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# The 1% Water Workshop Project

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**Abstract**: This paper charts creative development and real-life implementation of the 1% Water Workshop (1%WW) project, an innovative educational toolkit designed by a Hong Kong (HK) student-professor design team. The project addresses concerns about water sustainability by leveraging Research through Design as a construct for sustainable practices. Design is intertwined with experiential learning, play, poetry, and humour so as to enrich pedagogy and nurture sensitization to "pro-environmental consciousness", a focus of research carried out at a university design research laboratory. This paper also relates the project's subsequent development from school to start up so as to ascertain potential for novel approaches to environmental education design.

*Key words: Water sustainability, pro-environmental consciousness, educational toolkit, primary school play-based learning, design for change, research through design.*

## Introduction

Victor Papanek opens *Design for the Real World* (1983) lamenting "there are professions more harmful than industrial design, but only a very few of them." Can industrial designers address sustainability concerns? In *Design Revolution* (2009), Emily Pilloton argues for a multifaceted social design agenda, cataloguing "100 Products that are changing people's lives" along 8 categories, including Water, Education, and Play.

WWF (2015) reports that "The World Economic Forum's 2015 Global Risk Report ranked water crises as the top risk to global growth in terms of impact, rising from third position in 2014." In HK, water is no less an issue: HK depends on the Chinese mainland for 70% of its water provision; to the extent this underlies all its dealings with the central authority: "Hydrologically, the availability of local water resources is very limited (…) It would be

unimaginable for Hong Kong to achieve today's economic miracle and great prosperity without the water resource drawn from the Dongjiang (East River basin in mainland China)." (Chen, 2001).

Independent researcher Chan (2013) opines "With regard to the situation in HK and its supply from Guangdong, water issues pertain to issues including scarcity, accessibility, sanitation, pollution and contamination, water reform, anti-dam protests, transparency and information access, and social equity and justice." Like elsewhere, water in HK is core to social issues, its life-sustaining availability a resource tied to politics. The solutions lay with us, with education a change agent. But does it? Kollmuss and Agyeman (2010) "(...) do not attribute a direct relationship to environmental knowledge and pro-environmental behavior. We see environmental knowledge, values, and attitudes; together with emotional involvement as making up a complex we call 'pro-environmental consciousness'. This complex in turn is embedded in broader personal values and shaped by personality traits and other internal as well as external factors."

For Chawla (in Kollmuss and Agyerman, 2002), there is no single experience that sensitizes people's awareness but a combination of factors. She defines environmental sensitivity as "a predisposition to take an interest in learning about the environment, feeling concern for it, and acting to conserve it, on the basis of formative experiences." Significant factors include:

- Childhood experiences in nature
- Experiences of pro-environmental destruction
- Pro-environmental values held by the family
- Pro-environmental organizations
- Role models
- Education

**Environmental Education as a change agent**
Experts agree an early sensitization of children to environmental issues fosters better future behaviour. Cutter-Mackenzie and Edwards (2011) report that "Historical and emerging research suggests that environmental education is highly important in early childhood education." Hacking et al. (2007) see children as 'environmental stakeholders' who: "... are affected by environmental decision-making and have a right to be involved in it.", while Liefländer et al. (2013) assert "strengthening connectedness to nature is more

sustainable before the age of 11." 7 to 11 is Piaget's Concrete Operation stage, where children start using logical thinking and inductive reasoning, both essential for integrating abstract constructs and scientific concepts such as sustainability. In today's age-compression context, or KGOY (Kids are Growing Older Younger, Urist and Oliver, 2005), Piaget's age grade needs to be seen as indicative: a leading science education kit manufacturer has confessed to the first author that although his company markets to children age 8 and up, many of their product end-users were as young as 6 and below. For the purpose of this paper we shall refer to school age children from 6 to 12 as a user group to design for.

HK's Education Bureau's mission to enhance students' environmental awareness through education is embedded in its *Strand 2: People and Environment* curriculum learning objectives (2011). This project addresses these, helping children develop an empathic relation with the natural environment, adopt environmentally mindful lifestyles and educate others about these values.

