

Design for Classroom Units: A Collaborative Multicultural Studio Development with Chinese Students

C. S. Caires, A. Barbosa, W. Hanyou

Abstract—In this paper, we present the main results achieved during a five-week international workshop on Interactive Furniture for the Classroom, with 22 Chinese design students, in Jiangmen city (Guangdong province, China), and five teachers from Portugal, France, Iran, Macao SAR, and China. The main goal was to engage design students from China with new skills and practice methodologies towards interactive design research for furniture and product design for the classroom. The final results demonstrate students' concerns on improving Chinese furniture design for the classrooms, including solutions related to collaborative learning and human-interaction design for interactive furniture products. The findings of the research led students to the fabrication of five original prototypes: two for kindergartens ('Candy' and 'Tilt-tilt'), two for primary schools ('Closer' and 'Eks(x)'), and one for art/creative schools ('Wave'). From the findings, it was also clear that collaboration, personalization, and project-based teaching are still neglected when designing furniture products for the classroom in China. Students focused on these issues and came up with creative solutions that could transform this educational field in China.

Keywords—Product design, interface design, interactive design, collaborative education and design research, design prototyping.

I. INTRODUCTION

THE "Interactive Product Design for the Classroom" workshop aimed to promote students from the Wuyi University to broaden their international horizons, learn leading-edge, innovative design thinking and creative design skills, and to improve the communication and cooperation between international academics and students in Wuyi University. Students went through different learning stages, going from concept design, ideation, sketching and technical drawings to interaction mockups and 3D model prototyping for manufacture. During the workshop, the practical work was led by Prof. Carlos Sena Caires and Professor Álvaro Barbosa (both from USJ), Prof. Mohsen Jaafarnia (Iranian designer and now teaching at the Hunan University, China), designers Vincent Ho and Simon Huang (from China), and the fabrication laboratory managers, Professor Gerald Estadieu, Mr Tiago Monteiro and Mr Marco Leong Chou Kin (both

from USJ).

On the one hand, Design and Education have been approached in many different ways, from secondary school to the University [1], [2]. On the other hand, the design of new products for classrooms brings new challenges in terms of creativity and collaborative work, mainly when creativity is clearly defined and intentionally practiced, and when all participants work together to bring to the utmost their learning experience. Furthermore, the design for classroom infrastructure (e.g. interactive furniture), as a collaborative multicultural studio development, can be approached as an innovative and substantial contribution to such field. The proposition is challenging, especially if we think that in today's classroom educators need the flexibility to incorporate new information and ideas into their lessons when presenting, sharing and interacting with students that are increasingly active contributors. To think about tomorrow's classroom is to imagine new products that allow not only endogenous interaction but also participation and collaboration between students and teachers. It is to design new interactive products [3] and think about new forms and means, new functions and interactions, respecting ergonomic dimensions and relations [4], [5] within behavioural affordance and feedback [6]. It is also to define the entire digital interaction-navigation framework contents and the overall experience by their users.

The projects developed by the students were designed to encourage better class participation and to encourage the use of digital and interactive products in the classroom. Upon completion of the workshop, students were able to demonstrate the whole design process from initial sketches to detailed technical drawings and renderings. Each group of students developed a project under a framework of sustainability from the first concepts to final prototypes. The final results demonstrate their ability to tackle fundamental issues related to interaction design, ergonomics, interior design, furniture design for kids, collaborative work, and learn and play in the classroom.

II. A COLLABORATIVE WORKSHOP

The 22 students, from year two and year three design program at Wuyi University, were divided into five groups of 4 to 5 students each. At the beginning of the workshop, the main challenge was presented: to design new solutions for the classroom of the future (in China), taking into account the real needs of lecturers and students. The first part of 90 hours' lectures and practical work that took place between the 14th of

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May to the 1st of June. The second part, of 60 hours, was devoted to prototyping and interactive design. The main goal of the workshop was to search for new solutions related to the design of the classroom, including the design of interactive furniture and a systematic approach to new interaction design for collaborative learning and teaching. Students were required to research, ideate, plan thoroughly, prepare, produce and present their projects, making decisions regarding their concepts, materials, technologies and design strategies for manufacturing that best translate their final ideas. The whole process focused on 1) how to learn to create a design strategy that differentiates new products from their competitors. 2) How to use design as a research tool to discover students and teachers needs, motivations and goals and how to design for them. 3) How to use ideation and brainstorming best practices to create innovative new products and solutions. And, 4) how to understand interaction design to define product design. In this paper, we present a critical review of the projects developed by the students during this workshop.

