D4.3 METHODOLOGICAL PLAN

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Executive summary

Deliverable D4.3, Methodological plan, intends to involve the participants in research work conducted through focus groups (Metaplan method) and directed towards:

(a) identifying the pertinent dimensions of the WP research space to be explored and

(b) defining and tailoring the related appropriate explorative tools (e.g., workshops, focus groups, questionnaires, etc.) in order to effectively gather and analyse qualitative and quantitative data relevant to answer WP4 central research questions:

- what are the current transformations that the use of DiDIY is producing in European educational and research practices and structures?

- what are positive and negative effects of these changes on the quality of European education and research?

- what are the factors that are promoting these positive and negative effects?

| Revision history			
Version	**Date**	**Created / modified by**	**Comments**
0.0	16/09/15	ABACUS	First draft. Informal distribution to partners.
0.1	20/09/15	ABACUS	Second draft, resulting from several online documents to which all partners contributed. Informal distribution to partners.
0.2	25/09/15	ABACUS	Third draft, resulting from meetings in person or via videoconferencing with all partners. Written contribution of MMU for Section 5 and LIUC for Annex 1. Informal distribution to partners via Hackpad.
0.3	29/09/15	ABACUS	Fourth draft incorporating written contribution from POLIMI for Section 4.4, and from AC for Ethical Issues questions in Section 4.3. Informal distribution to partners via Hackpad.
1.0	30/09/15	LIUC	Approved version, submitted to the EC Participant Portal.

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1. Introduction

D4.3, Methodological plan, is based on the preliminary results of WP4 and WP8 and its results will be used to gather information in the coming months and will feed both the last deliverables of WP4 and other WPs, such as WP3 (schools and movements where informal education using DiDIY takes place are indeed organization structures), WP7 and WP8, as well as the Transversal Activities, so to contribute to the consistency of the whole Project.

Visually, below are the inputs and outputs of D4.3, divided by WP and deliverable.
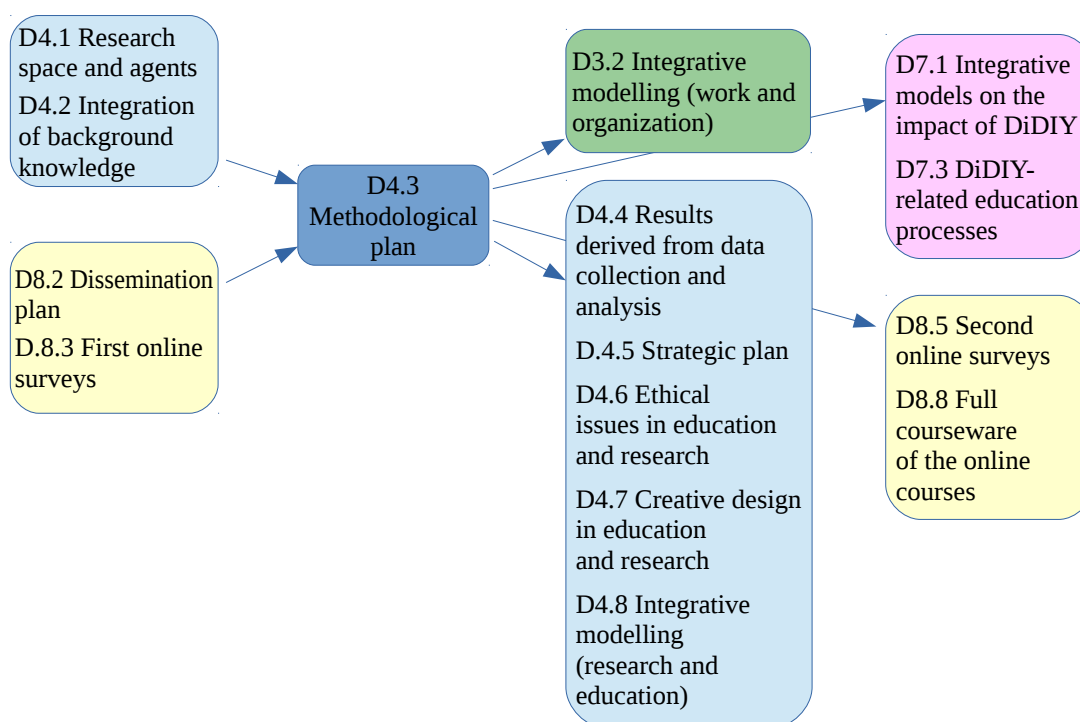
Considering the complexity of the proposed activities and the variety of how its outcomes will feed the different WPs, the document is structured as a roadmap for the collection of information, depending on the different stakeholders involved, the different areas of investigation to be tackled, the research instruments to be used and how they will be used for modelization. The document will be concluded by a set of measures to maximize data collection.

1.1 Terms and acronyms

CAD	Computer-Aided Design
DIY	Do-It-Yourself
DiDIY	Digital Do-It-Yourself
ET	Explorative Tools
FLL	First Lego League
GA	Grant Agreement
GT	Generation Tools

ICT	Information and Communication Technologies
MIT	Massachusetts Institute of Technology
RCJ	RoboCup Junior
STEM	Science, Technology, Engineering, Mathematics
STEAM	Science, Technology, Engineering, Arts, Mathematics

2. Main stakeholders in the DiDIY in education and research areas

A series of stakeholders were identified as important actors in the field of DiDIY. The table below tries to expand those that were found in D4.1 and identifies them according to two axes, the role the actors play and the environment in which they play it.

Indeed there will be some overlapping (besides the obvious ones, for the particular nature of a student in high school can participate as trainer in activities taking place in informal environments, or a trainee in informal environments could also be a teacher in high school):

	Formal education (from primary school to university and post-graduate)	*Informal education environments (Fablabs, MakerSpaces, CoderDojos, etc)*	*Mixed environments (DiDIY Contests such as RoboCup, First Lego League, Museums, Research Institutes)*
Learners	students, post-graduate researchers	trainees, makers, hackers, coders, etc	players (often including also school teachers)
Trainers	professors, teachers and laboratory technicians	trainers, researchers	DiDIY experts, trainers, researchers, etc
Administration Organizers Management	school principals, pedagogues, officials from ministries or their provincial/regional offices	organizers, founders of FabLabs, networks of movements, etc	managers of museums, organizers of contests and exhibitions, etc

3. Areas of investigation

D4.1 has highlighted the pedagogical foundations of the use of DiDIY in educational activities,[1] that progressively move from Montessori to Piaget and Dewey and are best depicted, understood and used by Papert.

