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Transforming a Public School: A Case Study of Tongji-Huangpu School of Design and Innovation and Its Search for Synergy

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Abstract: In response to the changes of technological and sociological landscape, education policies and experiments are emerging globally. Tongji-Huangpu School of Design and Innovation (THDI) is a newly reformed educational institution in China. It operates in the Chinese public education system and is designed to model 21st-century learning practices by applying a design thinking (DT) methodology and problem/project-based learning (PBL) pedagogy. This case study gives an overview of the school, outlines the practice of the past 27 months since its establishment and elaborates the tensions during transition phases. Synergy, the concept of the whole being greater than the sum of its parts, is identified as the goal of reducing tensions, and three design initiatives have been implemented for improving the collaboration among high school and college teachers. The school reform is the first of its kind in China and it hopes to shed light on the design and education research.

Keywords: design thinking; pbl pedagogy; school reform; synergy

1. Introduction

Education has gone through several reforms in the past century. This started with replacing the classical education of the type offered to royalty and wealthy people with modern education that became more practical and civilian. Gradually, human capital theory that explained the economic value of a worker's experience and skill was put forward by economists like T. W. Schultz (1963), who further developed the notion of education as investment in human capital rather than consumption. Since then, education has reflected the national will and administrative power. With the development of globalization and the civil rights movement, however, education inequality has been criticized, and global organizations like the Organization for Economic Co-operation and Development (OECD) and United Nations Educational, Scientific and Cultural Organization (UNESCO) have started to play an important role in setting up educational goals. In recent years, education reforms

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have become fierce with the demand from the top and the bottom for change. People have never been more anxious than they are now, fearing that jobs will be filled by intelligent robots. New education policies, schools, curricula, and pedagogies are emerging as an antidote to the assembly-line production that formerly characterized the school system. Among these, problem/project-based learning (PBL); social emotional learning (SEL); STEM and entrepreneurship education (Zhou & Tang, 2018; Zupan & Nabergoj, 2012); and design thinking (DT) have become the buzzwords of the day. As the representative of this education reform, High-Tech High (HTH)¹ in the US just won the WISE Prize for Education², the world-class education reward, and spread its PBL philosophy and practice around the world.

The education innovations and reforms have had a great influence in China. Recently, China has even led educational innovation in the field of artificial intelligence (AI) by incorporating AI into public K–12 education³. This is one of the strategies that the state has adopted to fulfill its aims of transforming “Made in China” to “Created in China,” which was stated in the 13th National Five-Year Plan. Various education measures have been carried out to cultivate the future generation such that it will be more critical and creative. In 2003, the Law of the People’s Republic of China on the Promotion of Private Education was executed, which broke down the situation of the state-run public education system and offered the private and international school choices for families. In 2017, the National Entrance Exam reform was implemented on an experimental basis in a couple provinces to encourage students’ comprehensive competence development. However, the situation in China is similar to that in the United States, where most of the education initiatives are seen in extracurricular activities rather than core subjects (Mehta & Fine, 2019). To transform the core of the traditional school system, new Chinese schools emerged (see Table 1). It should be noted that international schools and courses have sprung up, but they are not categorized as new Chinese schools in this article. Rather, to be considered new Chinese schools, the schools must be based in China, have Chinese founders, and have curricula that were originally created in China.

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- 1 Developed by a coalition of San Diego civic leaders and educators, High Tech High opened in September 2000 as a small public charter school with plans to serve approximately 450 students. HTH has evolved into an integrated network of sixteen charter schools serving approximately 5,350 students in grades K-12 across four campuses. The HTH organization also includes a comprehensive adult learning environment including a Teacher Credentialing Program and the High-Tech High Graduate School of Education, offering professional development opportunities serving national and international educators. High Tech High is guided by four connected design principles—equity, personalization, authentic work, and collaborative design—that set aspirational goals and create a foundation for understanding our approach. See <https://www.hightechhigh.org/about-us/>
 - 2 Wise Prize for education established in 2011 is the first distinction of its kind to recognize an individual or team for an outstanding, world-class contribution to education. See <https://www.wise-qatar.org/wise-works/wise-prize-for-education/>
 - 3 Chinese Publisher Introduces AI Textbooks for Pre-schoolers. See <https://tinyurl.com/wzctab6>