While play has been widely accepted in educational settings as a framework for enhancing teaching and learning experiences, its effective inclusion in curricula has been nuanced, leading experts to reassess such pedagogical strategies.

Rogoff (1996, in Brooker, 2010) sees the debate as a pendulum swing between oppositional beliefs in learning as transmission (adult-led) and learning as acquisition (child-led), i.e. pedagogy (intentional actions to bring about learning) vs. play (voluntary, exploratory, and spontaneous). Rogoff (1990) solved this tension by defining learning as *the transformation of participation in cultural activities*, whereby a child's performance in culturally valued activities changes over time from that of a novice to that of an expert, as a result of drawing on the affordances of the environment, under the guidance of more experienced individuals. This involves "material arrangements (such as props and kits) of children's activities and responsibilities (...) with children observing and participating at a comfortable but slightly challenging level."

Environmental education seems best served when a balance between challenging and constraining activities derived from adults' experience and knowledge is struck with natural children's engagement through individual and peer-group journeys of discovery. This psychological equilibrium is akin to Flow (Csikszentmihalyi, 1980), where there is an even level of challenge and skills. A similar balance could be one between free play and

rule-governed, skill-demanding play, the Paidia and Ludus poles that Caillois (2001) places on a continuum structuring play. Environmental educational activities should harmonize different modes of instruction with ludic patterns i.e. "purposefully framed play" (fig. 1, Cutter-Mackenzie and Edwards, 2013), "a way of thinking about play in which open-ended play, modeled play, and teacher-child interactions about content knowledge associated with environmental education (...) connects with the importance of experience, content knowledge, and values in terms of environmental education, while also valuing the role of play and experience in teaching and learning from an early childhood perspective."
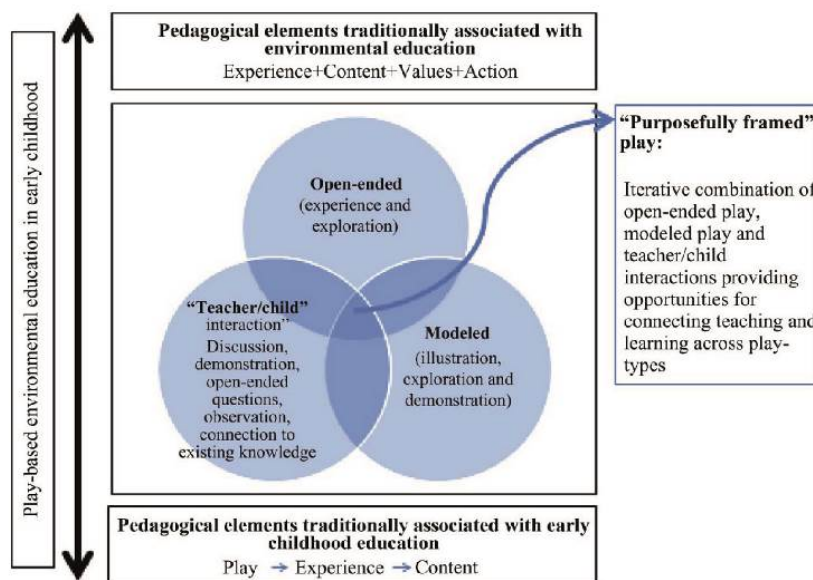


Figure 1. Pedagogical model for early childhood environmental education, Cutter-Mackenzie and Edwards, 2013

Education experts (Persson, 2010, and Honey & Kanter, 2013) argue for play as an appropriate framework for experiential, naturally self-motivated medium for exploration, discovery, creativity, and invention, which sustains children's engagement with different environmental concepts and effectively helps them connect these so as to appreciate cause and effect in sustainability.

