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Fixperts: models, learning and social contexts

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Abstract: Fixperts is a learner-centred, creative-problem-solving and project-based learning programme. In a Fixperts project, participants (Fixperts) team-up with an insight provider (Fix Partner) to identify a daily problem in the Fix Partner's life that becomes the focus of a project aimed at delivering a solution or Fix. This paper introduces four pedagogic models developed via delivery of Fixperts projects at leading international design universities. It presents four approaches to the challenge of moving from the Person, to the Problem, to the Fix. These four models – Primary, Partnerships, Community, Public - represent the evolution of the Fixperts framework to better enable the development of students as confident and empathetic socially-led designers. Fixperts builds competencies which are predicted to become essential to an ability to thrive in our increasingly uncertain future.

Keywords: social design; creative problem solving; project based learning; education

1. Introduction to Fixperts

Fixperts is a learner-centred, creative-problem-solving and project-based learning programme. It serves as an experiential hands-on introduction to human centred design, maker culture, and design-based thinking. It develops empathy, creativity and communication competencies in its participants. Fixperts was developed by Charny, to support delivery of a vision of a renewed design education which incorporates the disciplinary shifts needed to respond effectively to real world challenges.

Fixperts incorporates elements from established methods and approaches - user-centred design, universal design, design ethnography, participatory design, design thinking, action research, co-design, design activism, disruptive design, frugal design, multi-disciplinary, action-oriented – in an agile, adaptable and robust learning framework. Since 2013 it has been taught in 42 Higher Education Institutions across 20 countries, including design and

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engineering courses in universities in Australia, Canada, China, Denmark, Germany, Japan, Ireland, Israel, Mexico, Poland, Scotland, South Africa, Spain, Thailand and UK. Over 100 tutors have delivered versions of the framework to around 4,500 students, adapted to the needs of their accredited programmes for up to six years. Fixperts has also been adapted by Charny for use by schools, cultural organisations and companies. This paper identifies models for delivering Fixperts demonstrated by four of the universities around the world.

In a Fixperts project, participants (Fixperts) team-up with an insight provider (Fix Partner) to identify a daily issue in the Fix Partner's life that becomes the focus of their project. Following a process of empathic modelling and rapid prototyping of potential approaches to a possible solution, the collaborators improve and resolve the optimal solution through iterative real-life testing. On completion of the project, a working prototype is presented and gifted to the Fix Partner. The project is documented at all stages, and brought together in a narrative format, following provided guidelines to tell the story of the People, the Problem, and the Fix. This is usually a film, which is uploaded to a publicly available open source online archive (fixing.education). The archive is managed by the organisation FixEd, and curated into playlists which collate individual films in a teaching resource which is available worldwide. There are now over 550 films uploaded to the archive, and more on other online platforms. Some courses teaching Fixperts additionally require learners to upload the designs of their Fixes as 'How to' instructions on open source platforms such as instructables.com and thingyverse.com, so others can benefit from accessing the solutions.

Fixperts learning programmes were initially developed by Charny for universities in 2013. This paper is concerned with Fixperts for university-level learners. It describes four models of the framework. It presents the Pilot model, which led to the Primary model, and three further models that have evolved subsequently over the years by lecturers responding to local contexts and needs. This paper is jointly written with the lecturers who developed these variants on the Fixperts framework. The Primary model included here is from Kyoto Institute of Technology (KIT), Japan, presented by Julia Cassim. The Partnership model at Kingston University London, UK, is presented by Maya Alvarado. The Community model at Tongji University, China, is presented by Yumei Dong. The Public model at the Royal Melbourne Institute of Technology (RMIT), Australia, is presented by Ian de Vere. Guidance for delivery of Fixperts in universities is freely available online. (FixEd, 2017) The case studies presented below are examples of putting this into practice.

2. Pilot and Basic model

Fixperts was initially thought of as a micro volunteering initiative inviting design professionals to use their imagination and skills away from their offices and screens, with the additional benefit of promoting repair. The pilot phase included five films, identity and a website developed by a group of volunteers. An example of the pilot model of Fixperts is 'The Little Things' from 2012, in which Denise volunteered to support the Fixperts pilot project as a Fix Partner. Denise has multiple sclerosis (MS) and finds it difficult to put her earrings on. She

was reached via the online Shift MS community, who published an invitation to which she and five other members responded.

The Fixperts team met Denise at her home where she shared the challenges of living with MS. They focused on her frustration with tremor in her hands, which impacts on small movements such as buttoning shirts or putting on earrings. Following an observation session, Fixperts spent time in the workshop developing a solution for earring placement. Feedback from Denise on the 'Earing stapler' concept informed another session in the workshops, resulting in a refined mechanism which delighted Denise. A year later, the Fixperts had a new concept based on tweezers, and returned to deliver the improved prototype to Denise. The stages of the project included: (1) Search for, and invitation of, a Fix Partner; (2) Interview between Fix Partner and Fixperts, and identification of problem to address; (3) Concept prototyping, and testing with Fix Partner; (4) Improvement; (5) Gifting the Fix to the Fix Partner; (6) Film production and upload to internet. The Pilot model did not include mentoring of the designers or empathic modelling as appears in later (pedagogical) models – both were identified as necessary and subsequently added to the process, as valuable for raising the quality of the solutions.