Table 1 Chinese Schools Founded in the Past Three Years

School Name	Ownership	Year of First Student Enrollment	Initiator/ Founder	First Campus Location	Academic System
Agilearning	Private	2019	Zhijuan MA	Beijing	Pre-K–12
Moonshoot Academy	Private	2018	Jason WANG	Beijing	G9–12
ETU School	Private	2017	Yinuo LI	Guangzhou	Pre-K–12
Tongji-Huangpu High School of Design and Innovation	Public	2017	Yongqi LOU	Shanghai	G9-12
Yungu School	Private	2017	Jack MA	Hangzhou	Pre-K–12

These newly established Chinese schools are the pioneers of an education reform that aims to make a revolutionary change instead of simply tinkering with the traditional rote testing school system. Among them, Tongji-Huangpu High School of Design and Innovation is the only public high school. It is intended to innovate in the public school system with design thinking and pave an alternative way of learning and teaching for more public schools. The dynamics of the change involves discrete agencies, agents, and conditions; this requires a synergism of the forces (learners, educators and the system) working together for a common goal that can exceed the original goals via focused efforts.

2. Overview of Tongji-Huangpu High School of Design and Innovation

The central theme of design is the conception and planning of the artificial. Design provides the thought that guides the making of all products, whether by individual craftsmanship or mass-production techniques. These include the following: (1) material objects; (2) verbal and visual communication; (3) organized activities and services; and (4) complex systems or environments for living, playing, working, and learning. Virtually all definitions of design today are variations of this theme, each intended to draw out a different aspect or emphasize different possibilities of its meaning in accordance with different (usually tacit) theoretical or philosophical assumptions (Buchanan, 1995, p. 82).

2.1 Challenges and approaches

When Tongji-Huangpu High School of Design and Innovation enrolled its first group of 48 students in Shanghai in the fall of 2017, it was the first of its kind—a public secondary high school purposefully designed around the core principles of design-thinking in China, although design thinking had been applied to K–12 education for more than 10 years in the United States (Roth, 2017). Through collaboration with the local education bureau, the school sought to create a model for teaching and learning that would combine the merits of both traditional rote test learning and the PBL way of learning. The core challenge is to

find a Doctrine-of-the-Mean between the two ways of learning within the state-run public education system. This philosophical goal of maintaining balance and harmony to a state of constant equilibrium (Legge, 1893, Chapter I, Para. 5) is rooted in the Chinese culture and people's mindset and will be easily accepted by educators and learners. Another challenge was transforming an old school to a preferred condition. Tongji-Huangpu High School of Design and Innovation is a new school in an old campus. For its new characteristics, it adopts a way of teaching and learning that is strongly aligned with 21st-century practice. In terms of being old, the high school took over everything from the old school except the name. Instead of building a brand-new school, the high school is exploring the possibilities of making changes within the public education system with design-thinking. In practice, transforming the school includes the design of a leadership structure, a professional development community, curricular structures, an assessment framework, the supporting infrastructure and more. The success of the school transformation is not only the completion of each building block but also the building of organic relationships among them.

The approach to achieving the "Doctrine of the Mean" can be seen from the school schedule, where 60% of the school time is allotted for subject matter courses and 40% for PBL courses. The 60% mode is for meeting all the requirements for high school students set by the National Ministry of Education, including passing all the standardized exams. It is taught by high school teachers or subject teachers. In this article, the two terms are used to refer to the teachers from the high school. The 40% mode, curated by the college team, is employed to break the disciplinary boundaries and features via open-ended learning chains that can fuse new knowledge and experiences through a problem- and project-based curriculum. This 40% mode is also called PBL courses and taught by teachers, researchers and postgraduates from the college. The two modes go in parallel at the beginning, but the key to their success is found in the interdisciplinary synergy of the two modes.

Choosing problem and project-based learning as the teaching pedagogy is based on a school goal of cultivating students to be future leaders in diverse areas. This requires the students to master a depth of knowledge and have various capabilities that can cope with increasingly complicated real-world problems. A three-dimensional (3D), T-shaped framework and knowledge cube was proposed by the initiator, Prof. LOU (Figure 1). The framework was developed from the T-shape concept (Leonard, 1995), which emphasizes the importance of both vertical and horizontal knowledge and skills. The metaphor of a thumbtack best describes the T-shape's capability. Only if the two work together can a thumbtack be pushed into a wall (Lou & Ma, 2015). Lou and Ma (2015) further emphasized that the "connection part" of the vertical and horizontal is crucial, and people who are strong at the connection part can be trained through applying "depth of knowledge" to solving real-world problems. Apart from problem-based learning and project-based learning under the rubric of PBL, which forms a global norm (Mohd-Yusof, Graaff, & Kolmos, 2016), another seven PBLs are proposed at the high school (Lou, 2018)⁴. The nine PBLs work together as a manifesto of the teaching and learning philosophy, promoting the interweaving and linking of "vertical" and

4 Passion-, personnel-, process-, participation-, practice-, prevision-, and peer-based learning

“horizontal” capacities.