While creativity lies at the core of play, humour enhances creative construction of knowledge. Vance (1987) established "that the use of humor helped promote recall and retention of material on tests in 1st graders". As environmental sensitivity puts us in touch with our own nature, nurturing this development through education takes an ontological tone: for Baughman (1974), "Humor (and laughter) in education help us get the larger

view of life, the incomparably more enthralling view, the view to start motions of wonder and reverence within the deepest of self."

**Design, education, play: the 1% Water Workshop**

The project started with this hypothesis: *Playing with appropriately designed learning props sensitizes children's awareness of environmental issues and helps them develop life-long sustainable habits*. To efficiently sensitize environmental stakeholders to water issues, one needs to deploy an array of instructional and experiential approaches. The project's main objective was to identify design opportunities to define how complex, critical contents could be connected to children's daily lives through play.

The project leveraged Research through Design (Frayling, 1993). RtD sees designing as a research and creative activity that generates new knowledge, ideas, concepts, product-systems and experiences, in 'context mapping' processes, abductive, iterative, and reflective design refinement processes, engaging with stakeholders, and harmonizing contradictory information to finalize a design. Methods are borrowed from science and the humanities. Leveraging such processes we aim to avoid treating people as the problem, and work with people to address the problem from their perspective. We involve children playing with 'affordances' - the action possibilities of material environments - to design the kit.

*Groundwork*

Literature review defined age-level appropriate educational content such as water sustainability issues, their causes and foreseeable consequences, and how to best address the issue from a standpoint of a designer working for children. This steered research priorities and structured assessment tools for product, user, and design research. Online research offered a number of perspectives to inform semantic and functional toolkit design. Charts were used to visualize assessment and prioritize design decisions.

*Product analysis*

120 artefacts related to water education were charted under three emerging ecological knowledge categories (fig. 2): *Basics*, *Economics*, and *Ethics*.
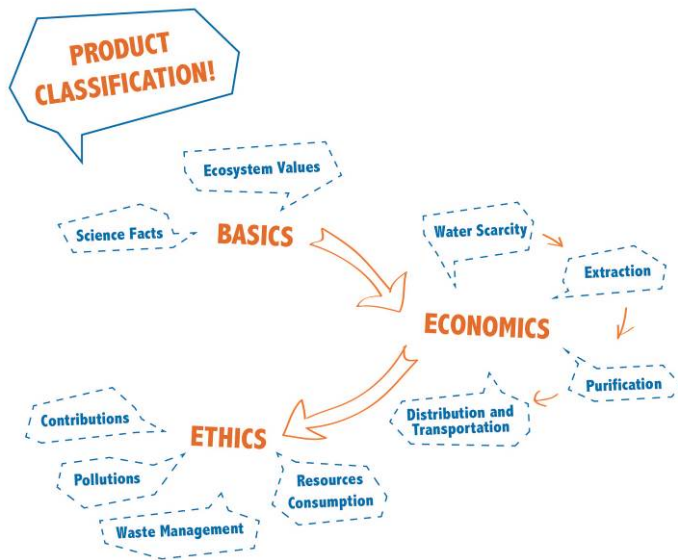
Figure 2. Product categorization chart

## Toy analysis

Product categorization informed analysis of 18 environmental issue-related toys, to discern eco-education value, using 8 criteria (fig. 3): *functionality*, *aesthetics*, *eco-wheel quotient*, *safety*, *creativity*, *fun*, *complexity*, and *educational efficiency*.



**CREATIVITY**
How much the toy allows the kids to be creative and bring out meaningful new ideas, forms, methods or interpretations.

**EDUCATION EFFICIENCY**
How effective the kids can learn about the knowledge that the toy is trying to tell.

**ECO-WHEEL QUOTIENT**
It refers to the sustainability of the toy itself, such as the materials, manufacturing methods.

**COMPLEXITY**
It refers to the depth and breadth of the knowledge the toy is providing.

**AESTHETIC**
It refers to how the toy appears to all the senses of the kids, including sight, hearing, touch, smell and taste.

