: The Design Council.

[10] Fleischmann, K. (2012). Industry-driven design education: how much should industry dictate pedagogy? In G. Muratovski (Ed.), AgIdeas Research: Design for Business (pp. 76-95). AgIdeas Press. https://researchonline.jcu.edu.au/23799/2/23799_Fleischmann_2012.pdf

[11] Gabriel, A., Monticolo, D., Camargo, M., & Bourgault, M. (2016). Creativity support systems: A systematic mapping study. Thinking Skills and Creativity, 21, 109-122. https://doi.org/10.1016/j.tsc.2016.05.009

[12] Gao, X., & Cao, S. (2007). Innovation and Entrepreneurship Education,Develop New Era Career Pioneer -- Summary of the Symposium of Innovation and Entrepreneurship held by Chinese Association of Higher Education. China Higher Education Research(7), 91-93. https://doi.org/10.3969/j.issn.1004-3667.2007.07.035

[13] Gaynor, L., Dempsey, H., & White, P. (2018, 25-28 June). How design thinking offers strategic value to micro-enterprises. Design as a catalyst for change - DRS International Conference 2018, Limerick, Ireland.

[14] Guinness, P. (2012). Based learning: Teaching development through fieldschools. Journal of Geography in

Higher Education, 36(3), 329-339. https://doi.org/10.1080/03098265.2012.696188

[15] Harkema, S. J., & Schout, H. (2008). Incorporating student-centred learning in innovation and entrepreneurship education. European Journal of Education, 43(4), 513-526. https://doi.org/10.1111/j.1465-3435.2008.00372.x

[16] Helle, L., Tynjälä, P., & Olkinuora, E. (2006). Project-based learning in post-secondary education–theory, practice and rubber sling shots. Higher Education, 51(2), 287-314. https://doi.org/10.1007/s10734-004-6386-5

[17] Jagtap, S., Larsson, A., Hiort, V., Olander, E., & Warell, A. (2015). Interdependency between average novelty, individual average novelty, and variety. International Journal of Design Creativity and Innovation, 3(1), 43-60. https://doi.org/10.1080/21650349.2014.887987

[18] James, S., & Holmes, C. (2012). Developing vocational excellence: learning environments within work environments (1466-1535). https://www.researchgate.net/profile/Susan-James-6/publication/264210972_Developing_Vocational_Excellence_Learning_Environments_within_Work_Environments/links/53d23b100cf2a7fbb2e985b3/Developing-Vocational-Excellence-Learning-Environments-within-Work-Environments.pdf

[19] Jiang, X., Pan, X., & Chen, P. (2018, June 23-24). Reflections on the Integration of Innovative Entrepreneurship Education and Professional Education. 2018 2nd International Conference on Management, Education and Social Science (ICMESS 2018), Qingdao, China.

[20] Krajcik, J., & Shin, N. (2014). Project-based learning. In R. K. Sawyer (Ed.), The cambridge handbook of the learning sciences (2 ed., pp. 275-297). Cambridge University Press. https://doi.org/10.1017/CBO9781139519526.018

[21] Larmer, J., & Mergendoller, J. R. (2010). Seven essentials for project-based learning. Educational Leadership, 68(1), 34-37. http://www.ascd.org/publications/educational_leadership/sept10/vol68/num01

[22] Liu, X., & Zhao, Y. (2021). Research on the Application Strategy of Project-Based Learning Teaching Mode in Practical Teaching of Product Design. 2020 International Conference on Modern Education Management, Innovation and Entrepreneurship and Social Science (MEMIESS 2020),

[23] Movahedzadeh, F., Patwell, R., Rieker, J. E., & Gonzalez, T. (2012). Project-based learning to promote effective learning in biotechnology courses. Education Research International, 2012, 1-8. https://doi.org/10.1155/2012/536024

[24] Nystrand, M., & Gamoran, A. (1991). Instructional discourse, student engagement, and literature achievement. Research in the Teaching of English, 25(3), 261-290. https://www.jstor.org/stable/40171413

[25] O'Sullivan, C., Slocombe, A., McKenzie, C., & Salisbury, F. (2019, 23-27 June). Digital dexterity: A sustainable model for building essential skills for the future workforce. Proceedings of the IATUL Conferences, Perth, Australia.

[26] Venkataraman, S., & Shane, S. (2000). The promise of entrepreneurship as a field of research. Academy of Management Review, 25(1), 217-226. https://doi.org/10.2307/259271

[27] Vogler, J. S., Thompson, P., Davis, D. W., Mayfield, B. E., Finley, P. M., & Yasseri, D. (2018). The hard work of soft skills: augmenting the project-based learning experience with interdisciplinary teamwork. Instructional Science, 46(3), 457-488. https://doi.org/10.1007/s11251-017-9438-9

[28] Wang, Z. (2015). On the Systematic Framework and Theoretical Value of the "University-wide" Innovation and Entrepreneurship Education. Educational Research, 5, 56-63.

[29] Wentworth, J., & Davis, J. R. (2002). Enhancing interdisciplinarity through team teaching. Innovations in Interdisciplinary Teaching, 16-37.

[30] Wurdinger, S., Haar, J., Hugg, R., & Bezon, J. (2007). A qualitative study using project-based learning in a mainstream middle school. Improving Schools, 10(2),

150-161. https://doi.org/10.1177/1365480207078048

[31] Yang, M., & Alex, R. (2014). Innovation Explore of Entrepreneurship Education Based on Extenics. Procedia Computer Science, 31, 832-841. https://doi.org/10.1016/j.procs.2014.05.334

[32] Yang, M. Y., You, M., & Chen, F. C. (2005). Competencies and qualifications for industrial design jobs: implications for design practice, education, and student career guidance. Design Studies, 26(2), 155-189. https://doi.org/10.1016/j.destud.2004.09.003

[33] Yu, C. W. (2018). Understanding the ecosystems of Chinese and American entrepreneurship education. Journal of Entrepreneurship Education, 21(2), 1-18. https://vc.bridgew.edu/management_fac/42

[34] Zhou, M., & Xu, H. (2012). A review of entrepreneurship education for college students in China. Administrative Sciences, 2(1), 82-98. https://doi.org/10.3390/admsci2010082