Figure 1 *'The Little Things' (Pilot Fixperts project, 2012). Fix Partner: Denise Stephens; Fixperts: Florie Salnot, Peter Judson and Rachel Singer.*

'The Little Things' demonstrates the Basic independent model of Fixperts, developed for the pilot phase and based on independent people initiating their own project in their community and building a Fixperts team with others. Fixperts was not yet a pedagogical format.

3. Primary model

In the Primary pedagogic model, authored by Charny in 2013, learners are introduced to the Fixperts project by their tutors and are tasked with finding their own Fix Partners with whom to identify a problem through conversation. They develop initial possible solutions and make prototypes on which they gain feedback from the Fix Partner, improve this and make a final model to gift to the Fix Partner, and document the process of the Person, the Problem and the Fix. This story is made into a short film for dissemination.

Daniel Charny was invited to run a workshop at KIT in 2015 on the theme 'One, Two, Many', to introduce students to a more conceptual and experiential ideation style. The impact of this workshop led Julia Cassim and three other teaching staff with different specialisms (media, interaction design, product design) to embed Fixperts in the curriculum that year as a means to:

- Provide an understanding of a human-centred design process from inception to finish;
- Gain skills in solving practical real world problems;
- Generate a real word learning experience with face to face engagement;
- Help students understand the vital role of iterative prototyping;
- Promote a team-teaching model of instruction;
- Introduce the ethical and IP issues of working with design partners;
- Allow a pedagogical structure to be built around it.

The project was run as an elective over a three-month period, using the allotted curriculum time slots, the longest being a three-hour teaching period. Hence, the physical design and fabrication took place in the students' own self-directed time, with contact time devoted to critical discussion and evaluation by the teaching team. Fixperts guidelines were respected, but the project followed the inclusive design model developed previously by Cassim (Cassim & Dong, 2013). A design brief was set each time: 'Invisible People', 'Silver Workers', 'People who work outside', 'People who work in small spaces'. Emphasis was placed on the idea that the design solution, while inspired by the needs of an individual, should be broadly applicable and have the potential to be developed as a commercial product in its own right.

Students were briefed on the project structure, aims, and ethical considerations, and introduced to ethnographic techniques and documentation formats and styles. They were asked initially to identify three potential Fix Partners, and present their reasons for selection and the issues they wished to address. Critical discussion around this ensured that the final choice of a single Fix Partner was robust and considered, rather than expedient, and had been sufficiently interrogated to enable an interesting Fix.

A key learning for staff was that students had little understanding of iterative prototyping as an ideation method in its own right – prototyping was perceived as the final step of the design process. In collaboration with the designer Frank Kolkman, KIT's first Design Associate, the Fixperts project was enhanced with a 'methods-based approach to rapid protoyping

for designers'. The aim was to help students understand the different purposes for which prototyping can be used, at different stages of the design process. This workshop has since been held each year within the Fixperts project programme, once teams have identified their Fix Partner and have rough prototyped initial ideas, and has proved to be a significant accelerator in the development of their thinking through making.

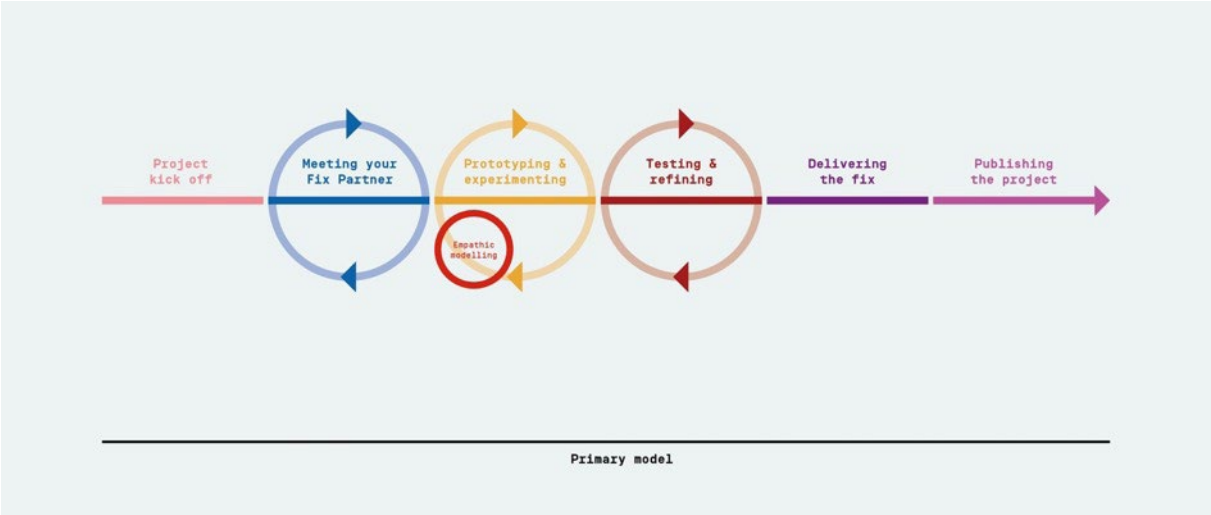

Figure 2 *Primary pedagogic model of Fixperts (as demonstrated by Kyoto case study) has 6 stages with a distinct element of the students identifying their own Fix Partner. Fixperts method diagrams, developed by Daniel Charny with Maya Alvarado, communicate the linear stages, iterative phases (noted by the circles with arrows) and discrete embedded activities (indicated by small circles) The diagrams are designed to help tutors understand and plan a Fixperts project fit for their context. The method and diagram learn from and reference lean, agile, scrum and design thinking methods.*

Key specific principles for success:

- Students gained an understanding of the realities of real-world design practice which were difficult to transmit through the previous conventional curriculum;
- Participants' confidence in subsequent work has demonstrated the value of Fixperts as a unique knowledge transfer model at KIT.