A. The Education Pyramid Model

During this workshop, the training team followed a pedagogical approach based on project-based experimentation. It relies on the concept of the inverted Educational Pyramid (Fig. 1), where instead of providing a traditional training workflow, students are introduced to several topics or disciplines and later on try to make sense of it converging to the integration of this knowledge in a Project, an inverse strategy is proposed. In the Inverted-Pyramid Educational Strategy, students are challenged with a problem or a need from the beginning, having to develop a capstone project and learning the necessary skills and knowledge to address the requirements that arise from developing this project. Following this strategy, students achieve results that are experimental and unique. They can fail several times before converging to the final result, which is something that should preferably be done at the University (less in the Industry). In this particular case, the challenge was related to the development of interactive furniture for the classroom, which is also aligned with the strategic development of an industrial cluster in this area for the region of Jiangmen in the Province of Guangdong, in China.

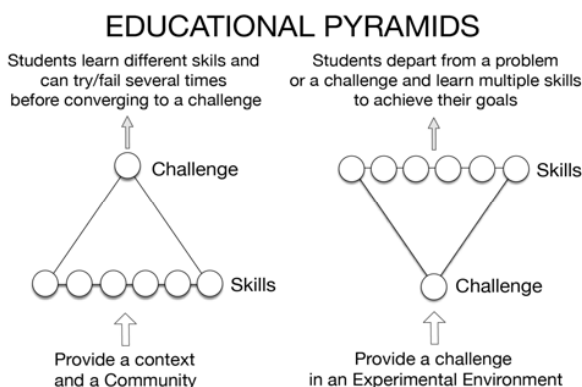


Fig. 1 The Educational Pyramid scheme

III. DESIGNING FOR THE CLASSROOM

How to transform the learning space in something that reflects today's teachers' and students' needs, breaking away from traditional classroom layout and furniture? How to invent new ways to make these rooms more conducive to 21st-century learning? Education is a process intended to improve human capacity and potential. An essential issue for consideration, however, is that effective pedagogy is not limited to standard instructional and learning strategies but extends to environments and products that are conducive to learning. Somehow, the work done during the 5-week workshop helped to understand this great challenge better and enabled us to produce solutions that can help answer these questions. Increasingly student-centred classroom design and flexible seating and workstations have indeed been taking place everywhere [7], [8]. However, it is also true that learning-friendly principles design are still to become a reality in the majority of educational programs, from kindergarten to primary school and colleges.

Collaboration, personalization, and project-based teaching are becoming the norm; nevertheless, the classroom layout and pieces of furniture continue quite traditional and the same. The classroom of the new century needs to reflect this changes, and when rethinking the design of such spaces and pieces of furniture, more collaborative spaces and interaction products are in need, and involving the students in this process can help to find better solutions. Two of the classroom infrastructure that requires improvement are seats and desks, especially those used by elementary school students, but also in kindergartens and colleges. It is inevitable, classrooms, where project-based learning and design thinking methodologies are taking place, need different spaces and pieces of furniture where students can sketch, built, make, and prototype. That kind of learning space requires transparent surfaces and interactive solutions where students can access digital contents, communicate well and also work together to solve problems, sharing information and collaborating in their projects.

A. Interactive Furniture Products for the Kindergarten

The students' group 1 and group 2 developed two sets of furniture for Kindergarten classrooms. Their main concern was to build inspiring friendly spaces and furniture for children to learn and play. While with *Candy*, group 1 was focused on the design of a multifunctional table, where available digital content could help young kids to learn by collaboration and playing with digital games, group 2 developed a set of multifunctional chairs, called *Tilt-Tilt*, where the main purpose was to find a better way to improve learning strategies in the classroom while kids are having fun just by adding different features to the same product.

Candy (Fig. 2) is an interactive table set that can be pedagogical and playful at the same time. Designed for kindergarten classrooms (for kids from 3.5 to 5/6 years old), *Candy* was designed to bring to the classroom new learning strategies. Where joy and fun are combined with real schooling content, to learn numbers, letters, colours, and daily

life words related to clothes and animals, for instance. Xu Ying Zhu, Xiao Zhe, Guo Han Xu, Ou Xiao Lin, and Peng Chun proposed this new approach, where they believe it will increase kids interest for learning, and keep them focused on educational content.



Fig. 2 Candy, an interactive table for primary school: a new approach to learning with digital content in kindergarten

When turning on, the table uses a large screen as the primary interface for interaction (Fig. 3). Three interactive areas are defined: the "Selection Area" or play mode buttons, where the users can define and select the different modes (e.g. Learning Numbers; Catching the Words; Matching Colors, etc.); the "Drag and Drop Area", where users can move around the digital content (e.g. Numbers, Clothes, Colors, Shapes, etc.), and the "Result Area", where, for example, the result of the mathematical sum or the word that you are looking for are shown. When turning off, the table can be dismantled and split into modular pieces, where the legs can be used as pins of a bowling game.