**SAFETY**
It refers to the level and quality of not causing injury, risk or danger while the kids are playing with the toy.

**FUN**
It refers to how much mirth, amusement, enjoyment or playfulness the kids can have with the toys.

**FUNCTIONALITY**
It refers to how useful the toy (tools) can be in the kids daily life and daily activities.
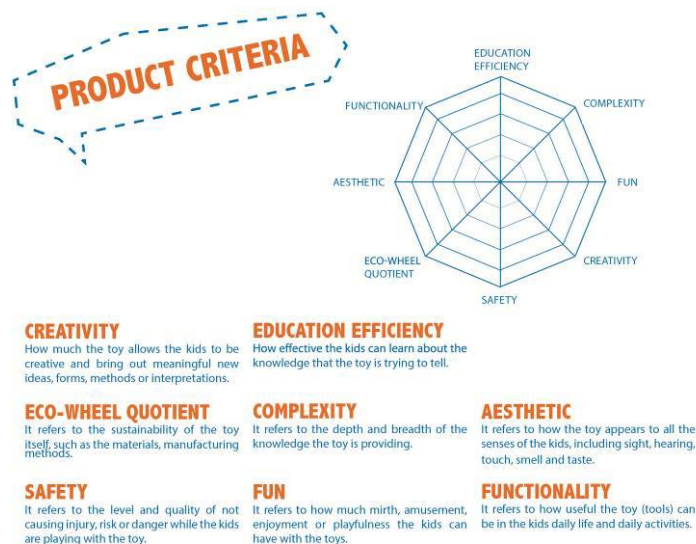
Figure 3. Toy analysis tool

## Artwork analysis

A study of artworks helped shape playful toolkit rhetoric, leveraging art's power to influence people through sensation and thought. The tool (fig.4), created by the first

author in 2010 deploys 5 criteria: *communication effectiveness*, *interaction*, *theme tactics*, *feasibility*, and *relevance* to *eco issues*. It helped identify strategies to inform 1%WW advocacy tactics.
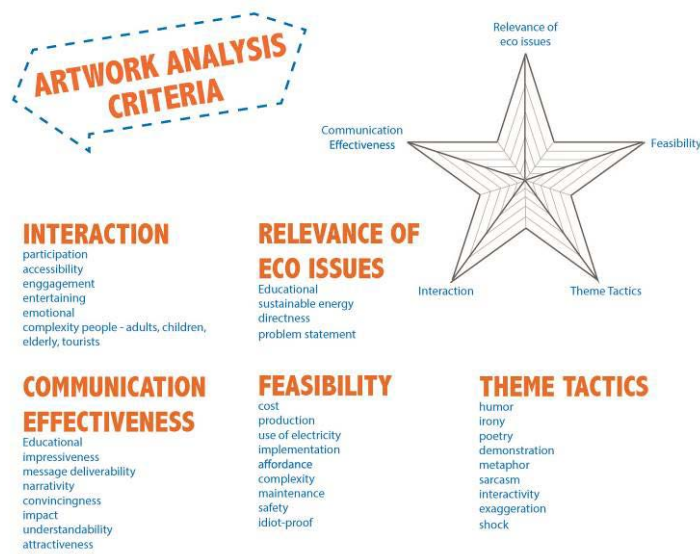


Figure 4. Artwork assessment tool


*Field study: Science Museum*

The visit helped discern institutional approaches to public science education. Fixtures were assessed on a chart (fig. 5) measuring levels of challenge and degrees of interaction.
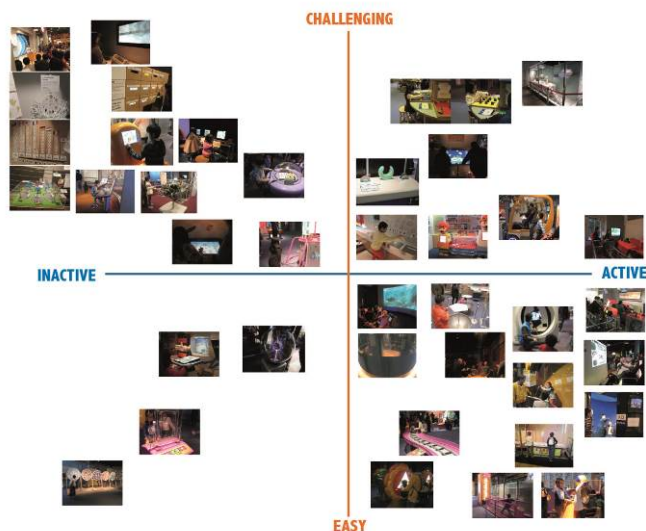