The 'Bebento' project at KIT is notable in that the student Fixperts team had to gain the trust of a Fix Partner who was both a skilled maker, and did not initially want to appear on film. The students created an initial blue foam prototype of their proposed Fix, of which the Fix Partner promptly produced a final version in wood, thereby completing the fix himself. On their next visit, the students then had to return to square one, and identify an alternative problem and potential additional Fix. His delight at their final solution is evident in the video.

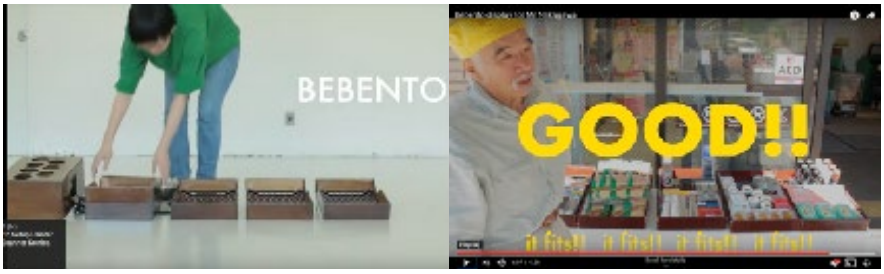

Figure 3 *'Bebento display solution' for itinerant shoe repairer Mr Nakagawa (Fixperts project at KIT). Stills from Fix Film that can be seen here: https://vimeo.com/270312611*

4. Partnership model

In the Partnership pedagogic model, tutors develop Fix Partner relationships before engaging students. This is often with an organisation, and includes secondary Fix Partner support in the form of carers or teachers.

The Product & Furniture Design undergraduate course at Kingston University has delivered Fixperts via partnerships with local community institutions, notably The Bradbury Centre for over 60-year-olds, and Bedelsford School, which specialises in educating pupils with a wide range of physical disabilities including profound and multiple learning difficulties, moderate learning difficulties, and complex health needs. In addition to the aims of the Primary model, the Partnership model seeks to:

- Help students understand the social role of designers in a community;
- Build sustainable connections between the university and local organisations;
- Understand and learn to work with those around Fix Partners, for example carers.

Fixperts tutors Rodrigo García González, Kathleen Hills and Maya Alvarado were aware of the difficulties posed by the Primary model in finding a Fix Partner within a given timeframe. Securing partnerships in advance seemed a more promising approach. Local institutions that could be potential partners for Fixperts were identified, based on close proximity, high level of prior direct engagement, and perceived openness to engage with outside people. They took time to build their understanding of Fixperts and assess whether collaboration was feasible. Tutors have built and sustained these partnerships across three years of Fixperts projects.

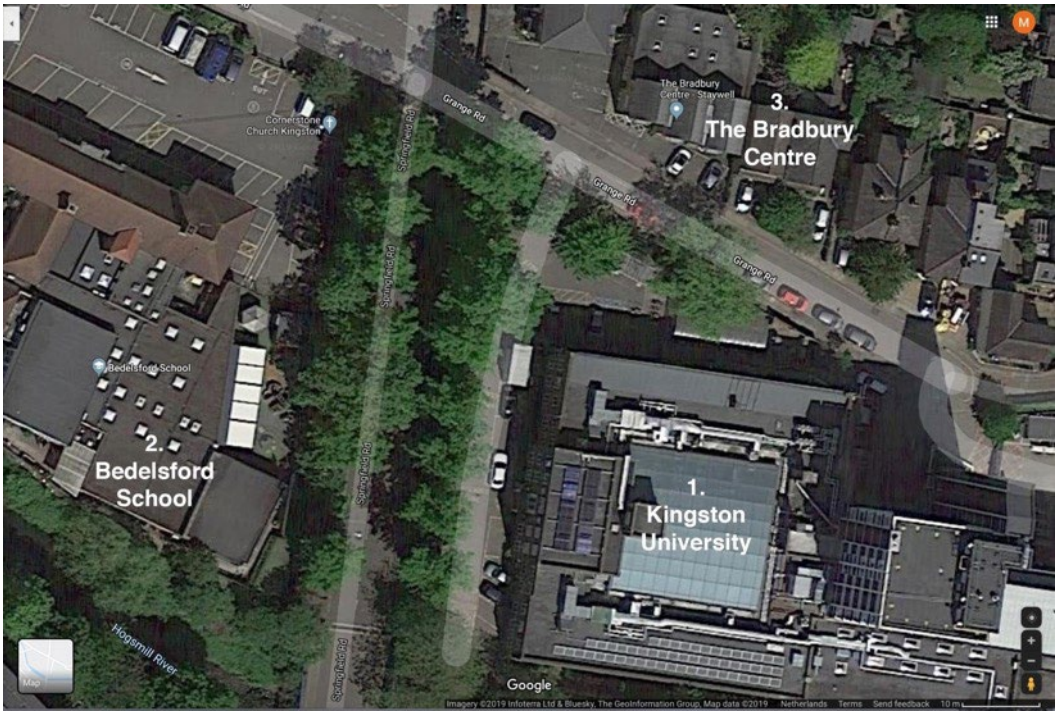

Figure 4 *All collaborators are located in close proximity within a five-minute walk, allowing close and continued direct contact: (1) Kingston University, (2) Bedelsford School, (3) The Bradbury Centre. Image adapted from Google Maps.*

Both locations are nearby the University, so the partner institutions are already familiar with the University and its community. This proximity also allows students easy access to their Fix Partners - typically three to four visits during a project.