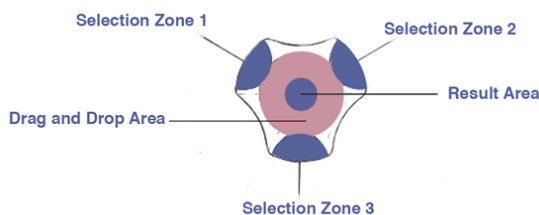


Fig. 3 Candy, the three main interaction areas.

Tilt-Tilt, developed by Group 2 (Fig. 4), consists of an educational furniture set that is made of two main products: The *Tilt-Chair* and the *Ball-Pool-Chair*. The *Tilt-Chair* can be flipped to become either a table with an interactive screen interface on the top plane or, on the opposite side, a chair for children. The *Ball-Pool-Chair* can be used as a regular

softening chair and when assembled, with at least eight pieces, can be transformed into a ball pool. The students Wang Yi, Liang Hui Yu, Zheng Miao Sheong, Liu Jia Quing, and Sheng Jin Fa designed this fresh set of furniture as a new educational approach to play and learn at the same time.



Fig. 4 The Tilt-Tilt set is composed of the "Tilt-Chair" and the "Ball-Pool-Chair"

When used as a table, the *Tilt-Chair's* interactive screen is turned on to teach basic concepts for children such as counting numbers until 10, learning primary and complementary colours and learning the alphabet from A to Z (Fig. 5). The interactive interface has three learning modes: the "Alphabet mode", the "Number mode", and the "Color mode". When sliding the screen to the right with the palm hand users can activate each different setup. When the mode selected is enabled, then users can press down the middle sensor button that switches the displayed picture and gives a corresponding sound, allowing the children to learn new knowledge in a synchronized stimulation of vision and hearing. When the product is used as a chair, the system is turned off and locked to prevent malfunction.

The *Ball-Pool-Chair* can be used as a chair alone, or when joining at least eight chairs together can be combined with rubber bands to form a ball pool where children can play. *Tilt-Tilt* is multi-functional, intuitive and funny to use. Young kids grow up continuously in interaction with their environment (people, objects, time, and space) and if we think about education as mainly shared and collaborative learning, *Tilt-Tilt* can bring to children more opportunities to interact together in a traditional way or by using multimedia digital content.

B. Interactive Furniture Products for the Primary Schools

Groups 3 and 4 designed flexible and dynamic interactive products of furniture for the primary school, for children aged from 6 to 12 years old. Their main concern was to solve the issues related to classroom layouts and to try to find solutions for automatic setup of at least two modes of teaching and learning: A first-one, when the teacher needs students' attention, and a second one when it requires group work and more practical projects. *Closer*, designed by group 3, makes use of concepts such as easy to use, dynamic shape and

adaptability for all children while at school. *Eks(x)*, designed by group 4, focused on collaborative work, interaction, and participation. Here, kids can learn while playing with an interactive screen, in a funny, attractive and pedagogical way.

In Group 3, Chen Zhitao, Deng Qiyuan, Liu Lifang, and Lu Huilin designed a new furniture cluster called *Closer* (Fig. 6), a multifunctional piece of furniture designed for the classroom

of primary schools. In primary schools, classroom chairs and tables are mainly traditionally organized in rows. It makes it a struggle for teachers to reach and take care of every student in an equitable way. Using the *Closer* solution, students and teachers can define the best space layout of the classroom to teach and learn.