Figure 5. Science museum fixture assessment matrix

*Participatory stakeholder research*

A diverse stakeholder group was involved at early stages of the project to assess broader sociocultural contexts and define educational needs. In later stages, it helped validate design propositions in prototype-testing workshops.

*Home visit*

A visit was paid to a 6-year-old girl's family home. The second author "shadowed" the child and her parents' daily routines so as to assess a household's environmentally-friendly awareness and habits.

*Sensitization workshop*

Shadowing informed activity contents for an in-class workshop facilitated by the second author. 12 pupils aged 6 to 7 helped define how much knowledge they can assimilate on such issues. After exposure to basic water sustainability facts (fig. 6), children imagined ways to stop water pollution and shared daily water habits. The workshop confirmed children would engage in such issues if most topics were related to their daily lives, and if play was core to activities.
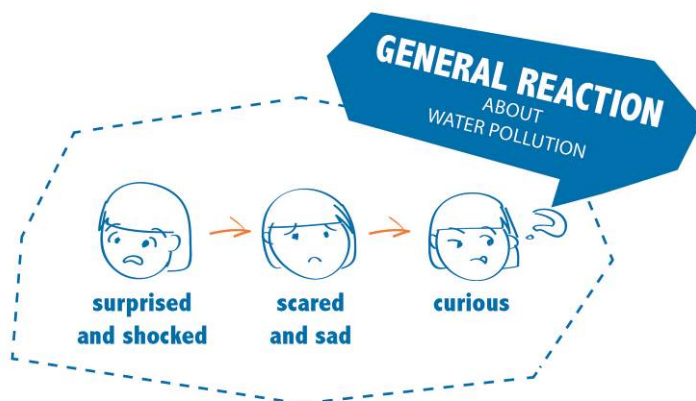


Figure 6. Children's reaction following exposure to water pollution facts

*Environmental expert interview*

An environmental NGO chairperson was interviewed to assess community advocacy priorities. He emphasized children were important stakeholders as they could influence their parents, and early sensitization to ecologic principles would foster pro-

environmental consciousness. Proximity was also important: elements from stakeholders daily, domestic contexts should be used to connect them to the issues' broader picture.

### Design prototyping
Data collected was mapped at each stage. Findings were harmonized to inform the design of an educational workshop, with a balance struck between flow (diachronic narratives) and activities (synchronic stations).

### Flow model analysis
An activity flow was modelled to assess the workshop system. This primary design outcome was used to test the 1%WW's play pattern appropriateness, progressive complexity, and narrative consistency.

### Paper prototypes
Paper prototypes were designed for each station. These helped evaluate the designs' educational contents' appropriateness, narrative flow, and play patterns.

### Educational expert interview
A senior primary school teacher was interviewed to confirm whether the scope of information, level of knowledge, flow, and types of activity were appropriate for children. Useful cues were suggested such as edification and enlightenment through play, and durability, as the kits needed to remain relevant to the curriculum for at least 5 to 10 years.

### 1%WW educational framework
The 1% Water Workshop educational toolkit-system aims to address the concerns of water sustainability by leveraging design as a construct for fostering sustainable lifestyles. The name refers to the fact that only about 1% of the world's water is fit for human consumption. Significantly, design is intertwined with play and education so as to enrich experiential learning process and nurture constructive approaches to environmental education. The design articulates the following educational framework:

*Purposefully framed play* (Cutter-Mackenzie and Edwards, 2013): 1%WW aims to foster pro-environmental consciousness among children. Its objective is to nurture sensitization through purposeful play.

