FRAMEWORK

FOR THE

KEY DESIGN THINKING COMPETENCES

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introduction

In the Future of Learning, published by the EU (The future of learning: a foresight study on new ways to learn new skills for future jobs, 2012), the authors highlighted three key concepts that should guide learning in the future: personalisation, collaboration and informalisation. And despite the terms are not new, the urgency of placing them at the centre of the learning design and facilitation still lacks priority and action.

As the OECD reported in 2015 (Schooling Redesigned: Towards Innovative Learning Systems), education used to be "about teaching people something" but has evolved to "making sure that individuals develop a reliable compass and the navigation skills to find their own way through an increasingly uncertain, volatile and ambiguous world". Schools should therefore be preparing students for a fast pace changing world, for jobs yet to be created, technologies to be invented and to solve problems yet to arise. And to do so, schools need to focus on nurturing *"ways of thinking, involving creativity, critical thinking, problem solving and decision making; ways of working, including communication and collaboration; tools for working, including the capacity to recognise and exploit the potential of new technologies; and, last but not least, the social and emotional skills that help people live and work together"*.

In the COM(2015) 408, the EU argues that *"Early childhood education and care is the starting point and one of the most efficient means for raising proficiency in key competences"*. *"(...) developing the larger frameworks so that knowledge can be transferred and used across different contexts and to address unfamiliar problems is one of the defining features of the 21st century competences"*.

The *"ability to apply meaningfully-learned knowledge and skills flexibly and creatively in different situations"* or as many scholars presented the adaptive expertise/competence along with empathy are considered critical skills for the 21st century learners: *"Every child must master empathy and teens must be practiced at the new requisite skills of cognitive empathy-based ethics, working in teams of teams, new leadership and changemaking"* (Henry de Sio, Ashoka) (Education transforms: papers and reflections, 2015).

The focus on Design Thinking is rooted on research which clearly demonstrates that the competences in the core of the design thinking mindset are critical to the integral development of learners and to their success. As an educational tool, Design Thinking allows educators and learners to organize and facilitate learning experiences based on transdisciplinary approaches, supported by a project-based learning and boosting the need to incorporate and put in practice knowledge from different fields of study to deliver a shared solution to a specific problem.

When applied to learning, Design Thinking promotes the ability to use a systematic process to understand people and situations, define problems, and come up with innovative solutions. Learning through Design Thinking demands for integrated learning hands-on projects, following a design thinking process, and focusing on building empathy, promoting a bias toward action, encouraging ideation and fostering active problem solving.

1. motivation and goal of tis document

Design Thinking enables students to work successfully in multi-disciplinary teams and enact positive, design-led change in the world (Lindberg, 2009). However, Design Thinking Education (and transversal skills in general) has not yet been effectively addressed at primary school level in Europe. Our objective is to identify a competences framework for nurturing children mindset setting the key Design Thinking processes and skills. Within this educational context, we provide information on the DT leading models and projects to define a framework.

2. methodology

In order to find out DT models used in education to identify the framework for the project, the team searched and selected recent research, models and projects using DT in the area of children's education.

The ChangeMakers team conducted a work session consisting in a brainstorming to identify strategically selected competences (and skills) in the frame of the project. The collection of competences resulted from the brainstorming session have been iterated in order to understand their relation to the Key competences at school in Europe (EACEA, 2012).

The final framework of competences is placed in the selected DT model.

To that extent, the review is divided in two phases, as follows:

> **Phase 1:** Develop a review of the leading DT models and use cases used with children to establish the most suitable framework to teach DT to children.

> **Phase 2:** Identify the most convenient Design Thinking framework of competences for children Design Thinking development.

3. design thinking models

This section analyzes key DT models, its different applications in projects and other formats in which they are developed to be implemented or distributed (see Table 1). Further detail on the models and documents is provided in Appendix A.

The work done by the Institute of Design (D.School) at Stanford, is a key reference in the area of Design Thinking. The process and model described in (Plattner, 2010) has been widely applied in different contexts mainly with adults for the improvement of their careers or business, but also in workshops for children (Carroll et al., 2010; Rauth et al., 2010).

With the aim of exploring the feasibility of DT to enhance teaching and learning in schools, **Stanford's K-12 Initiative** sparked a partnership between the **Stanford School of Education** and the **Hasso Plattner Institute of Design (d.school)**.