For the sake of the present deliverable, it is enough to recall that, according to later studies,[2] the four pillars of constructionism (as the pedagogical perspective of Papert is often referred to) are:

• learning by designing meaningful projects and sharing them in a community;

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1 See D4.1, in particular paragraph 2, "21st Century Challenges in Education".

2 Bers, M.U., Ponte, I., Juelich, C., Viera, A. & Schenker, J. (2002). Teachers as Designers: Integrating Robotics in Early Childhood Education. Information Technology in Childhood Education Annual, 2002(1), 123-145. Association for the Advancement of Computing in Education (AACE).

- manipulative objects for supporting the development of concrete ways of thinking and learning about abstract phenomena. (object to learn with);
- powerful ideas from different realms of knowledge;
- self-reflective practice. Documentation is a wonderful vehicle for making self-reflection concrete and being able to share its products with others.

Based on this, a series of areas of investigation have been individuated. The first four refer to the pillars of constructionism:

a. the role of creativity;

b. the role of sharing;

c. the role of teachers;

d. DiDIY and learning flows.

They were individuated together with the following four in D4.1:

e. how is school as institution responding to the use of DiDIY?

f. DiDIY in education and gender issues;

g. DiDIY and special education;

h. DiDIY: from STEM to STEAM.

Finally, two more areas were added, after discussion with the DiDIY Project partners, so to fully explore and analyse how DiDIY is affecting education and research:

i. how is research affected by DiDIY?

j. ethical issues in DiDIY education and research.

4. Research instruments

In the first nine months of the DiDIY Project, a number of research instruments have been identified and tested in different environments, so to provide insight on the Areas of investigations that were progressively identified, and thus also the research instruments have been progressively developed and widened so to tackle all aspects of the DiDIY phenomenon applied to the education and research contexts.

The first two instruments are designed to be filled both in person and online, while the last three are intended to be performed in person (or via videoconferencing).

4.1 Online surveys

The online survey described in D8.3 was distributed to students and teachers that participated in both general and DiDIY specific events.[3]

Based on its structure, the following template expands its content (which was limited to the first 5 question of the survey below) to be used to investigate on education and research, with particular regards to Areas of Investigation a,b,c and d. In agreement with the partners, the online survey will be made available online through the www.didiy.eu website and will exploit Lime Survey (https://www.limesurvey.org).

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3 See D8.3 for structure, methodology and results.

a.   Something about you
1. How old are you?
2. Are you male or female?
3. What is your nationality?
4. Your background is: (tick only one)

	Humanistic
	Scientific-technological
	Artistic
	Technical-professional

b.   Write two adjectives that come to your mind when thinking of a maker

c.   Making something with your hands (tick only one per line)

	Do not know	False	Sometimes	Often	True
Gives me satisfaction					
Is useless, a waste of time					
Is boring					
Makes me save money					
Is fun					
Is a hobby, leisure					
Helps me develop my competences					
Is reassuring					
Reduces wastes					
Something for nerds					
Makes my inspirations real					
Useful to find a job					

d.   What do you think of Digital Do It Yourself (DiDIY) (tick only one per line)

	Do not know	Do not agree	Partially	Almost true	True
Is just a game					
Good ideas will save our world					
Better to leave it to professionals					
Is a way of making lots of money fast					
You cannot be an entrepreneur without technology					
Finally an active use of technology					
Good to show off					
Useful to find a job					

e. Regarding the following tools (tick only one per row)

	Never heard of	I know they exist	Used sometimes	Often Used
Software to create and manage websites, blogs, etc				
If you have used those tools, which one you use?				
Software and hardware to create digital video/audio				
If you have used those tools, which one you use?				
3D printer and scanner				
If you have used those tools, which one you use?				
Arduino/Raspberry Pi, etc				
If you have used those tools, which one you use?				
3D software (CAD)				

f. Where do you use those tools?

	School
	FabLabs
	Home
	Other (please specify)

If you have used any of the tools above, congratulations, you too are a DiDIYer! Please find below four other questions that will allow us to better understand how DiDIY is reshaping education and help you use it at its best

g. CREATIVITY – If and how DiDIY is promoting your creativity? (tick only one per line)

	Do not know	Do not agree	Partially	Almost true	True
When I use DiDIY, I can fully express my creativity					
There are things left behind that students that use DiDIY do not do anymore					
Putting the tools in the hands of the learners empower them to solve their problems differently compared to traditional off the shelf products					
different kinds of solutions to real problems emerge					
DiDIY is scaffolding new creativity (allows to do more, differently, etc.)					
Add comments if you wish					

h. SHARING – How important is sharing in your DiDIY activities? (tick only one per line)

	Do not know	Do not agree	Partially	Almost true	True

DiDIY activities lead to conformism					
DIDIY communities are prompting new connections with people (digitally and/or physical)					
When I do a new project, I find pleasure in sharing it with my friends and online communities					
DiDIY activities lead to new ideas					
I gather information on possible projects through online sharing tools					
Add comments if you wish					

i. THE ROLE OF TEACHERS AND TRAINERS – How does training happen? (tick only one per line)

	Do not know	Do not agree	Partially	Almost true	True
DiDIY is transforming the role of teachers					
New competences are expected from teachers and trainers					
DiDIY activities lead move from a teacher / curriculum-centered school to a student / experimentation-centered education					
In DiDIY activities teachers and trainers are no more the main source of knowledge and competences					
I gather information on possible projects through online sharing tools					
Add comments if you wish					

j. FLOWS OF COMMUNICATION – Is DiDIY changing the way in which knowledge and competences flow between trainers and learners?

	Do not know	Do not agree	Partially	Almost true	True
Compared to traditional subjects, DiDIY is taught in the same way					
There are major changes in the traditional roles of education (teacher-student)					
Working in teams maximize success in DiDIY activities					
In most cases learners actually know more than DiDIY trainers					
Add comments if you wish					

In a second stage, further questions will be asked to include the other six areas of investigations, which at present are excluded so to keep the filling of the questionnaire to less than 10-15 minutes (otherwise we would have a limited number of respondents).