*Educational play value:* the product-system demonstrates introductory knowledge of water consumption economics, pollution, and conservation.

*Educational play pattern:* 1%WW combines practical experiments with whimsical, poetic, and humorous manipulation of props and water play. The approach balances structured, goal-orientated play with free play, allowing adult-led, top-bottom instruction of principles by facilitators without hampering opportunity for child-led, bottom-up construction of knowledge.

*Educational play depth:* the mixed approach optimizes play depth to captivate children's imagination and sustain their engagement throughout the event.

*Age appropriateness:* selection of the toolkit contents' knowledge-level is adequate.

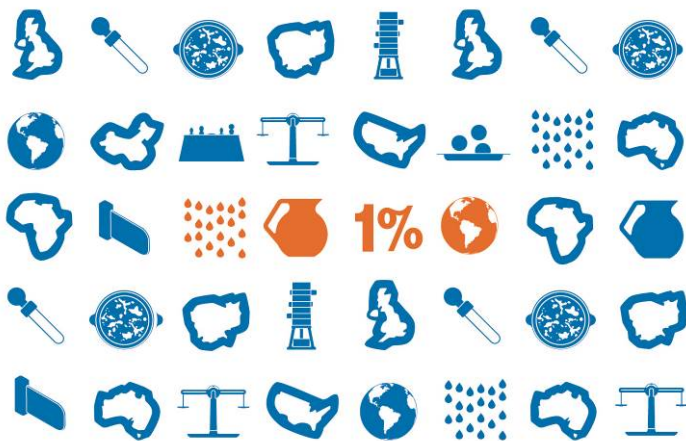*Facilitation:* 1%WW is facilitated by adults. Facts are communicated with infographic labels (fig. 7).

Figure 7. 1%WW graphic style

The event raises awareness of water issues, helps participants better appreciate the value of water as a resource to respect and preserve, and advocates development of personal sustainable habits.

*1%WW educational toolkit*

The toolkit comprises 5 educational science toys, a pitcher, and 1 Lablog per participant (fig. 8). It is aimed at schoolchildren 6 to 12, playing in groups of 5 in classroom activities. Each pupil gets a "Lablog" to record knowledge and process. Props are designed for playing in any direction so each child can participate in the activity from any side of the workbench. Recyclable materials were proposed in the manufacturing of parts. Given water sustainability issues are global, props relate to international concerns; yet the toolkit's labels and tags can be updated to relate to region-specific facts. Such information graphics are accessible online and easily printed to actualize props' information stickers and Lablog.



Figure 8. 1%WW toolkit

*Symbolic representation of elements and affordances*
To enrich the communication of water sustainability principles, the toolkit uses visual metaphors (like a scale) and metonymic representation of daily water usage (say, a washing machine).

1. The *Aquasphere Pitcher's* simple geometric design is a sphere, our blue planet.

2. *The National Aqua Levels* take from wells and tanks, an "extruded" representation of global water resource distribution. A mappemonde serves as mat. While all containers share the same height, concealed containers have different capacity. A grill hiding the size of the inner container allows water in. As players pour water in, containers fill at different speed, creating a surprise effect designed to highlight unequal global water distribution.

3. The *Water Consumption Scale* represents the balance of our planet's ecosystem, and includes a dripper, sponges, water level, miniature houses, washing machines, toilets, showers, and bath tubs, conveying notions of domestic water usage.

4. The *Water Saving Basin* is a sink with "message in a bottle"-like notes in test tubes. Test tubes arise one after the other as water is poured into the basin, like a clepsydra, whimsically maintaining players' focus. An LED smiley water plug indicates sate. Tips refer to tap usage, glass filling, and teeth brushing.