Students work in groups of four to five, with around ten projects per year group. Project kick-off involves a '1-minute film brief', independent of the main project, in which students create proto-fixes via a 'simulations workshop' using existing Fixperts resources, and document the problem they are trying to solve and the 'Fix' they propose. Including this stage ahead of 'Meeting your Fix Partner' allows students to build-up the skills to prototype and design quickly with basic materials, something they may need to do in situ with their Fix Partner, particularly as they may be limited to a small number of visits. Filmmaking skills are thereby developed through an initial three-week project. One person from each team then becomes the 'filmmaker', responsible for documenting the process from start to finish, as well as designing.

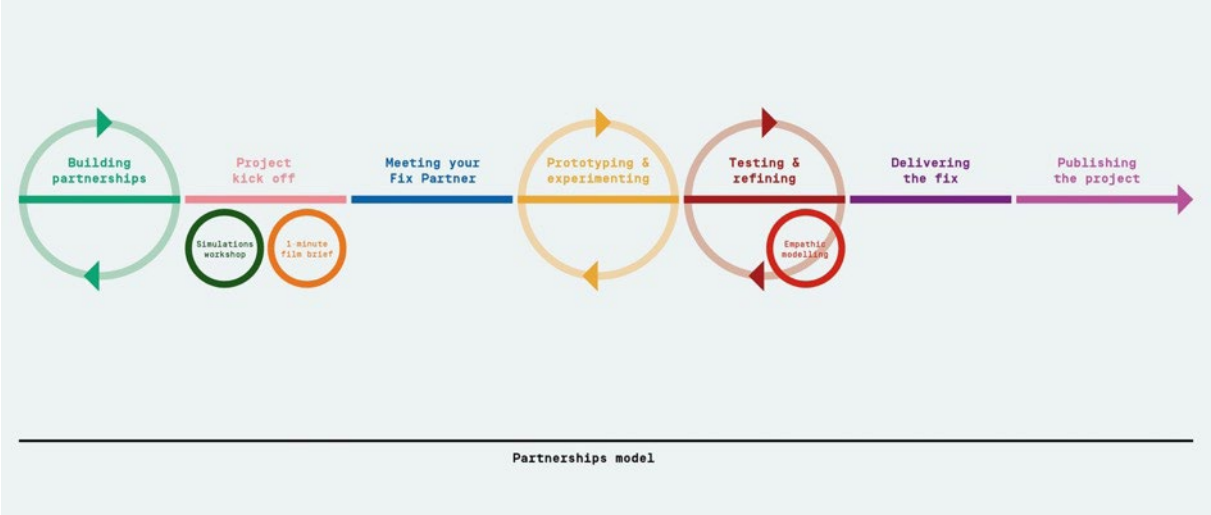

Figure 5 *Partnership pedagogic model of Fixperts (as demonstrated by the case study at Kingston University) has 7 stages. It is based on the primary model but with a distinct additional preparatory stage of the staff building external partnerships before engaging the students who are introduced into the relationship.*

The value and success of a Fix is defined by the impact for the Fix Partner in their daily life. Kingston Fixperts projects have often been associated with, but are not limited to, topics of disability, particularly in partnership with the specialist Bedelsford School and The Bradbury Centre. Other themes include: walking, mobility, carrying, play, music, cooking, eating and drinking. Projects are assessed academically on:

- Significance of impact on Fixpartner's daily life;
- Scalability of the solution;
- Quality of the story telling and film making;
- Quality of the making and finishing.

Key specific principles for success:

- Use existing Fixperts films to share process and value;
- Co-create the relationship and expectations with your partner;
- Timetable visits to your partner's environment where appropriate, to avoid overload of students on site;
- Check in on the project regularly with your main point of contact;
- Wrap up the project by checking that everyone has received their fixes;
- Check-in later in the year to see if any fixes need repairs or updates.

The Fix Partner of 'A rocket for Reece' was a Bedelsford school student who is oxygen-dependent. Reece's carer typically follows him around as he moves, carrying his oxygen tank. Kingston students designed a rocket oxygen tank carrier for Reece himself. Tutors added an empathic exercise element to the Fixperts model by inviting students to each carry around a fire extinguisher for a whole day, to gain an understanding of the weight and volume, and the difficulties of taking it everywhere you go. Empathic techniques such as this can be helpful

to progress with prototyping when it is not always possible to meet with a Fix Partner when most convenient.