4.2 Individual questionnaires

The partners of the DiDIY Project distributed individual questionnaires (prepared by LIUC) to the participants in the Italian Finals of RoboCup Jr, and they were particularly focused on the understanding of the dynamics and flows of communication among teams that participated in the competition.[4] Similarly they can be of use to determine how groups that use DiDIY manage their activities.

Methodology: Each student and teacher of each team is asked to answer to 12 questions about the teammates or other individuals who contributed to the project.

Respondents are asked to identify, for each question,

with an "X": the individuals important relating to the theme of the question;

with an "O": the individual who was the most important relating to the theme of the question.

	Questions	Name 1	Name 2	Name 3	Name xxx
1	Who participated to the team				
2	Who worked with the software				
3	With whom you interacted most (in person, by phone, via email or social network)?				
4	Who do you think was most important in the realization of the project?				
5	When a problem arose (eg: in the hardware or software) who was most useful in solving it?				
6	Who gave the most creative and innovative ideas?				
7	What was responsible for time management?				
8	Who had the most previous experience?				
9	Who gave you information and suggestions on how to complete the project?				
10	Who gave you information and suggestions on the hardware?				
11	Who gave you information and suggestions on the software?				
12	Who gave you information and suggestions on the components?				

4 The outcomes of the questionnaire can be found in Annex 1, elaborated by Aurelio Ravarini of LIUC.

4.3 Interviews

Among the different research instruments, interviews are the most direct, as they allow for a real interaction with the different stakeholders involved.[5] For each of the Areas of investigation as emerged in D4.1 some questions had been individuated and asked for the preparation of D4.2. Based on its results and further discussions with partners, other more specific questions have been added (in italics the questions that have been added).

Interviews can take place in person or via videoconferencing, and exceptionally also in writing. Based on the experience of D4.2, interviews can last from 25 minutes to more than one hour.

a. The role of creativity

The many uses of DiDIY in education and research have one element in common: creativity has a crucial role and is often relieved from the burden of the actual "making" of the outputs (if you can imagine it, you can create it). Thus pupils really have the opportunity to work on their ideas, shaping them mostly in a non-physical environment, and even the last part of the process does not require them to have particular dexterity. How do teachers and students use this unique feature of DiDIY? *Does putting the tools in the hands of the learners empower them to solve their problems differently compared to traditional off the shelf products? What different kinds of solutions to real problems emerge? How DiDIY is scaffolding new creativity (do more, differently, etc.)? What is left behind that students that use DiDIY do not do anymore?*

b. The role of sharing

Thanks to new social media and the growth of the free software and open source / hardware movements (that are a fundamental component of DiDIY) pupils work on common projects and share working spaces with their colleagues-friends. Does this lead to new ideas or to conformism? *How DIDIY community is prompting new connections with people (digitally and/or physical)?*

c. The role of teachers

How can DiDIY be exploited to ease / emphasize the transition from a teacher / curriculum-centered school to a student / experimentation-centered education ("flipped classroom")? Is DiDIY also transforming the role of teachers accordingly? How? What new competences are expected from them? What do teachers need to engage with this and dare to take that step? Do we need to set up spaces where the learners take the lead and demand support from other learners and teachers when they need it? Does the additional excitement that DiDIY can bring to STEM subjects sometimes come at the cost of distorting the way a given discipline is taught? All these aspects need to take into account that DiDIY educational activities are also related to environments different from schools (such as labs, museums, robotics academies, etc) and educators that are not teachers.

d. DiDIY and learning flows

How does the learning process happen during "make to learn" activities? Who are the stakeholders involved and which is their role in the process (teacher, students, educators, DiDIYers,

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5 See D4.2 for structure, methodology and results.

etc)? What are the similarities with learning flows that happen in other fields (e.g. in companies)? Which formats/contexts for these learning flows facilitated by which tools and led by which roles are the most successful?

e. How is school as institution responding to the use of DiDIY?

Papert indicates that school as institution could have greatly benefited from the computer age, but was somehow reluctant to do so. Will DiDIY have better chances to allow for major changes within the educational system, also taking into account the concurrent existence of multiple forms of do-it-yourself aimed at substituting schools (such as MOOCs)? Are there Governmental funds to help schools acquire DiDIY technologies? *Is there need of curricular reform? Is there need to have support from the management? How is the governance model affected? Do teachers get the space, freedom and support to experiment with these different educational methodologies and technology? Which is the level of awareness and commitment at management level to a vendor-neutral technology strategy?*

f. How is research affected by DiDIY?

Although in many areas students and researchers are still learning DiDIY techniques (thus not producing fully fledged research), there is huge potential in the exploitation of DiDIY for research purposes, both within and outside the more traditional academic and R&D environment. *What are the main differences between traditional and DiDIY-enhanced research? Which are the motivations and strategies behind decision to use one option or the other? Which are the research areas that are attracting most researchers from the DiDIY world? Who is responsible for the scientific validation of DiDIY-enhanced research?*

g. Ethical issues in DiDIY education and research

The use of DiDIY in education and research raises ethical issues. To properly assess these, it is important to establish first, including with the help of expert input, what the effects of DiDIY in that context are likely to be over the coming decades. *To what extent does the use of DiDIY in education and research pose threats to intellectual property, and how concerned should we be about such threats? To what extent is the safety of products manufactured using DiDIY devices a concern? What sort of devices for bits-to-atoms conversion should we expect to become widely available, thanks to falling prices, beyond "controlled" environments like school labs (which could raise further concerns about safety)? And could such devices help produce hazardous preparations in fields like biotechnology or chemistry? A final issue is responsibility, both moral and legal: for example, who is to be held responsible if the use of a digitally made artefact results in harm to someone in the relevant context? The manufacturer of the device, the institution that owns it, the user, or the designer of the artefact?*

h. DiDIY in education and gender issues

Considering that DiDIY is used in many countries as a special tool to attract more students and make them study more STEM subjects, and considering that STEM faculties have a very low percentage of female attendance, one possible areas of interest could be that of evaluating if and