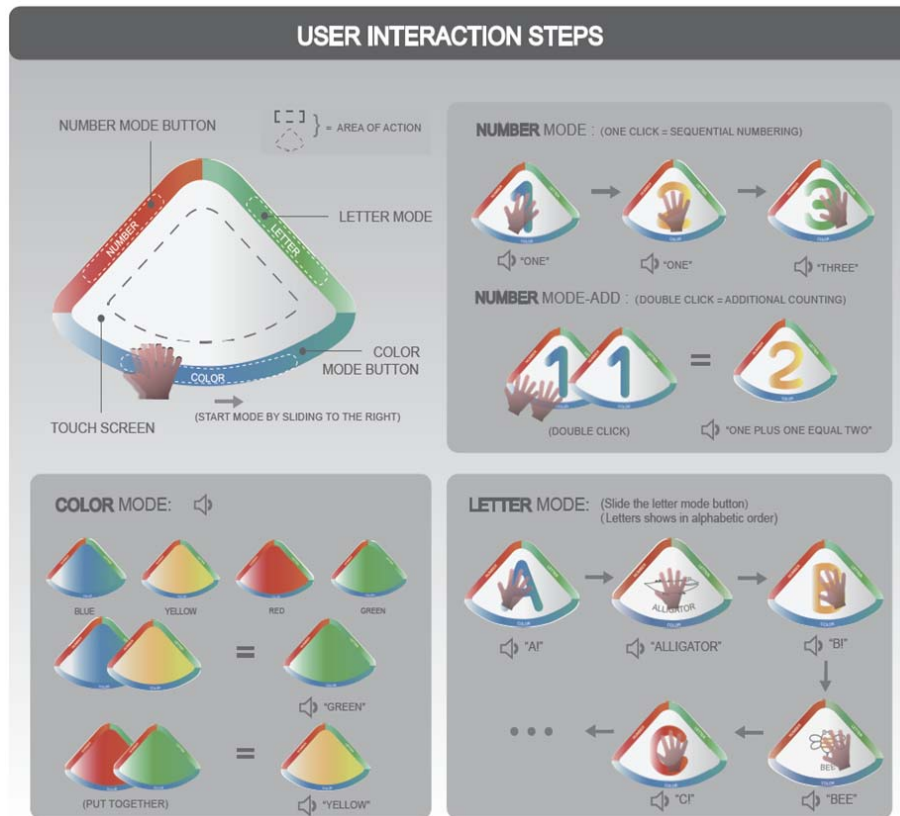


Fig. 5 Interaction modes with the Tilt-Chair product



Fig. 6 Closer: The "listen mode" (open) and the "Cooperative mode" (closed).

Closer is a cluster of chair and table designed for 6 to 12 year-old children in primary school. The interaction between students and teachers is the principal element to be considered in this project. The table is movable, and it can be shared with at least six children as a group. The table is assembled in 3 parts and can be configured in two different positions, "Open" as a listening mode and "Closed" as a collaborative one. Two interactive areas, or conjunctions, were designed to react to a swiping movement that defines the shape of an open trapezoid, when students need to be closer to the teacher, or a closed triangle when they need to start group work, helping them with their studies. The smart chair moves back and forward synchronically with the table. To avoid any injury, the table has an infrared sensor system that detects if any children are in front of it and stops moving, if it is the case.

The smart chair (Fig. 7) is designed with a cabinet for keeping books and personal belongings, and a touch screen that shows class schedules and a fingerprint touchscreen check-in system that sends messages to parents to inform

about their kids' safe arrival at class.

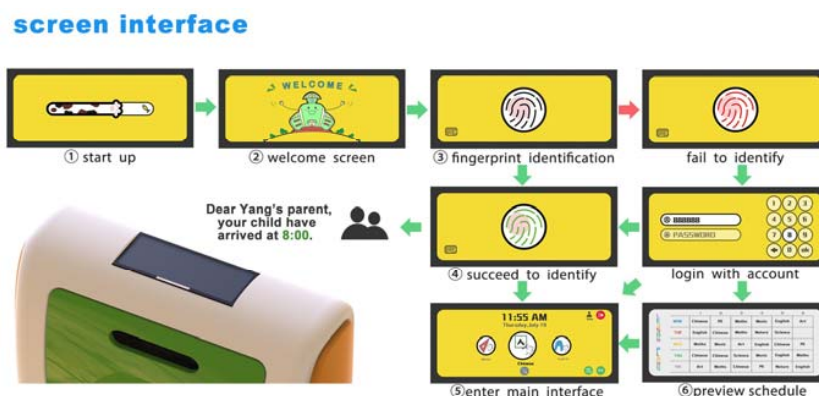


Fig. 7 Closer, the Chair: interactive screen and interface modes

Eks(x) (Fig. 8) is an interactive and multifunctional set of furniture for primary schools for students from 6 to 12 years old. It is a set of table and chair with two main functions: one for educational purposes set-up in a more traditional and standardized way and the other one for communication and sharing with friends and classroom colleagues.



Fig. 8 Multifunctional and interactive Eks(x)

Tables and chairs in primary school classrooms are always set up into the rows-traditional way, which makes it difficult for the front and back rows of students to communicate with each other. Zhang Hui Ting, Jiang Xue Min, Xie An Lin, and Li Jia Yi, designed the *Eks(x)* furniture set, a table, and chair that is not only convenient for students to attend classes but also for students to communicate and interact together after class. The table works as a swing structure, and the chair resembles a wooden horse.