Similarly, the **Game Design Thinking Research Group** (Stanford) from the **Persuasive Technology Lab** (Stanford) have studied the intersection of game design (as a science), behavior design, and design thinking. Focused on game design thinking, children have sessions where the main aim is to apply the DT process to design games. It is a collaboration between the **Design School X (DSX)** and the K12 Lab. The K12 Lab also defined several games and activities for Design Thinking published at the "K12 Lab Wiki" (Adam Royalty, 2014).

Within this context two similar models emerged from Stanford, each used in different contexts, building different variations to adapt the models to the specific necessities. The **Stanford's d.school Design model** of 5 phases (empathy, define, ideate, prototype, test) and the 6 phases **d.school model** (understand, observe, point of view, ideate, prototype, test) resulting from the partnership between the Stanford School of Education and the Hasso Plattner Institute of Design (d.school).

The *Taking Design Thinking to Schools Research Project* applied the DT process of the **Hasso Plattner Institute of Design** to an ethnographic qualitative study to extend the knowledge base that contributes to an improved understanding of the role of design thinking in K-12 classrooms (Carroll et al., 2010).

The City X Project (IDEAco, 2014) adapted the Stanford's d.school Design model by adding a "sharing" process (Figure 1), this adaptation was proposed during an international educational workshop for kids with the aim of using 3D modeling, printing & design thinking skills to solve real-world social issues. Each kid was faced with a fictional character in City X with a problem to solve. To do so, the kid needs to invent, design, and prototype something to solve their character's problem. **City X Project Toolkit**, also provides support for teacher as guiding templates.
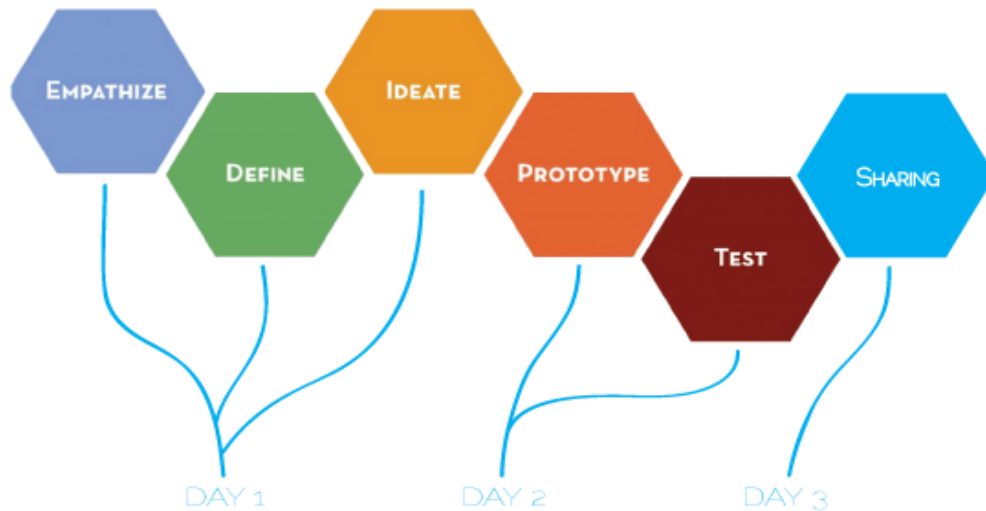
Figure 1: Stanford's d.school Design model adapted for The City X Project (IDEAco, 2014)

The Sustainable *Design* School (SDS) co-developed a series of toolboxes through collaborative workshops. SDS with the PERL (Partnership for Education and Research for Responsible Living) Erasmus network worked in a Social innovation project called **LOLA** (Looking for Likely Alternatives) (Thoresen et al., 2008). LOLA is a toolbox to support education for sustainable lifestyles for primary and secondary school. LOLA also applies the d.School model from Stanford.

Beyond the work done at Stanford, another well-known contributor in this field is the *DT for Educators toolkit* (IDEO and Riverdale school, 2012), used as a complete tool for educators to foster creativity and Design Thinking for children by applying a design challenge of curriculum, spaces, processes and tools or systems. IDEO and other partners have extensively worked on many other toolkits and materials to teach and work with DT skills but those are adults focused, deriving from their vast experience of working within several professional contexts for instance product manufacturing sector (Brown, T., 2009).