how DiDIY could attract more women to STEM classes and faculties. Interesting (and worth studying if/how the same thing is happening in DiDIY) is the "When Women Stopped Coding" issue: "The share of women in computer science started falling at roughly the same moment when personal computers started showing up in U.S. homes in significant numbers".[6] *Could female leadership in DiDIY help working towards a more balanced situation? Does it help remove the masculine image of the relevant disciplines? Or does it simply make the relevant disciplines more exciting in the eyes of some people, including some women?*

i. DiDIY and special education

There are many promising tests and trials on the use of DiDIY that are being applied to special groups of students (persons with motor and dexterity disabilities, visual impairment, mental and behavioural disorders). *Will this help them better integrate in schools and also create something particularly relevant for their needs?*

j. DiDIY: from STEM to STEAM

At present DiDIY in education is mainly used in close relationship with STEM subjects (and if other subjects are involved, they have an ancillary role). *Is there a main role for DiDIY in other subjects, such as humanities, arts, etc?*

4.4 Focus groups

Two focus groups were organized during the Italian Finals of RoboCup Jr.[7] Based on that experience and the lessons learned on the occasion, a similar research instrument has been set aimed at evaluating with teachers and school managers how schools are responding to the use of DiDIY and the potential it has to be further implemented. Three areas of study were identified.

- Technology and skills: what technologies and skills a school and its teachers would be desirable to have to fully exploit the potential of DiDIY?
- Flows of knowledge: what is the best model of cooperation between students and professors? In what other school subjects you may extend this model? Study of the dynamics of the group. How did the different members of the team (teachers, students, external members) interact?
- What are the side effect of DiDIY projects? What are elements that you considered unexpected but useful for us as elements of further research? What are the other interesting areas to be evaluated?

The focus group is better conducted in an isolated room, where professors (maximum 10 per focus groups) are seated around a table. At one end there a video camera, a flip chart to the other.
Focus groups can be held in the following way:

1. each teacher has Post-Its to write on;
2. once written, the Post-Its are then put on the board;

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6 See http://www.npr.org/sections/money/2014/10/21/357629765/when-women-stopped-coding and http://www.smithsonianmag.com/smart-news/what-happened-all-women-computer-science-1-180953111/?no-ist and http://jaxenter.com/when-women-stopped-programming-111998.html.

7 See D4.2 for structure, methodology and results.

3. the moderator asks teachers to elaborate on the basis of the answers on the post it and write a summary on the board;

4. at the end of the focus group participants are asked to agree on the complete synthesis.

4.5 Workshops

One of the research instruments to explore the DiDIY phenomenon in its complexity are co-design workshops in order to detect, together with the different actors involved (in their role as creators, developers, users), the change of the creative process in relation to open source technologies and develop new tools to support the process itself. The workshops are structured in relation to specific dimensions in each of the DiDIY Project's main areas (Organization and Work, Education and Research, Creative society and Law Systems). In particular, for the Education and Research Area, according to D4.2, we will explore in depth the Areas of investigation as individuated above.

Considering the Maker Movement activities categorization made by Vossoughi and Bevan:[8]

- making as entrepreneurship and/or community creativity;
- making as STEM pipeline and workforce development;
- making as inquiry-based educative practice.

For each category we are planning to examine:

- the flow of skills and knowledge between the different stakeholders involved in the learning process (trainers, learners, organizers) and their role in the process;
- the steps and outcomes of the learning processes and how they are influenced by creativity and sharing;
- the technology involved in the learning processes.

Since these three categories often overlap in practice, it could be interesting then to cross the results to figure out new findings and scenarios of learning.

The main objective of the co-design workshops in the Education and Research area is to understand in depth how the learning process takes place during making activities and which is the role of the different persons involved. Hence, the questions are: Who are the persons involved in the learning processes? What is the role they play? How the teaching/learning flow happens? How are creativity and sharing involved in the learning process?

The learning process and the persons involved are different according to the activities, the space and the tools used. For example, in communities of practice participants learn from others' prior frustrations.[9] The community served to alert members to false paths and unproductive approaches when trying a new project. Sharing knowledge among learners is fundamental, regardless of age. "If you learn something, you are responsible for teaching it."[10]

From the literature, many researchers have described the pedagogical skills and understandings that support meaningful participation in making and tinkering.

8 Vossoughi, S. & Bevan, B. (October, 2014). Making and Tinkering: A Review of the Literature. National Research Council Committee on Out of School Time.

9 Wenger, Etienne. (1998). Communities of practice: learning, meaning, and identity. Cambridge University Press.

Norris[11] argues that teachers should support the development of positive self-concepts and identities as part and parcel of the design process. Also, the literature research highlights different learning arrangements that are common in making activities and that usually take place in different learning environments, with different type of tools and participant. We can classify them in: solo project; collaborative group projects; forums for feedback on work; structured workshop; open-ended paly; solo, dyadic and small group facilitated projects.

In preparation for the workshop we will hold, this research will be useful to:

- identify the personalities we want to work with;
- identify what we want to test or develop with them.

The intention is to analyse the relationship between persons in the learning process and the skills exchange in each one of the different identified categories: this could give a clearer vision about the needs to develop kits to support the learning processes.

A case study approach allows the integration of diverse sources of evidence to build a deep within-case understanding of the dimensions to analyse. A comparative case approach, however, is particularly suited to analyse commonalities and differences across categories. Hence, the comparative case protocol will focus on activities and processes, personalities, tools and technology, environment. This research will help in identifying and developing ad hoc tools to be tested and used during the workshops. Besides, it will be possible to use the results of this research to improve the learning flows in other fields (e.g., in companies) and for the other WPs.

Workshop Structure

The research space is structured on different theories. The hypothesis is to put together theory and practice with a particular focus on the creativity levels adapted from Sanders's categorization: Doing, Adapting, Making, Creating.

A 2 set of 8 workshops and 4 debrief will be held in 2 selected countries of intervention, one in a North European country and the other in a South European country.

The people to be involved in the workshops will be chosen in relation with the dimensions previously listed for the in depth investigations as well as the space and the specific aims. The selection will be done in two selected European countries and will be supported by the existing network of co-design research centres. The Centres identified in the two countries will act as consultant for finding the user groups to be involved in the fields activities.