Figure 6 *Empathic modelling exercise – gaining appreciation of the burden of an oxygen tank by carrying around a fire extinguisher for a day.*

Figure 7 *A rocket for Reece' (Fixperts project at Kingston University) – Reece can now transport his own oxygen tank, rather than relying on a carer to walk with him and carry it.*

5. Community model

A Community pedagogic model is a Partnership model with a group of Fix Partners, rather than an individual. Building and maintaining the relationship with the community is seen as part of the learners' responsibilities – a unique aim of this model.

Hua Dong introduced Fixperts as part of her undergraduate User Research course at Tongji University. She used it as a structured project for design students to apply their user research skills in a real-world context. Class sizes have ranged between 30 and 70 students in different years, and project group sizes ranged between three and five students. Students have worked with a variety of individual Fix Partners, including an express mail delivery worker, a shop keeper of a local flower shop, a personal trainer suffering colour blindness, and a cleaner working for the University. In 2017, Hua introduced the Fixperts project to postgraduates, and developed a new model - the Community model. In this model, students no longer worked with a single Fix Partner, but each group of two to three students worked with a Neighbourhood Centre in Yangpu District, Shanghai.

In addition to the aims of the Primary model, the Community model seeks to:

- Engage collectively with organisations such as civic community centres;
- Learn and apply co-design tools for use with participant groups;
- Scale useful results for wider use, to bring positive changes to a broader community.

Neighbourhood Centres are a relatively new phenomenon in Shanghai. They are run by third parties such as independent social organisations, that receive Government funding to improve community services by engaging local residents. The Centres provide easy-to-access communal spaces for a variety of free activities such as playing chess, practising calligraphy, reading and dancing. Neighbourhood Centres are open to all, and their users are typically retired people as they have more free time. Each Neighbourhood Centre has its unique characteristics, and differs in size and type of services and activities. Through working with Neighbourhood Centres, the postgraduate students were exposed to social contexts full of product and service 'fixing' opportunities. They were encouraged to work with the Neighbourhood Centres' users, volunteers and service providers, as their Fix Partners.

Before commencing the Community Fixperts project, Hua and her teaching assistant identified 16 suitable Neighbourhood Centres through visiting them, to ensure a variety of Centre types, and that they were within reasonable distance of Tongji University, to ensure students could visit several times without too much difficulty. An official letter was given to students to introduce the project upon their first visit to the Neighbourhood Centre.

The course lasted nine weeks, half a day per week. In addition to attending lectures on user research and design innovation, the students paid visits to Neighbourhood Centres, on average three times. The first visit was to become familiar with the environment, make observations, and identify problems or opportunities. The second visit was to investigate the problem and explore opportunities with different stakeholders, and co-design concepts and

potential solutions. The third visit was to implement a solution and gain user feedback.

Students made two presentations during the project: one after the initial visit, and one towards the end. These presentations were to share insights and gain feedback from tutors and fellow students. Of the 16 proposed solutions, six focused on product design, two on visual communication design, and eight on service design and interaction design.

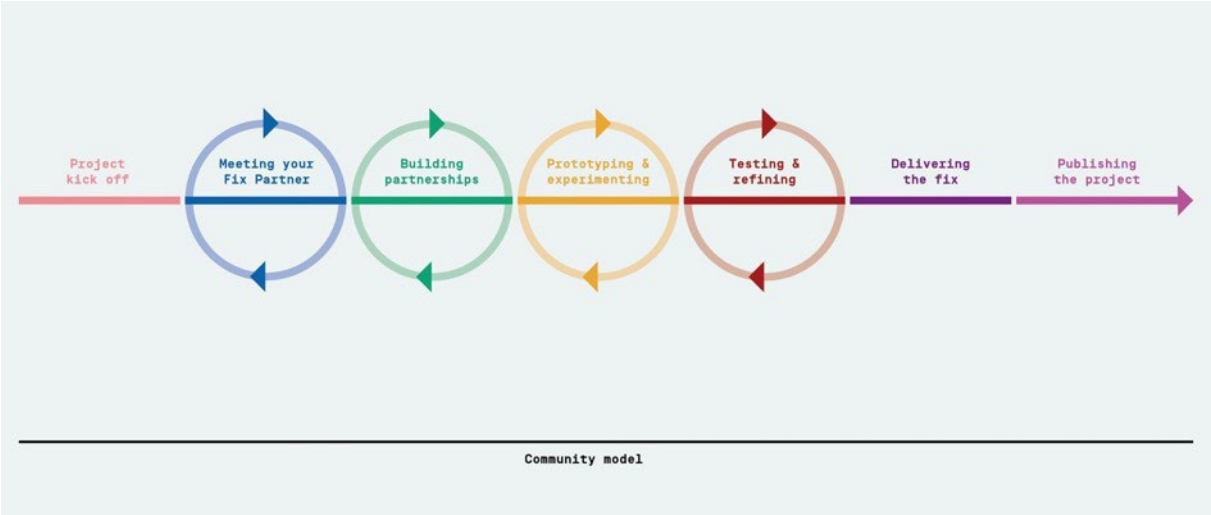

Figure 8 *Community pedagogic model of Fixperts (as demonstrated by the case study at Tongji University) has 7 stages. A distinct aspect is the work across a group rather than an individual and requires the students to engage with building partnerships with the community.*

Key specific principles for success:

- Engage with a group of Fix Partners collectively, rather than individuals;
- Use collaborative making as a means to develop skills exchange between Fixperts and Fix Partners;
- Remain inclusive by finding communal activities that can accommodate differing skills levels of participants.