The *DT for Educators toolkit* (IDEO and Riverdale school, 2012), has been used as a complete tool for educators to foster creativity and Design Thinking for children by applying a design challenge of curriculum, spaces, processes and tools or systems. IDEO and other partners have extensively worked on many other toolkits and materials to teach and work with DT skills but those are adults focused, deriving from their vast experience of working within several professional contexts for instance product manufacturing sector (Brown, T., 2009).

In a similar direction, the **REDlab** (Research in Education & Design) emerges to study the impact of DT in education with the *Taking Design Thinking to Schools* project, aimed at

helping teachers learn about design so as for them to see its value, and have the confidence to bring it to their classrooms (Carroll et al., 2010).

Finally, the work done by Tschimmel can be cited as one of the most recent DT model: *The Mindshake Design Thinking model Evolution 6²* (Tschimmel, 2014; Tschimmel, 2015) which consists in 6 phases (emergence, empathy, experimentation, elaboration, exposition and extension). *The Mindshake Design Thinking model Evolution 6²* is the model applied to the D-Think project. However, there is still a lack of evidence of the adaptability of this model for children.

design thinking models for children

Among all the DT models described previously, three are two which are the most documented to be used in projects focused on children.

- Stanford's d.school Design model (Stanford, 2009)
- DT for Educators (IDEO & Riverdale school, 2012)

IDEO's DT toolkit for educators focuses on guiding teachers through the DT process while Stanford's d.school Design model has been applied successfully with children in projects like the *Taking Design Thinking to Schools Research Project* previously mentioned. And the **Entrepreneurial Engine** is designed to teach entrepreneurship to children which limits its possibilities to implement the model to other fields.

The Stanford's d.school Design model promotes learners' development in an integrative framework capacitating the new generations with the competences required to act in a context of complexity, adaptive challenges, innovation, technology and active citizenship.

Especially the d.school model has proved to be easy to adapt and use with children and it is between the two most widely-used in projects with children together with the educator's toolkit from Ideo.

In each project the Stanford's d.school Design model has been adapted to be used by children for a specific context or purpose but all of the adaptations maintained the structure of 5 phases (empathy, define, ideate, prototype and test) or added one or more phases or skills to adapt the model for a specific activity or context (e.g. empathy, define, ideate, prototype, test and storytelling).

Picture								
University or institution	Stanford + University of Postdam (Hasso Plattner)	Stanford	IDEO			IDEO & Riverdale	Nicole Arnett Phillips	Next Gen Minipreneurs
Model	d.School models		3 I's	HCD 2009	HCD 2015	DT for Educators	Nicole Arnett Phillips	Entrepreneurial Engine
n° phases	6	5	3	3	3	5	3	5
Phases	Understand	Empathy	Inspiration	Hear	Hear	Discovery	See	Inspiration
	Observe					Interpretation		
	Point of View	Define	Ideation	create	create	Ideation	Shape	Ideation
	Ideate							Interaction
	Prototype					Experimentation		Innovation
	Test		Implementation	Deliver	Deliver	Evolution	Build	Initiative
Complementary toolkit	No	yes	No	yes	yes	yes	No	yes

Table 1: Comparison of the phases of different DT Models. Adapted from (D-think, 2015).

4. design thinking competences framework

First of all, it is necessary to clarify that in this context a competence is defined as a combination of knowledge, skills and attitudes that students need to achieve.

According to the EU commission, there are 8 key competences that the educational curriculum of primary and secondary schools should incorporate (European Commission, 2012). The eight key competences are:

1. Communication skills in the student's mother tongue
2. Communication skills in a foreign language
3. Basic competences in science and technology
4. Digital competence
5. Learning to learn
6. Social and civic competences
7. Sense of initiative and entrepreneurship
8. Cultural awareness and expression

Based on these key competences, the report 'Developing Key Competences at School in Europe: Challenges and Opportunities for Policy' (EACEA, 2012) gives more detail related to the specific characteristics of these competences and how to organize them. In this report, we will include those ones that will be related to our proposed DT framework.