The structure of activities to be developed for WP4 will also be used for WP3, WP5, WP6 (2 main workshops as previously stated), but different ad hoc tools depending on the specific WP (e.g., Interaction tools > consulting group: MEDEA Sweden; game design tools > consulting group:

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10 Attributed to Jeff Sturges, founder of Mt Elliot Makerspace. Quoted in Kimberly Sheridan, Erica Rosenfeld Halverson, Breanne Litts, Lisa Brahms, Lynette Jacobs-Priebe and Trevor Owens. (2014). Learning in the Making: A Comparative Case Study of Three Makerspaces. Harvard Educational Review Dec 2014, Vol. 84, No. 4 (December 2014) pp. 505-531.

11 Norris, A. (2014). Make-her-spaces as hybrid places: Designing and resisting self constructions in urban classrooms. Equity & Excellence in Education, 47(1), 63-77.

ENCORE at Aalto University Finland (ref. Mattelmaki), Antropology design > consulting group Co-design cluster at KADK).
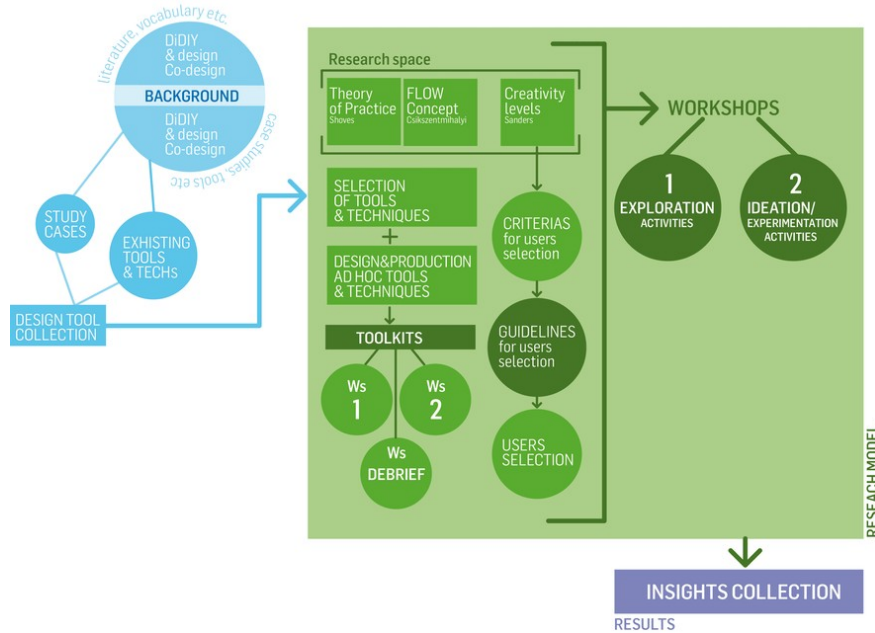
For example the ENCORE team's toolkit includes approaches such as design probes, design games, situated make tools, performative toolkit, developed and tested in collaboration between users, businesses and public sector. Playing games is not about "easy fun", rather it is kind of "hard work". Gamers want to do something that feels challenging and productive and feel really good about how they spent their time. In fact gamers, according to scientific research, are spending 80% of their time failing inside games: not finishing a level, not achieving the mission, not getting the power up.

The first set of workshops called Explorative Workshops will be more investigative and more focused on better understanding the Areas of Investigation while the second set of workshops called Generative Workshops will be more generative and more focused on identifying new possible futures and visions.

Different kind of tools and techniques will be used according to the 2 different sets of workshop

i. **Explorative Tools (ET)** are very specific tools. Explorative Tools trigger the entire process identifying specific needs and expectations. Any concrete case is different from the other ones. Individual peculiarities are a very high value to be preserved and enhanced. A specific ET will be also dedicated to identify strategic decision problems making explicit their constraints, alternatives and evaluation criteria. The ETs are a mix of instruments capable of defining a specific profile and characterizing the type of intervention and the strategy required in order to achieve an innovation of meaning. The profile highlighted through the use of these tools allows to draw up the necessary guidelines for the production of specific toolkits for ideation WS. Explorative tools will be configured with a mixture of qualitative and quantitative elements following the learning of the European Innovation Scoreboard. Examples of ET are "Share inspiring stories", "Cluster into Themes", "Create insights

Statements" and "Create How Might We questions" and "The Landscape Game". The Landscape Game aims for collaborative sense-making of empirical data on a flat game board. How it works: participants collectively make patterns stand out from prepared open-ended materials by continuously reconfiguring the materials, defining the meaning of interrelations, and by taking turns. By the end of the game the board will be populated by partially shared, and at least explicitly explained, material configurations of important issues as seen from different points of view. The tool enables a kind of clustering with photographic images, small artifacts, and textual descriptions. It can be followed by the prioritization game that enables discussion of the impact and prioritization of the produced configurations.

ii. **Generation Tools (GT)** constitute the kernel of the innovation generation supporting the path from the idea to its implementation. The goal of the generation tools (es. brainstorming, photo boost, provocation, brain sketching, cluster & dots…) is to generate many new solutions for the problem to be solved or the objective to be achieved. This activity has a twofold value, aiding both in generating ideas and in identifying which are most interesting and hold the most potential. Using specific tools, the ideas generated during the session are captured, clustered, selected and perfected. Some examples of ad hoc Generation Tools are "Brainstorming", "Photo boost", "Brain sketching", "Cluster & Dots" and "Doll scenarios"Doll Scenario aims at developing new possibilities in a concept by focusing on it as a lived sequence, to express existing concerns, as well as exploring future stories in a miniature world of 'what if…' Acting through dolls but in recognizable environments may enable new ways for players to see and understand themselves and their opportunities. How would my life unfold under different conditions?

The co-design workshops are developed by a scientific methodology and are divided in three phases, the main two are *Explore* and *Generate* and the third one is the transversal *Build Team*.

The moments of downtime between sessions are held by the Research Group, according to the description of the creative process of Graham Wallas,[12] as critical stages of incubation in which the active search for a solution to the problem is temporarily suspended and it is not dealt with consciously. The incubation period also allows the group to work independently and collaboratively, applying what they have learned during the sessions.