Figure 1 Relationship between the T-shape and knowledge cube (LOU, 2012).

2.2 Consensus and infrastructure building

The school goal was initially narrowly defined, but the consensus that design thinking as a teaching and learning catalyst and design-driven innovation education as the school guiding ideology will better prepare students to face the complex technological and sociological challenge of tomorrow than rote learning does. The district education bureau was determined to take the risk; thus, it quickly selected a school for the experiment and allocated special funding. The school principal was attracted by the vision; thus, she left her previous school and joined forces with the new school. Parents and students bravely joined the experiment. Many gave up an acceptance by a “key school” with a high reputation and chose the new school. Several teachers from the previous school left, but most remained, regardless of the high uncertainty ahead. The school vision brought the stakeholders together.

With the shared goal and government funding, the school infrastructure has been developing along with the development of the school activity. The school campus and classroom have been redesigned to fulfill the educational goal of a student-centered school that enables social interaction (Dewey, 1916), open and flexible communication and collaboration, and a happy and safe learning environment (Figure 2). The school space encourages students and teachers to organize and create an environment that serves their learning purpose. Therefore, students are no longer passive receivers, and teachers have to change their role from “dictator” to facilitator (Figure 3).

Figure 2 Environmental design principle and rule system (Ran XUN, thesis proposal under the supervision of Prof. LOU, 2017).

Figure 3 Classroom before (left) and after (right) the school reform at Tongji-Huangpu High School of Design and Innovation.

From a wider perspective, the school should be open to the social community and share resources with other parts of the community. For example, the school will build cooperation with the museums, galleries, and hotels in the community. And the community can access to the resource and space of the school. Ultimately, the walls of the school are no longer a barrier to being part of the wider community and community is integrated as a part of the school for teaching and learning (Figure 4).

Figure 4 *Tongji-Huangpu High School of Design and Innovation and the neighborhood community (Yiting WU, college studio work, 2017).*

2.3 A college and high school partnership

The collaboration between the design college and high school advances mutual interests. The college conducts teaching and research activities at the high school and applies the findings to help transform the school. The high school teachers learn from working with the college teachers, and students gain access to rich resources from the college. As a result, they co-design the school and the related studio curricula at college. This partnership enables the design to expand beyond the traditional arts and craftsmanship and shift the paradigm to solve strategic and holistic problems (Lou, 2017). It also explores the possibility that design-driven innovation education can be extended to younger students at high school.

Figure 5 Partnership between the college and high school.

3. School in transition and increased tensions

Pendergast et al. (2005) proposed a three-phase model of the general sequence in which reforming schools attend to particular core component changes in their reform initiatives after the distillation of the massive amount of data.

- **Initiation phase** that typically occupies the first year or two;
- **Development phase** that typically consumes the next two to five years; and
- **Consolidation phase** that can last over a further five to ten years. (Pendergast et al., 2005, p. 64)

An agenda as ambitious as transforming a school does not come without its share of tensions and failures. The school reform has been in progress for 27 months, and tensions have emerged at different phases. These are itemized below.

3.1 Phase 1: culture shock

The initiation phase was the first year, between the fall of 2017 and 2018, when the school just resumed its admission and teaching after suspension for a year. The school campus had been partially redesigned to support the new curriculum. The PBL team was led by a Finnish design educator. Basic teacher training had been conducted to align the understanding of the school vision and design thinking methodology. Students were exciting and anticipating a brand-new learning experience. During this phase, the subject teachers who participated in the PBL course played the role of spectators and babysitters. They observed and took part in the PBL only to maintain class order. As Figure 6 depicts, the high school and college teachers

who are in charge of the PBL course stayed in their zones, with limited collaboration.

Figure 6 Typical scene of the PBL course during phase 1.