5. The *Water Pollution Roulette* uses a gold searcher's pan, suggesting gold-striking luck. Players "roll-and-hold" 3 loaded mini-globes. Each reveals on its top a sentence fragment about water pollution to be pieced together. Inspired by French experimental literature collective Oulipo (Ouvroir de Litérature Potentielle), the combinatory word play is a humoristic incongruous tactic; a random match producing a perfectly intelligible piece of pollution fact (colour-coding dictates sequence), so as to engage children with dramatic facts.

6. The *Natural Water Purifier's* mimics water towers. It is a whimsical yet effective means to communicate sustainable principles, focusing children's attention.

*Workshop rundown*
The ratio of participant group size to facilitator is 1, ideally 2 for a class of 20 to 25. Children are exposed to basic knowledge regarding water sustainability, and then briefed about the workshop. They experimented under the supervision of a facilitator, documenting process on their Lablog. This follows Fleer's (2007) approaches to teaching science, which includes Transmission (briefing), Process (experimentation play), Discovery (through instrument manipulation), and Interactive (quiz and discussion to verify learning). The 1%WW ends with the awarding of a Certificate, a memorabilia children treasure and parents value.

**From School to Startup**
Initially a BA (Hons) graduation project, 1%WW was highly commended by the jury at the RSA Student Design Awards 2012/13 Valuing Water design competition for its educational value. To meet certain criteria, it was enhanced with a twofold business plan (fig.9): a Business-to-Business sales and distribution channel for Schools to purchase 5 toolkits for

25-pupil classroom workshops; and a Business-to-Consumer retail model allowing consumers to purchase individual props.
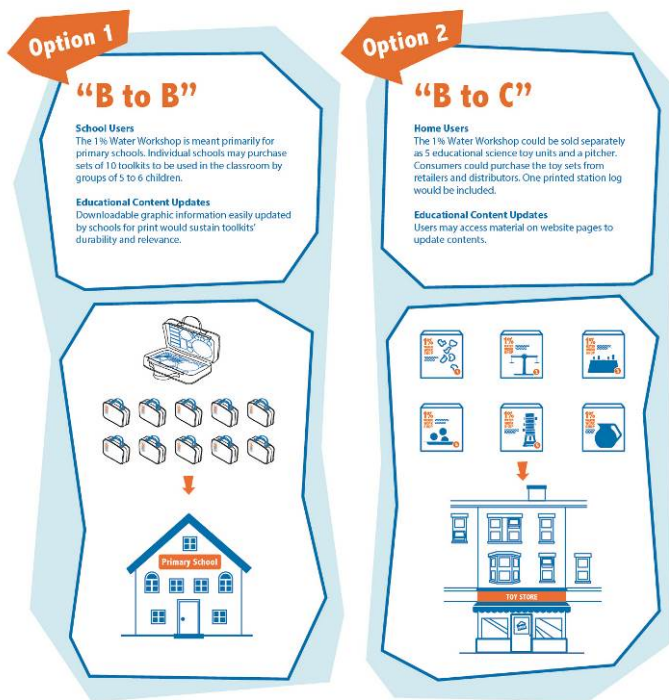


Figure 9. 1%WW business plan for RSA Student Design Award

The project underwent a third iteration (fig. 10) for a HK$100,000 Microfund to test the concept as a fully-fledged start-up company, Lilliput Studio, set up by the second author and her partner.
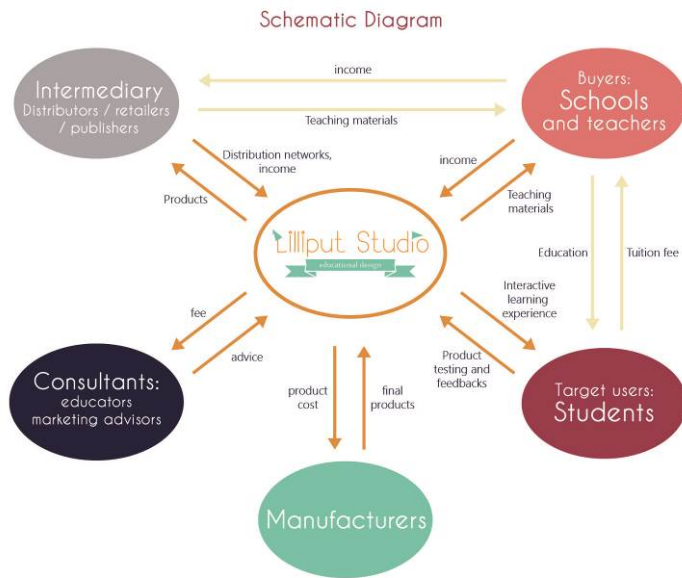
Figure 10. Lilliput start-up business framework