Fig. 9 Operating modes of Eks(x), regular mode vs open mode

The set of table and chair can be used in two different

modes (Fig. 9): 1) when closed, the table and the chair are in a traditional mode and can be used as a regular workstation for study; 2) when the table is opened, the student can sit in a comfortable cushion and use the digital screen to interact with their classmate. The chair also has two modes of operating: when the back of the chair is in its vertical position students can seat regularly and ergonomically; on the other hand, they can rotate the backside up to 90 degrees and use the incorporated touch screen to play and interact.

The interactive screen (Fig. 10) works as a touch screen with fingerprint recognition for log-in. Once logged on, students can check their time-schedule, watch pedagogical and instructional videos, take notes of the class content or even play available games with educational purposes.

C. A New "Wave" for Creative Schools

Group 5 designed a product set for creative schools that is possibly the most inspiring and challenging system presented in this paper. The *Wave* project is a modern, attractive and innovative product that use new technologies to reinforce and inspire creativity in education. It explores the use of interactivity and touch screens in the classroom as tools to teach and learn, avoiding the standard applications of a desktop computer-keyboard-mouse set (Fig. 11).

The *Wave* is a furniture set for the classroom of creative schools, such as Art schools, Design schools, and Architecture. Designed by Zheng Hai Ting, Xie An Lin, Sun Zhi Kang, and Ying Ouyang, the set is made of an interactive table and a chair with a trapezoid form as its main formal structure. The chair is mainly used for seating and has a hanger shape in the back to hang backpacks. The table has two screens embedded (Fig. 11), a large interactive screen for learning and doing practical work and a smaller display screen to give regular and standard information to the students. The large screen, when turned on, can be used as a smooth LCD touch screen display, with high resolution, where the students can draw and sketch, using wireless pencil tools, with standard software such as Photoshop, Illustrator, Corel Draw, Maya or Rhinoceros. It is an interactive screen mainly used for practice-based learning, but can also be used as a theoretical

research tool when connected to the Internet and whenever the teacher allows doing so (Fig. 12).



Fig. 10 Eks(x), touch-screen and main interface design



Fig. 11 The Wave interactive table cluster



Fig. 12 The Wave interactive table and furrow shape zone with screen display and wireless charger

A furrow shape in front of the table is mainly used to keep drawings tools and other belongings for direct access and comes with a screen display and a time-bar to show daily information, such as the class schedule, the remaining time of the class, a clock and a wireless charger zone for smartphones and tablets (Fig. 13).

The Wave project was thought to facilitate a better learning environment in schools and more active engagement and interaction with students' learning path. Using integrated high image resolution quality and LCD touch screen technology, students can work directly on their projects, avoiding the use of personal computers. That is important in creative schools (but not only) where new technologies and software are commonly used, and more especially for young teenagers who enjoy interacting using "touchscreens" in their daily life.

IV. CONCLUSIONS

The primary purpose of doing a design workshop as a collaborative multicultural studio was primarily to be able to involve design students from China with new skills and learning methodologies inspiring them for creativity and

innovation towards design projects. By working together with international teachers, the students' proposals surpassed this goal, and the final results demonstrate how this valuable experience can be beneficial for their future as young Designer in fields that relate Product and Furniture Design with Interaction Design. On the other hand, the development of new products that can enhance engagement with students in schools, was a rewarding result, in the sense that innovative ideas and out-of-the-box solutions (for instance the furniture design for the classrooms in China are very outdated), were introduced and suggested from a different approach, and more than that, taking into account students' perspective. Despite the considerable research devoted to the relationship between furniture design and education, we believe room for improvement still exists. First, the integration of interactive technology within pieces of furniture such as interactive tables or chairs is still very costly, and the study for adequacy of such typologies of equipment for kindergarten classrooms is still required; Second, studies on the lack of attention involved when using digital content in class such as games for learning purposes requires more research within Chinese society and habits. In future editions of this workshop, the final results can benefit from a more robust approach on real-scale prototyping and fully functional interactive mockups, as well as on the testing phase, where problems and new solutions will show up, getting students ready for a further iteration within the design thinking methodology approach. At present, the students who have attended the workshops have applied for more than 10 utility models and design patents successfully. The students generally thought that this was the best way to get them to participate in an international design workshop with lower time and economic costs. It not only improved their professional skills, but also enhanced their cross-cultural learning and communication capacity, and strengthened their confidence in communication and expert knowledge. In a word, it was a very effective new talent training workshop.



Fig. 13 The Wave, main features

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