Tension soon emerged in the initiation phase. This phenomenon was similar to the culture shock people experience when they move to a cultural environment that is different from what they are used to. The PBL course embraces an open, transparent, democratic, and non-competitive environment. This is partly because the PBL curriculum lead is from Finland; tesought . The curriculum lead was strongly against competition and tried to create an experience-oriented and a failure-friendly way of learning.

In contrast to the Finnish way of learning, China is a highly competitive society. Efficiency and efficacy take priority across industries. The high school teachers described the PBL course as a utopia and expressed their concern for the learning outcome. They worried that the students took the advantage of the PBL course to have fun and in the end the students wasted their time without learning anything at school.

In addition to the cultural differences between China and Finland, there are also culture differences between college and high school. At the college level, students and teachers have great autonomy, and their interests are not tied together. However, the interests of high school teachers are closely related to students' academic performance. Hence, high school teachers engage in rote memorization for the sake of efficiency. In sum, the same group of students mean differently for high teachers and PBL course teachers and therefore are taught differently.

3.2 Phase 2: competitors and conflicts

The development phase occurred from the second year on. After one year of observation, several high school teachers took initiatives to experiment with interdisciplinary teaching in the PBL course. Later, a task force made up of high school subject teachers was built. A couple of high school teachers started to apply the PBL pedagogy and design thinking methodology for teaching subject matter during the 60% mode. Several courses in the PBL

mode settled as module courses in the PBL curriculum. From this semester on, the high school sported a full-time staff of four, including one design educator, one game designer, and two curriculum specialists. Members of the curriculum development team meet with subject teachers daily and took ownership for the PBL curriculum refinement. The school started to attract increasing attention from the public and gained a reputation as the Chinese version of High-Tech High School in the U.S.A.

After the culture shock period, high school teachers start to fight for their interests. The 60% and 40% occurred in parallel, and hence, become competitors; this led to the deviation from the vision that both modes were organically synergized. The competition of the two modes can be seen from different perspectives. For one thing, high school and PBL teachers were competing for limited time. High school teachers faced an ever-changing slate of rules and regulations and struggled to coordinate with other subjects. However, the school reform phased out block scheduling, which allotted about 40% of school time to do PBL practice without lowering the national standards for subject matters. Moreover, reaching a better PBL outcome usually required extra time after school. The scramble for time led to high dissatisfaction among the high school teachers. For another thing, high school and PBL course teachers fought for the control of students. In the PBL course, students can easily engage with interesting topics or materials and feel relaxed, without experiencing exam pressure. In contrast, students find the subject textbooks boring and are very passive in learning. One high school teacher complained, “students have no interest and energy in the traditional subject class after taking PBL courses.”

Competition is due to the conflict of interests, which can be resolved as the two modes are synergized. Bigger conflicts come from institutional rigidity. How much autonomy can high school teachers have? How much freedom can high school teachers employ to teach at their pace rather than busily coping with various inspections and tests from the district, province, and state? The ideal of the PBL curriculum is the synergism of the high school syllabus across disciplines and practicing the content in a problem- and project-driven way of learning. It requires subject teachers to take on identities as designers rather than content experts who are only charged with delivering information to students. Similarly, how much autonomy can high school students have? How can they be evaluated as whole persons rather than exam machines? Unlike students at international and private schools, who can choose the Gaokao (national college entrance exam) or to study abroad, THDI students take the Gaokao, in which the test score means everything. As the Gaokao approaches, high school teachers and students become anxious and can hardly concentrate on the PBL courses in the senior grade. Although they believe in the vision of the school, they prefer to increase their scores through practicing the content on paper repeatedly to be on the safe side.

After 27 months, the school is still at the early stage of transition. The competition between subject courses and PBL courses and emerging conflicts are the inevitable result of socio-political processes involving different stakeholders, classrooms, schools, locales, and even national factors. Quick reaction to the conflicts and intensive action maintained over years are required.

4. Efforts at synergy

4.1 Toolkit development

Although Tongji-Huangpu High School of Design and Innovation is a new school, the high school teachers are all from traditional high schools. They've got used to the chalk-and-talk way of teaching and got great pressure to learn and try PBL pedagogy without enough guidance and support. In some degree, the school reform adds extra burden to them rather than helping them reduce their burden. Therefore, first and for most, let the subject teachers benefit from applying design thinking and PBL in their teaching that can help increase students' interest in learning and turn them from passive learners to be active learners. It will therefore make teaching easier for high school teachers.