Environment plays a key role as it is an incentive for working groups building that would be opened to creativity and to the ability of working within the co-design approach. An environment open to creativity, also in terms of an open-minded attitude, foresees sharing of principles such as the abstention from judgement and the suspension of hierarchies and business roles.

"The three factors related to the person, process, environment interact to produce specific results. In other words, the quality of the creative product depends on the fact that people support certain processes within specific environments."[13]

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12 Wallas, G (1926) The Art of Thought. New York: Harcourt Brace.

13 Puccio, G.J., Mance M., Murdock, M.C., (2011). Creative Leadership, Skills That Drive Change, Sage Publications, CA.

To complete this open environment, images and colors are joint in. The very straightforward visual language, expressed by keywords, sketches, photographs, recordings, is adopted as the main mode of communication for the entire workshop.

The methodological approach

As mentioned above, 2 different sets of 8 workshops (8 Explorative workshops and 8 Generative workshops) will be organized and for each set specific tools and technique will be used (respectively ET and GT).

The first set of workshops are called *Explorative Workshops*: *building personas and identification of opportunity*.

At the beginning of this phase, the POLIMI team (called IDEActivity group) will organize information in a visual form by rearranging the contents through one of the techniques present in the IDEActivity toolkit, the conceptual mind-map.

One of the principles of the guidelines proposed by Mayer,[14] stated that learning is better if we associate the word to the picture because the integrated mental model is richer in information that can be retrieved later on. Following this principle, the use of a conceptual map is characterized by a block structure that consists of: conceptual issues, associative relationships and descriptive labels that allows to disclose the information, simplifying and improving the understanding and retention of contents.

This mode of (re)presentation conveys "at a glance" and in an extremely synthetic way, even those nuances that otherwise, with the use of only key words, could be lost, as well as it enables the group to share and "maintain a constant focus" on the end users and their requests.

Different activities will be proposed: Personas and Scenarios (instruments found in the IDEActivity toolkit).

Building personas allows the definition of fictional characters based on real people, that are due to representing users profiles. The objective of this technique is to illustrate the behavioural patterns of a hypothetical user through the detailed description of his lifestyle, aspirations, needs, values, cultural background. Building scenarios allows to setup fictional representations of a possible interaction in order to provide a suggestion or an interpretation of a situation that could possibly occur. They can be used both to communicate a concept in an immediate way as well as facilitate a conversation about an issue / specific subject. Personas tool has a strategic importance in identifying the end user. In order to facilitate its understanding the use of three-dimensional shapes, combined with images arranged through the Empaty Tool is applied.

The second set of workshops are called *Generative workshop*: *idea generation*.

In this kind of workshops, the creative session, is an opportunity to imagine, create and freely generate ideas starting with the bases set so far. This activity has a double meaning, on one hand generate ideas and on the other identify the most interesting ones and with the greatest potential.

14 Mayer, R.E. (2000). Intelligence and education. Handbook of intelligence, Cambrige University Press, New York, pp. 519-533.

The preparation of the tools for the support of the creative session is crucial in order to start this step. The IDEActivity group foresees, other than displaying the part of what has been acquired during previous sessions, the construction of work tools due to stimulate the idea generation. As a replacement to the traditional Brainstorming, Brain sketching or other tools could be proposed in order to encourage visual solutions and facilitate the systematic exchange of ideas through drawings and sketches.

Each one of this set of workshop, Explorative and Generative, are anticipated by an initial step of preparation of the creative team called Build Team. This first step is oriented towards the presentation of the design process and focuses on the transfer of some creativity tools. In this context, the transfer of the technical know-how will be joined by a series of short activities aimed at facilitating the generation of a favorable creative climate encouraging team spirit, sharing objectives and enabling familiarization with some research tools through "learning by doing".

In order to foster a group of people into becoming a formed and cohesive "creative" team, it is required for them to become familiar with the surroundings and with all the team components.

For this reason, at the opening of the work session carry out a ice-breaker activity, meant to literally break the ice and overcome the initial resistance and preconceptions that could become possible barriers to teamwork.

The choice will be on a creative technique that allows each participant to introduce herself and share her expectations for the workshop, creating a progressive familiarization and sharing of a common goal. After this first activity, that usually lead to changes in the internal climate, the research group follows an Action Learning, characterized by a playful, proactive and emotionally engaging approach.

The starting point is to suggest an activity based on the concept of "experiential learning", designed to be engaging in both emotional and physical terms. The environment will became an integral part of the experience, the training factor, along with the decision to foster alternative languages as compared to the traditional word based communication. Two instruments could be selected based on their ease of application, e,g.: on site interview that allow direct communication with the users and user journey map that enables mapping of the user experience for a predetermined time laps in relation to a particular product or service.

Another important step will be to try out two techniques, the Role Play and expert observations derived from the Human Centered approach, in order to show to the participants the importance of the user observation phase. By making sure that the environment would reproduce a real situation, and through the activity cards (toolkit tools designed ad hoc) the IDEActivity group assign tasks to some participants in order to perform specific actions and, to others, the task of identifying the potential problems through observation and interviews. The group is thus introduced to familiarizing with these tools through these preparatory activities, focusing on the very "learning by doing".

Results

i. Highlights the moments of interaction in DiDIY and Education

Storyboard as a tool that maps and displays the user experience by identifying the key moments.

ii. Guidelines for designing the user experience by tracking and managing the user experience from the physical to the digital identifying all the touch points. Handmade digital book that explore the

results of the WSs and shows how DiDIY hands-on productive work and making, can supplement and extend critical reflection on technology, work, society, education and intellectual properties with video guidelines for designing DiDIY and collaborative blog. (e.g., http://conceptlab.com/criticalmaking)
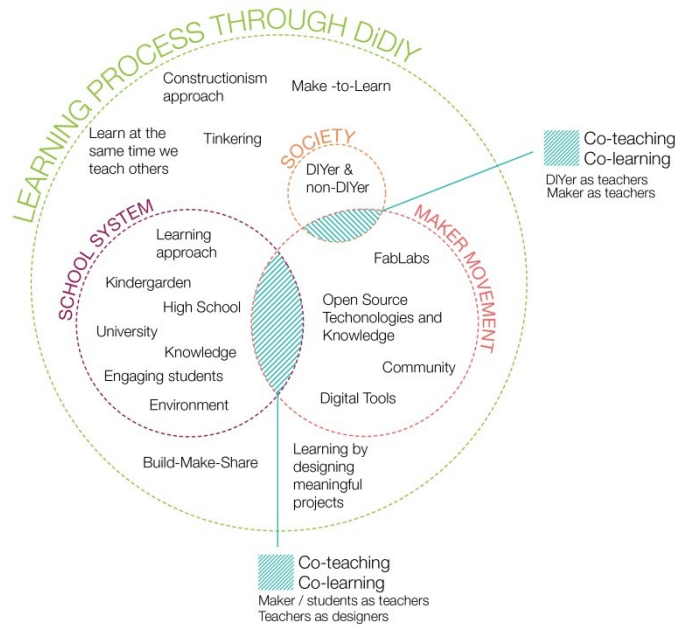
4.6 Summary