'Co-knitting' is a product solution demonstrating the Community model. The two Fixperts identified several problems and design opportunities when they visited the Miyun Neighbourhood Centre near Tongji University, where many retired teachers ran chess clubs, knitting clubs and Ping-Pong clubs. After their first presentation, the Fixperts focused on the knitting club activity by developing a knitting template for participants, accommodating those with high skills and those with no skills. To test the inclusiveness of the concept, the Fixperts invited university students who were knitting novices to join a knitting session with the skilful 'grannies'.

Figure 9 'Co-knitting' at Miyun Neighbourhood Centre (Fixperts project at Tongji University).

The Community Fixperts project was well received by the postgraduate students, who said they really enjoyed working with 'real people' and developing 'real-word' solutions which had a clear impact on users. A limitation of the Community Fixperts model is lack of time for observing the projects' long-term impact. When Fixperts is applied in a community context, the collective Fix Partner is a combination of multiple stakeholders. In this project, as the Neighbourhood Centres shared some common issues, it was decided to additionally create a set of cards for knowledge exchange. The cards illustrated the 16 design solutions developed via the project, categorized as 'space', 'facility', 'activity', 'people' and 'other', each with a short description of the problem and solution. These cards were given to each of the participating Neighbourhood Centres, to enable mutual learning from each other's Fixperts experiences. The card set was called 'Empower', as all the Fixes aimed to empower local residents to run their Neighbourhood Centres better.

Figure 10 'Empower' cards for Neighbourhood Centres (Fixperts project at Tongji University).

6. Public model

A Public pedagogic model is a Partnership model with two distinct variations. The Fix Partners are met via a host Partner, and this meeting as well as final presentations of Fixes are part of a public programme.

Having previously run a Primary and Community Fixperts model at Brunel University London 2014 - 2018 (de Vere and Phillips, 2015; de Vere and Charny, 2017), a move to RMIT offered a new collaborative opportunity for de Vere. Fixperts was here initiated by MPavilion (mpavilion.org), Australia's leading architecture commission. The aim was for students and the university to generate social benefit via cultural organisations.

Unlike de Vere's previous Fixperts projects with up to 160 first year design students using the Primary model at Brunel University, this was envisioned as a more boutique project with a small group of up to 15 third year Industrial Design students working directly with predetermined community partners. Whilst the Fixperts engagement model often requires student teams to go out into their local communities to find a suitable partner and project, in this instance Fix Partners were sourced from MPavilion's network. Three partners were secured, two of whom had previous interactions with the MPavilion, with another direct referral from Occupational Therapists at Royal Melbourne Hospital. The project began with direct engagement between the Fixperts project leader and community Fix Partners. This direct contact enhanced the lecturer's understanding of the core issues in this specific instance, which proved key to developing the trust necessary to conduct a sensitive project in such a public forum.

In addition to the aims of the Primary model, the Public model seeks to:

- Learn to engage with cultural organisations;
- Communicate to public audiences.

The process of engagement in the MPavilion project was aligned to the Partnership Fixperts model, in which partnerships are developed prior to student involvement. An initial project pitch was written and distributed to invited participants, who on acceptance were invited to a public launch event at which Fixperts was introduced, the project was explained, and sensitivity, privacy and other ethical concerns were discussed. It was at this point that invitees became participants and Fix Partners. The audience was primed with FixFilms of previous Fixperts projects. These were chosen to illustrate the sensitivity of both the design intervention and the filmed presentation of the community partner. Issues and projects were selected based on what was feasible within the six-week timeframe and the skills of, and technical resources available to, the student Fixperts. Project proposals involving potential health and safety risk, for example mounting a baby carrier on a wheelchair, were gently deflected to professional assistive technology organisations. In this model, there is a deeper level of involvement for the tutors as ambassadors of the project across the cultural organisation.

Students and Partners met at the MPavilion in an open to the public event, where student groups were formed and initial discovery discussions were held. Partners were paired with student teams and initiated the observation and problem definition processes, facilitated by design lecturers. This process was key to an early establishment of the rapport and trust, which must underpin these projects. From this point students worked directly with their community partners.

Figure 11 Initial community engagement process: partners and students meet at MPavilion for the first time to discuss projects (Fixperts project at RMIT).