Students at school level have to develop (in different levels according to their age), transversal and basic skills. In particular the following ones are especially mentioned:

- Ability to think critically
- Take initiative
- Problem Solving
- Work collaboratively

New ways of learning are necessary, and in particular it is important to help students to develop entrepreneurial skills. These learning has to be based in the following knowledge and skills:

- Real-world experience
- Problem-based learning

The EU commission promotes the development of STEM (Science, Technology, Engineering and Mathematics) skills. The DT process, and particularly its application through a learning digital game, will help the students to practice technological and engineering skills.

Other basic skills are also very important, as the literacy competence and particularly the promotion of new forms of reading and writing. In our context, children will practice their literacy competence by playing to the digital resulted game.

The report also emphasizes the importance of stimulating and open and flexible learning. And considering the main characteristics of the Design Thinking process, we can state this is an adequate methodology to support this kind of learning.

It is worth to mention, that in the EEUU level, the Partnership for 21st Century Skills states that the 21st century public education system should be focused on *innovation, creativity, critical thinking, problem solving, communication and collaboration* essentially to prepare students for the future.

In Table 3 (see next section), we will see how the previous mentioned competences are contained in the resulted ChangeMakers DT Framework and will be considered when designing the ChangeMakers game. In addition to these competences, more fine grained skills (related to the main tasks of the DT process) have been included in the framework.

changemakers: dt framework brainstorming session

The ChangeMakers team conducted one work session to brainstorm ideas aimed at analyzing existing Design Thinking programmes and related documents to define the set of competences and skills that would define the ChangeMakers DT framework.

The session was formed by a total of 8 participants, researchers and professionals from different disciplines / expertise related with education, design and engineering. The session took place during the first project meeting in Barcelona in December 2016.

The brainstorming activity was divided in 3 tasks. During the first task, each subject worked individual writing skills in post-its. The second task was done in groups of 4 (2 groups in total) and consisted in clustering the post-its (figure 2). During the third task each group and then all participants of the meeting discussed criteria to prioritize consideration of skills in the frame of the project.

Figure 2: Pictures of the result of the brainstorming work session.

The outcomes from the work session (Figure 2) were later listed to identify the most used words and concepts (Table 2).

Words Team A	Words Repeated T A	Groups Words Team A	Comments Team A	Words Team B	Words Repeated T B	Groups Words Team B	Comments Team B
Phase 1	Phase 1	Phase 2	Phase 3	Phase 1	Phase 1	Phase 2	Phase 3
empathy	5	skill 1	productive failure	(iterative) problem solving	1	G_A	open-ended-close
explore	1	skill 1	evil creativity	goal setting	1	G_A	chunking and setting the other indicated but not implemented
obervation	1	skill 1	reverse engeenering	progress monitoring	1	G_A	selecting an aspect not exploited
reflecting on experiences	1	skill 1	creating a failing solution	debugging (...)	1	G_A	selecting a key aspect
exploring continously	1	skill 1	analisy failure/from users pep....	lateral/transversal thinking	1	G_B	feasibility of implementing ...
recognizing patterns	1	skill 1		accross disciplines	1	G_B	more difficult
awareness of environment	1	skill 1		critical thinking	1	G_B	critically lacking at school
questioning their surroundings	1	skill 1		"listening" to others	1	G_C	
"what else?"	1	skill 1		be able to project yourself into other users		G_C	
questionning (problem setting)	2	skill 1		user empaty (...)		G_C	
awareness	1	attitude		empathic (user ...) analysis		G_C	design or etnography
curisity	1	attitude		empathy	4	G_C	
listening		attitude		humility	1	G_C	
listening actively	2	attitude		inclusion	1	G_D	
investigation skill (curiosity)	1	attitude		capacity to integrate	1	G_D	
understanding	1	attitude		global citizenshi...	1	G_D	
agency	2	result		stewardship	1	G_D	
responsibility	1	result		visioning	1	G_E	
independence	1	result		emision alternative futures	1	G_E	
feedback	1	- A		creativity (...)	1	G_E	
fun	1	tools		agency (...)	1	G_E	
stewardship	1	tools		visualize storytelling- capacity to picture a scenario	1	G_F	
being focused while having fun	1	tools		embody-capacity to materialize into an artefact	1	G_F	
artfull	1	tools		visual and makes skillls (...)	1	G_F	
visualizing ideas	1	tools		authenticity	1	G_G	
storytelling	1	tools		Self-confidence (...)	1	G_G	
creativity		tools		meditation-capacity to perform brorering between parts	1	G_H	
unleashing creativity	2	- B		leadership	1	G_H	
collaboration	2	- B		team work	2	G_H	
social skills	1	- B		Cooperation	1	G_H	
team work	1	- B					
co-creation (collaborative)	2	- B					
daring	1	dare 2					
failing is ok (...)		dare 2					
experimenting without the fear of failing		dare 2					
Risking		dare 2					
Risk Failure	4	dare 2					
Building skill	1	do					
prototyping	1	do					
service learning	1	do					
system learning	1	do					
What is wrong was right	1	- C					