Constraints were two-fold: classroom deployment and manufacturing costs. 4 out of 5 stations were kept (fig. 11): the Natural Water Purifier was abandoned. Materials were changed from plastic to paper; consequently water play wasn't possible. Paper increased recyclability of the set and improved packaging, storage, and shipping performance. The Water Cycle Marble Run prop was added, introducing the concept of a water drop's lifecycle. Water Pollution Roulette balls were converted into dice displaying shocking pollution photos. The Water Saving Basin was converted into a puzzle communicating the planet's interconnected nature and uses a colour lens to discover hidden water saving tips. Also, in establishing Lilliput, the young designers broadened their scope of stakeholders to include manufacturers, institutions, government and entrepreneurs.

Figure 11. Lilliput's 1%WW toolkit iteration

Conclusion

Does 1%WW work? Chawla believes pro-environmental consciousness is borne out of a combination of factors, which we address (see quotes in following sentences): despite HK's easy-access to nature (country parks make up 40% of HK's land mass); "childhood experiences in nature" are few and far between. 1%WW simulates reality and "experiences of pro-environmental destruction" through narratives and humour so as to sensitize inner-city children to water sustainability. It promotes "pro-environmental values held by the family" by pointing daily habits to children, and connects children to parents through the Lablog. 1%WW engages with "pro-environmental organizations" to remain socially relevant. "Role models" are taken up by workshops facilitators. Finally, it deploys multiple play types: social, narrative, manipulative, imaginative, creative, and cognitive play, to enhance education experiences.

The challenge lies in matching information with play (narratives, metaphors, humour, creative experimentation) to produce appropriate education props for children environmental stakeholders, to foster pro-environmental consciousness. We believe our hypothesis was validated in that the emotional connection children make with the issues through the engaging framework of play, leveraging humour and poetry, enhances environmental education, efficiently contributing to the development of sustainable lifestyles.

Whether the toolkit effectively fostered children's life-long sustainable habits remains to be seen - they are years away from adulthood. However in workshops, and in post-workshop quizzes and discussions, children were engaged, enjoyed the process, and acquired knowledge. Their laughter and attention was sustained. Teachers felt the experience was conducive to learning. A bridge of experiential learning was created, simulating 'significant life experiences', its foundations resting on research through design. Children's passage is a journey through play, and its crossing connects their daily lives to future sustainable lifestyles. Both iterations of the toolkit received positive feedback from stakeholders, a commendation from an international design competition reviewed by a panel of design and water conservation experts, and received funding for development. In its first year as a start-up business, Lilliput successfully adapted the design to fit its budget, while creating new content and optimizing play patterns.

HK's hyper-dense urban context and acute pollution crisis is an experimental springboard for such educational toolkits. Future project iterations could include props to be taken out to parks. The kit could employ water resistant yet biodegradable materials to allow manipulation of water, though production costs would increase.

The project is a demonstration of work carried out at a university research lab investigating the relationship between design, play, and education. It creates settings where stakeholders meet and:

- Identify areas to design learning aids for,
- Critically review traditional and contemporary design culture and humour to enrich educational frameworks,
- Explore notions of play and conventions of interactivity, and
- Research and cross-pollinate to
- Propose innovative educational product-systems.

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