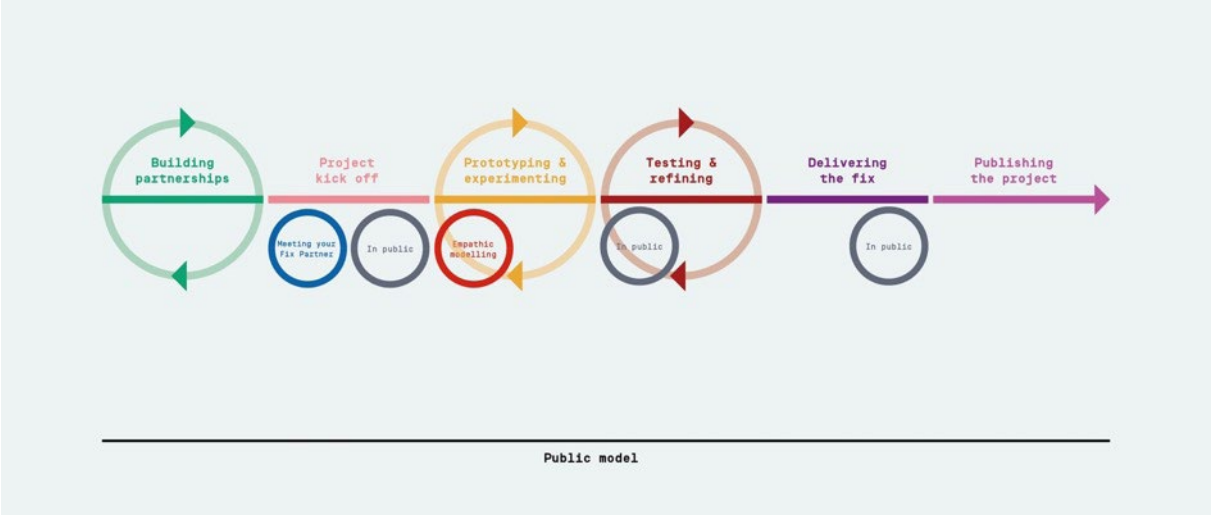

Figure 12 *Public pedagogic model of Fixperts (as demonstrated by the case study at RMIT) has 6 stages. Distinct to this model is the complexity of preparing the partnerships with a host organisation and Fix Partners from their wider network. An additional defining character is that part of the teaching takes place in the public eye.*

Key specific principles for success:

- Fix Partners were invited to review and sign an informed consent statement and form in which they agreed to filming and publication;
- Careful preliminary brokering between tutor and cultural organisation;
- Presentation of FixFilms by Fixperts and Fix Partners to a community audience at a public event at the MPavilion.

The Public model is demonstrated by a writing aid developed to help an elderly woman with an essential tremor to write again.

Figure 13 *Fix Partner Ann demonstrates the writing aid developed for her by students that allowed her to overcome her essential tremor and write again (Fixperts project at RMIT).*

Figure 14 Fix Partner Ann discusses the writing aid solution at the MPavilion (Fixperts project at RMIT).

7. Discussion

Comparative factual data relating to the four case studies presented above are compiled in Figure 15.

Model / year it emerged	Case study institution	No. of years Fixperts taught there	Year of case study	Group size / no. of groups	Project duration / delivery	Student level	Course	Tutors' Design expertise
Primary 2013	Kyoto	2015 - 2019	2016	4 x 6	12 weeks twice weekly + prototyping workshop	Undergraduate 3rd year + Exchange	Design	Product, Media Interaction Inclusive
Partnership 2015	Kingston	2013 - 2020	2016	4 x 11	12 weeks / weekly	Undergraduate 1st year	Product & Furniture Design	Product, Service
Community 2017	Tongji	2014 - 2018	2018	(2-3) x 16	6 weeks / weekly + event	Postgraduate	User Research and Design Innovation	Product, Service, Communication, Inclusive
Public 2018	RMIT	2018 - 2019	2019	3 x 4	6 weeks + event	Undergraduate 3rd year	Industrial Design	Industrial, Social Innovation

Figure 15 Summary data of the case studies of four pedagogic models of Fixperts presented in this paper.

More broadly, within universities Fixperts is mostly run in Product Design, Communication Design, Technology institutes and Engineering courses. This is mostly at undergraduate level, but a fifth are postgraduate programmes. Class sizes range from 12 to 160 students. Teams range from two to seven learners. Project duration can be an intense four consecutive days, up to a weekly class over a 12-week semester. The final film making is sometimes an additional stage.

Key reasons for courses using the Fixperts framework for teaching include:

- introduction to social design, user centred design, universal design and research methods, prototyping and material knowledge;
- building agency and an entrepreneurial mindset;
- engagement with specific themes such as design for disability, sustainable design, and design innovation;
- the appeal of the global platform, with high visibility and access to professional communities and audiences (for example the 'Bebento' project at KIT was selected to be shown at The Crafts Council's 'Real to Reel: The Craft Film Festival' in London in May 2019)

Fixperts builds creative problem-solving skills, and core skills in qualitative research methods such as shadowing, in-depth interviews and prototyping-led idea development. This in turn builds generative and evaluative approaches, and acts as a foundational introduction to, for example, service design. Tutors often see Fixperts as an important early project in building empathy and creative problem-solving skills to inform later years of study. It also opens up students to social design at an early stage, and often for the first time: "You saw the potential that designing has to improve people's lives. This was the first time I saw a direct impact on improving someone's lives." (Fixpert) "It forces people to engage with users with needs, marginalised needs, people who they, as young and fit people, may have not considered." (Design Tutor) (Tavistock Institute, 2016, pp. 12, 11)

The Primary model is still the most common; of the 42 known higher education institutions teaching Fixperts, 23 work with the Primary model. Additional benefits such as the accelerated process and greater quality control have however seen the Partnership model become more established. A Partnership is increasingly seen as the easiest way to start a Fixperts programme, particularly when specific collaborators are not yet allocated, and problems are identified and selected together after an initial meeting. Lecturers set up the invitation to a community or organisation, but the learners still find a specific person and identify an issue or problem with them.