Table 2: Words and concepts resulting from the brainstorming work session.

The discussions led to "empathy" and "letting students having the experience of daring / failing / iterating" as the most interesting aspects to focus in the project.

changemakers dt framework for children aged between 6 to 10

After the brainstorming session, and considering the analysis of the existing DT models, we have iterated the obtained results (see Table 3). Our aim was to iterate the collection of DT competences and skills, in order to identify those ones which are related to the suggested key competences to be incorporated into schools by the European Commission (European Comission, 2012; Eurydice, 2012).

The resulted competences have been allocated according to the 5 phases of the d.school model, by placing them into the phase to which they belong. Our aim is to propose an adaptation of the d.school model focused on the strategically selected skills and competences to teach DT to children between the age of 6-10 as envisaged by the consortium.

	EMPATHY	DEFINE	IDEATE	PROTOTYPE	TEST
Phases & Competences	Emotional intelligence	Reflecting on experiences	Visioning	Problem solving	Capacity to evaluate
	Capacity to observe	Problem-based learning	Storytelling/ Narrative capacity to picture scenario	Capacity to concretize	Capacity to analyze
	Learning from real world	Critical thinking	Agency	Capacity to adapt	Validate
	Questioning		Capacity to take initiative	Implement/create/building	Share
				Embrace experimentation	Learning from mistakes

Table 3: ChangeMakers Design Thinking framework for children aged between 6-10.

As summarized in Table 3, some competences have been related to a specific phase of the Design Thinking process following the d.school model as a reference.

However, during the application of the whole DT process some transversal competences will be developed by the children while playing with the ChangeMakers Game. These transversal competences are:

- Communication skills
- Team work/collaborative skills
- Interpersonal skills
- Literacy competence: reading & writing in new formats
- Planning and organizing skills

Finally, but not least importantly, one of the main aims of the Design Thinking process is to promote *creativity and fun* at the same time that the student is learning how to face realistic problems (Goldman & Kabayadondo, 2016).

Other potential skills: learning foreign languages.

conclusion

Due to our findings we propose an adaptation of the Stanford's d.school Design model within the teaching DT to children context of the project by providing a set of the main competences related to the DT process in the context of the schools educational curriculums.

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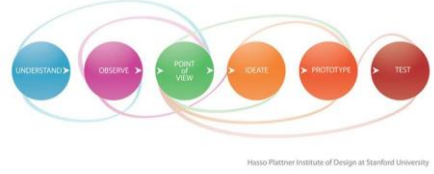
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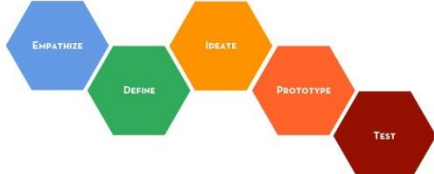
appendix a: models

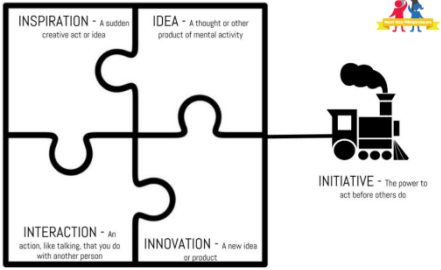| Institution:	IDEO	
Date:	2001	
Reference/Link:	http://www.designkit.org/	
DT model:	**3 I's** (Inspiration, Ideation, Implementation)	
Target:	Not defined	
Description:	Developed in the context of service and social innovation. Each phase has an associated space of action.	
Tools & materials:	NO	

Institution:	IDEO	
Date:	2 versions 2009, 2015	
Reference/Link:	http://www.designkit.org/	
DT model:	**HCD** (twofold meaning: Hear, Create and Deliver and Human Centered Design)	
Target:	Not defined	
Description:	The HCD (Human-Centred Design) model and its practical toolkit adopts a small set of rules for creating an environment to facilitate innovation: Building multidisciplinary teams (between 3 and 8), using dedicated spaces to focus on the challenge and Planning finite time frames, with a beginning, middle and end. The version from 2015 is the recent version of the one from 2009.	