The roadmap begins with a single subject and gradually will develop toolkits, protocols, and other resources to support cross-discipline collaboration. These tools aim to help subject teachers solve their teaching pain points. The college team chose Chinese and chemistry as the starting points; these are two subjects teachers are willing to make changes to in their classroom, but they have not done so because they do not know where to start. For Chinese, writing has been problematic for both students and teachers. The subject teachers pointed out the main points of difficulty in writing as how to structure an essay and how to make the elements of model essays visible for imitation. The college team created a template after rounds of communication with subject teachers and iterated them after gaining students' feedback.

For chemistry, the periodic table of elements is the entryway to the subject, but this is too abstract and boring. The college team helped turn the rote learning into a personalized way of learning by creating a toolkit to connect the elements to students' daily life story (figure 7).

Figure 7 Periodic table of elements assignment for students (Ying LIU, toolkit development for her master research, 2019).

These tools assist the subject teachers to turn a rote learning into a more interactive and fun learning process and shift their attitude of treating the PBL course teachers as competitors to teaching partners.

4.2 Collaboration and learning from doing

Traditionally, the teaching profession has been an isolating one. Accountable for the performance of the students in their classrooms and on the standardized tests, teachers rarely have time for professional development, much less collaboration. Moreover, they do not have the opportunity to engage in a process of design, iteration, and reflection. The pace at which they must move to cover all the required standards is just too fast. By introducing an internally collaborative project, the PBL team sought to change the experience of traditional teachers, and in so doing, build internal capacity at the school.

In the fall of 2018, a program called Student-Initiated Project Program (SIPP) was conducted for three months. After one year of PBL courses, students were given the space to conduct an inquiry independently, with the teachers as facilitators. Going through the design process, students learned the basics of conducting design research and shifted their attitude from a results-driven one to learning from doing.

In addition to building student autonomy and research capability, another original intention was to train the high school teachers through the project process. A high school teacher and PBL course teacher were assigned. Before and after every class, both parties shared their observations and points of confusion and prepared the resources for the next class. After three months of participation, the high school teachers had become familiar with the design

research process, learned to develop a toolkit for a specific purpose, and started to shift their identity. However, only a small group of high school teachers took part in the Student-Initiated Project Program (SIPP), and making it accessible to more teachers will take time.

4.3 Teaching and learning service design

Service design is an emerging practice in education. It takes a holistic view of all the related actors, their interactions, and supporting materials and infrastructures (Interaction Design Foundation, n.d.), and it requires a collaborative approach to customer needs and the competencies and capabilities of service providers (Kuzmina & Bhamra, 2014). A service design approach explores the relationship among various actors and identifies the interaction touch points, assisting the high school to navigate uncertainty during the transition.

After immersion in the school classroom for a year, the college team depicted different users' personas, working scenarios, and needs, offering teaching and learning services with a data platform. This data platform helped school administrators, teachers, students, and parents collaborate with resources beyond the school. Figures 8 is one sample of the service design.

Figure 8 Data board and work plan (Yuetong ZHAO, 2019).

5. Conclusion

Through the development of the PBL curriculum, we can see that the school reform sought to achieve more than a mere exchange of resources among the college and high school.

By synergizing the traditional exam-oriented learning, PBL pedagogy, and design thinking methodology, it expected to create something new and valuable—a whole that would be greater than the sum of the individual parts.

Currently, the school is in the second phase of reform, focusing on the teachers and the development of systems that engage them in realizing the vision. In essence, it is crucial to make the reform an integral element of the school culture. This can be difficult and frustrating, and the corrosive effects of resistance, cynicism, and burnout expressed by some staff can be anticipated. As Michael Fullan (2001) reminded us after his study of numerous education reforms, the change process is not linear, but rather, it is a continuous, interactive journey full of uncertainties, turmoil, and resistances. Apart from the creation of toolkits for the teachers, initiatives of collaboration culture building, and the development of a learning service platform, a sustainable model of innovation should be further explored. This dictates an extremely different relationship between the school administration and the frontline teachers.

The school reform has faced constraints from the beginning, and it still has to comply with the rules governing any urban public school. State syllabuses heavily restrict what can be taught, and standardized tests determine how the material must be presented. Given the unusual pedagogical model and public context in which it operates, the high school experiment is itself a precious lesson for both education and design research.

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