Considering the variety of stakeholders involved and the different Areas of investigation to be covered the following tables tries to individuate which are the most appropriate stakeholder for each Area of investigation, as well as the most appropriate research tools depending on the Area of investigation.

		The role of creativity	The role of sharing	The role of teachers and trainers	DiDIY and learning flows	How is school as institution responding to the use of DiDIY	How is research affected by DiDIY	Ethical issues in DiDIY education and research	DiDIY in education and gender issues	DiDIY and special education	DiDIY: from STEM to STEAM
FORMAL EDUCATION	students, post-graduate researchers	X	X	X	X		(X)	(X)	(X)	(X)	(X)
	professors, teachers and laboratory technicians	X	X	X	X	X	X	X	X	X	X
	school principals, pedagogues, officials from ministries or their regional offices	(X)	(X)	X	(X)	X	X	X	X	X	X
INFORMAL EDUCATION	trainees, makers, hackers, coders, etc	X	X	X	X		X	(X)	(X)	(X)	(X)
	trainers, researchers	X	X	X	X	(X)	X	X	(X)	(X)	X
	organizers, founders of FabLabs, networks of movements, etc	X	X	X	(X)	(X)	X	X	(X)	(X)	X
MIXED ENVIRONMENT	players (often including also school teachers)	X	X	X	X		X	(X)	(X)	(X)	(X)
	DiDIY experts, trainers, researchers, etc	X	X	X	X	(X)	X	X	(X)	(X)	X
	managers of museums, organizers of contests and exhibitions, etc	X	X	X	(X)	(X)	X	X	(X)	(X)	X

The (X) represent areas in which the stakeholders may not be able to provide relevant data for the DiDIY Project.

	The role of creativity	The role of sharing	The role of teachers and trainers	DiDIY and learning flows	How is school as institution responding to the use of DiDIY	How is research affected by DiDIY	Ethical issues in DiDIY education and research	DiDIY in education and gender issues	DiDIY and special education	DiDIY: from STEM to STEAM
online survey	X	X	X	X						
individual questionnaire		X		X						
interview	X	X	X	X	X	X	X	X	X	X
focus group	X	X	X	X	X	X	X	X	X	X
workshop	X	X	X	X						

5. Data exploitation for modelization

Data that is going to be collected through all research instruments will also be used to feed modelization. The models developed as part of the DiDIY project will be aimed at integrating the strands that emerge during the project. It will not be able to make specific models to cover every single area of investigation, but will aim at a few targeted models that will encapsulate many of the key issues, such as areas of investigation a,b,c and d. In terms of data/evidence to support targeted model creation the answers that will emerge from the different research instruments will have different levels of description.

MICRO

1. What are the goals of people in these circumstances - their relative importance, clashes between goals, how are goals obtained or formulated? (for interest or self expression, as part of an activity to generate income)

2. What are the strategies that people use to attain these goals? (trial and error, ask a friend, buy in expertise, etc)

3. Under what kinds of circumstance do people use these strategies? (as a creative individual, when needing a component that does not seem to be available, when stuck as to how to solve a particular DIY problem, as part of a community of peers etc)

MESO

4. What kinds of social networks of affordance/groups exist that can be joined and utilised by people?

5. What economic structures/constraints/incentives are there that influence their action?

6. What social norms, procedures, habits, traditions exist that effectively shape what one can or should do within each structure? Are these changing? Are there competing sets of such norms?

MACRO

7. Are there any longitudinal statistics concerning the development/uptake of the technology, or associated behaviours or patterns?

8. Are there any comparative statistics about use or uptake in different countries?

6. Measures to maximize data collection

Considering the different stakeholders involved a series of measures are going to be taken so to maximize data collection and the participation of all the stakeholders in the different research activities, so to gather data that are sufficiently relevant and statistically sound (in terms of stakeholders involved, their age and geographic coverage) to analyse the phenomena associated to the use of DiDIY in education and research.

To this end, and in particular for the online survey, ABACUS as Leader of WP4, with the active participation of each partner in the DiDIY Project will:

- exploit the channels that were individuated in the Dissemination plan that was prepared by FKI;[15]

- interact with the various Communities of Expertise that are on Facebook, with particular regards to the European and national communities of innovative teachers and DiDIYers;

- exploit the already well established links of communication (such as those emerged from D4.2 with the different stakeholders involved);

- coordinate with FKI for the launch of the online survey so to make it as easy to use as possible, lasting no more than 10 minutes and available on all platforms;

- request each partner in the DiDIY Project to provide at least 1 contact detail for each stakeholder individuated and individuate at least 5 events to which Project participants take part to where to distribute the online survey;

- individuate "DiDIY Champions" among the various stakeholders and monitor their activities in the course of 2015-16, so to have also a longitudinal perspective of the phenomenon over time. Similarly, although online surveys are anonymous, respondents can give their email address for further involvement in other research activities. All those involved will be able to be put on an interactive map and named "DiDIY Project co-designers".

15See D8.2, paragraph 3.5.

Annex 1: RCJ questionnaire

Each student and teacher of each team was asked to answer to 12 questions about the teammates or other individuals who contributed to the project. Respondents were asked to identify, for each question:

- with an "X": the individuals important relating to the theme of the question;
- with an "O": the individual who was the most important relating to the theme of the question.