Tools & materials:	IDEO Method Cards(IDEO 2003) Digital (iPhone and iPad) and physical.

Institution:	Stanford + University of Postdam (Hasso Plattner)	
Reference/Link:	https://dschool.stanford.edu/	
DT model:	d.school Design model from the Hasso Plattner Institute of Design at Stanford	
Target:	Not defined	
Description:	Developed in an educational context it is a model of the d.school of the Hasso-Plattner-Institute at the University of Potsdam in Germany, an institution directly connected with Stanford University and IDEO. The same DT model is proposed by Stanford University, with only a small difference in the first 2 phases. Based on process experience from IDEO the DT process is visualized in 6 steps connected by curved lines to indicate iterative loops which visually shows that the stages of the design process are not always undertaken sequentially.	
Tools & materials:	No	
Use case:	Taking Design Thinking to Schools Research Project	

Institution:	Stanford	
Reference/Link:	https://dschool.stanford.edu/	
DT model:	Stanford's d.school Design model	

Target:	Not defined	
Description:	Developed in an educational context it is based on process experience from IDEO. The DT process is visualized in 5 steps.	
Tools & materials:	Mixtapes; Document with an overview of some of our most-used tools; Crash Course (90 minutes video) Available at http://dschool.stanford.edu/use-our-methods/	
Use case:	Social innovation project LOLA (Looking for Likely Alternatives) (Thoresen et al., 2008); The City X Project (IDEAco, 2014).	

Institution:	Next Gen Minipreneurs	
Date:	From 2015	
Reference/Link:	http://nextgenminipreneurs.com/	
DT model used:	**Entrepreneurial Engine**. Life and career skill set on the 5 I's (Inspiration, Ideation, Interaction, Innovation and Initiative)	
Target:	Elementary and middle school children	
Description:	Project-based programs to make commercial and social entrepreneurship programs understandable and reachable to elementary and middle school children.	
Build Skills:	General: ● understanding basic business concepts, including branding, marketing, finance and sales; ● developing a basic business and marketing plan; ● learning leadership skills, team values and how to work **collaboratively**; ● in learning **business ethics** and the importance of diverse perspectives;	Main focus: ● natural creativity; ● self-awareness and self-esteem; ● Leadership capabilities; ● collaboration skills.

	- in unleashing your child's **creativity** and ability to dream big dreams; - in understanding good **social citizenship** and **globalization**; - in learning **public speaking** and presentation skills; - in understanding that **failure** is just one step closer to success; - And in developing **self-awareness** and **self-esteem**.
Tools & materials:	Not described

Institution:	Mindshake Portugal	
Date:	From 2015	
Reference/Link:	http://mindshake.pt/	
DT model used:	**The Mindshake Design Thinking model Evolution 6²**	
Author:	Katja Tschimmel	
DT Model Phases:	6 - Emergence, Empathy, Experimentation, Elaboration, Exposition, Extension.	
Target:	Not defined	
Description:	Six phases model composed by 36DT exploration or evaluation tools.	

Tools & materials:	Cards	

Use case:	D-think. Design Thinking applied to Education and training project; redesign of the Multimedia Course at ESAD; classes and projects of the Post Graduation Course in Design Thinking at ESAD (case studies for Apgei and Amorim Cork Ventures); Training and Coaching sessions for Portuguese companies (Roche, Moretextile, NOS, etc.) realised by the SME Na'Mente.

Institution:	IDEO + Riverdale School	
Date:	2012	
Reference/Link:	http://www.designthinkingforeducators.com/	
DT model used:	**DT for Educators**	
DT Model Phases:	5 - Discovery, Interpretation, Ideation, Experimentation, Education	
Target:	Educators	
Description:	Complete tool for educators to foster creativity and Design Thinking in children by applying a design challenge of curriculum, spaces, processes and tools or systems	
Tools & materials:	Toolkit	

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