In addition to the key specific principles for success given in each of the case studies above, we can identify key generic principles for success in using Fixperts:

- Significant involvement of Fix Partners in a co-design model, especially through the prototyping, testing and evaluation stages;
- Establishing a 'client-pull' rather than 'designer-push' process;

- Understanding Fix Partners are experts of their own situation and needs;
- Driving design by focus on bespoke solutions, tailored to address the specific needs of a single individual;
- Avoiding design driven by students' personal aesthetic or technical preferences;
- Ensuring solutions are underpinned by empathy and understanding of the disability or impairment, and the environmental context in which the assistive technology solution will be used;
- Constructing multiple iterations to test function, mechanisms, safety, ergonomics, and more, before the final Fix prototype is presented to the Fix Partner.

Some universities invite Fix Partners as guests into the classroom, rather than have the students go out to find them independently. Some courses however see an important entrepreneurial and agency-building aspect to students finding and establishing a Fix Partner themselves. Longer running programmes may develop a hybrid model based on returning to established sources of contacts. Although not a formal partnership, this reflects mutual interest in sustained collaboration, and is maintained through personal contacts.

This variation in delivery demonstrates Fixperts' value as an easy to engage, robust and agile framework that successfully synthesises (1) a user centred process, (2) a creative problem solving process, and (3) a social benefit agenda in a learner-centred project based format. Since Fixperts focuses primarily on the process, not on a specific agenda, the framework allows courses and tutors to introduce themes that are specific to their programme and local contexts. The flexibility in time frame and range of issues that can be addressed have enabled diverse courses to accommodate a Fixperts project. These projects offer students a real world, hands-on, empathy enhancing learning experience. As Fixperts, students develop their capacity in research and iterative prototyping, refining creative problem solving, decision taking, communication sharpening - and most importantly, empathy and agency building.

Model	Pedagogy	Design methods highlighted	Aims of the model	Unique to this model
Primary	Project Based Learning [A] Cooperative & Collaborative [A] Learner centred Active learning Real world learning Open-ended design task [A] Constructionist Learning [B] Social Critical **The Primary model pedagogic approach is the basis of the other models. Each then adds or modifies aspects in response to specific contexts.**	User Centred Design	• Understand human-centred design process • Gain skills in solving real world problems • Experience real word learning • Understand vital role of iterative prototyping • Introduce ethical and IP issues of working with design partners	Develop entrepreneurial skill through the students being tasked with finding their own Fix Partners
Partnership	Pedagogy of engagement [C] Multiple stake holder involvement	Social design Service design	**In addition to those of Primary model:** • Help students understand the social role of designers in a community • Build sustainable connections between the university and local organisations • Understand and learn to work with carers	Outreach Local outreach contacts Working in a care home
Community	Community Co-design [D] Participatory Co-design	Inclusive design Universal design Co-design	**In addition to those of Primary model:** • Engage with civic community centres • Learn co-design tools for group work • Scale useful results for wider use	Pursues advanced levels of understanding of Group work, Cross generational, cultural responsiveness and community based field experience
Public	Collaborative exchanges [E] Outreach and public engagement	Social design Social innovation Public engagement	**In addition to those of Primary model:** • Learn to engage with cultural organisations • Communicate to public audiences	Cultural organisation engagement brief Advocacy

Figure 16 Differences in context and pedagogical approach in the case studies of four pedagogic models of Fixperts presented in this paper. Cited sources: [A] Huang et al (2006), [B] Kafai and Harel (1991), [C] Layal (2018), [D] Thamrin et al (2018), [E] Ryan and Charman (2014).

All this accords with our understanding of how to teach design for social change:

> "Design for social change entails the adoption of a variety of strategies that at their core and in various degrees, are human-centred. The increased expectation that design education should cater for the skills and competencies that empower design graduates to deal successfully with the challenge of design for social interventions, brings to the forefront reflections on the pedagogies that rely upon teacher-centered and master-apprentice instructional approaches." (Souleles, 2017, S934)

Fixperts is a project-based learning (PjBL) pedagogy for real world design education. (Huang et al, 2006) It presents a model of social design education integrating sustainability pedagogy as described in MacVaugh (2009).

Fixperts also exemplifies use of design 'doing' as a mode of inquiry for learning, as discussed in Ejsing-Duun and Skovbjerg (2018), specifically to develop a "pragmatic philosophical underpinning" Barab & Squire (2004:6). The choice of which Fixperts model to use should relate directly to the teaching aims, local needs and opportunities which are to be addressed, via an "equation of suitability" between contextual factors and appropriate or desired pedagogies. (Huang et al, 2006: 31)

8. Conclusion

Fixperts builds key competencies and skills needed to thrive in the future, namely: problem solving, creativity, emotional intelligence, collaborative and communication skills. (WEF, 2016; Easton and Djumalieva, 2018) This paper is the first instance of capturing Fixperts pedagogy and its variations. The four models presented here were identified via the process

of documenting the case studies, and reflecting on them critically as a set. The paper demonstrates how Fixperts has been used and adapted in response to local contexts, and what can be taught through these variations on the method. We collectively hope this makes a valuable and timely contribution to design education. Sharing knowledge around the development of Fixperts via pedagogic practice has already proven useful in inspiring and enabling others to adapt the framework for courses that fit their own particular interests and curricula. In preparing this paper, we collectively hope to make the Fixperts project framework more accessible to others by demonstrating its flexibility and versatility in contrasting contexts.

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