	Questions	Name 1	Name 2	Name 3	Name xxx
1	Who participated to the team?				
2	Who worked with the software?				
3	With whom you interacted most (in person, by phone, via email or social network)?				
4	Who do you think was most important in the realization of the project?				
5	When a problem arose (eg: in the hardware or software) who was most useful in solving it?				
6	Who gave the most creative and innovative ideas?				
7	What was responsible for time management?				
8	Who had the most previous experience?				
9	Who gave you information and suggestions on how to complete the project?				
10	Who gave you information and suggestions on the hardware?				
11	Who gave you information and suggestions on the software?				
12	Who gave you information and suggestions on the components?				

a. Size of the teams

Calculated as the min number of evaluations expressed by the members of a team (in some cases only 1 or few team members showed up and answered to the questionnaire).
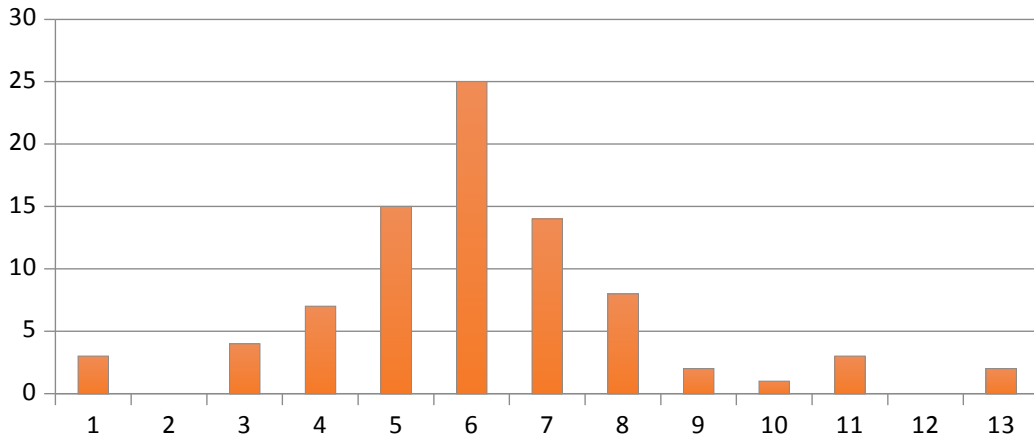
The typical size of a team is between 5 and 7 individuals.

b. Degree of "isolation" of the teams

Calculated as the difference between the minimum number of evaluation expressed by a member of the team and the maximum number.

e.g.: If all the members express the same number of evaluations then the difference is 0, and we assume that all the evaluated individuals were part of the team.
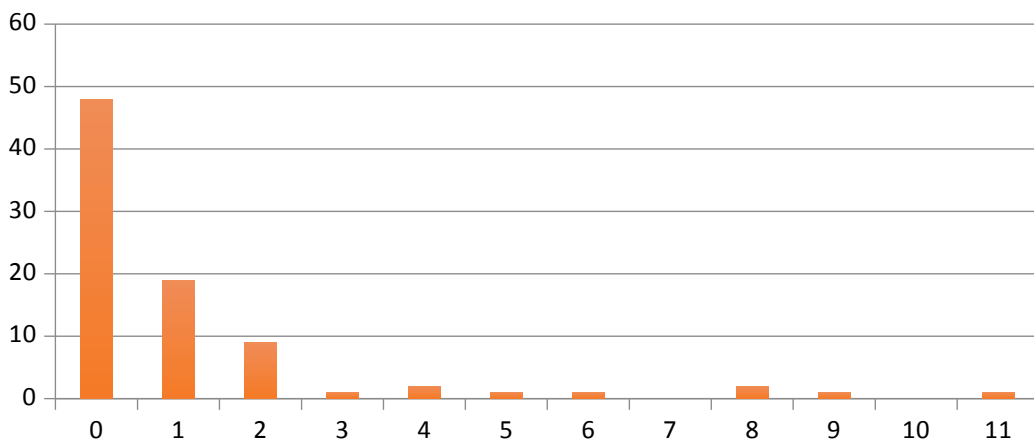

The large majority of teams do not involve individuals who do not belong to the team, thus we can say they are "isolated" teams.

When they involve someone, typically they involve 1 or 2 individuals outside of the team.

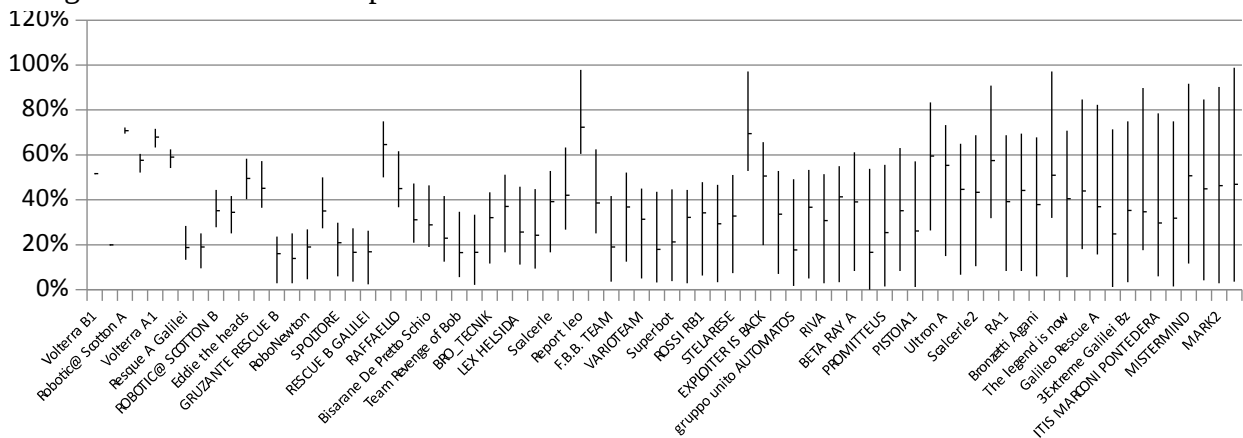## c. Distribution of contributions within each team

Average, Min and Max number of X's assigned to the evaluated individuals by the interviewees of each team, assuming 100% when all interviewees gave a X or a O to each of the 12 questions relating to a certain evaluated person
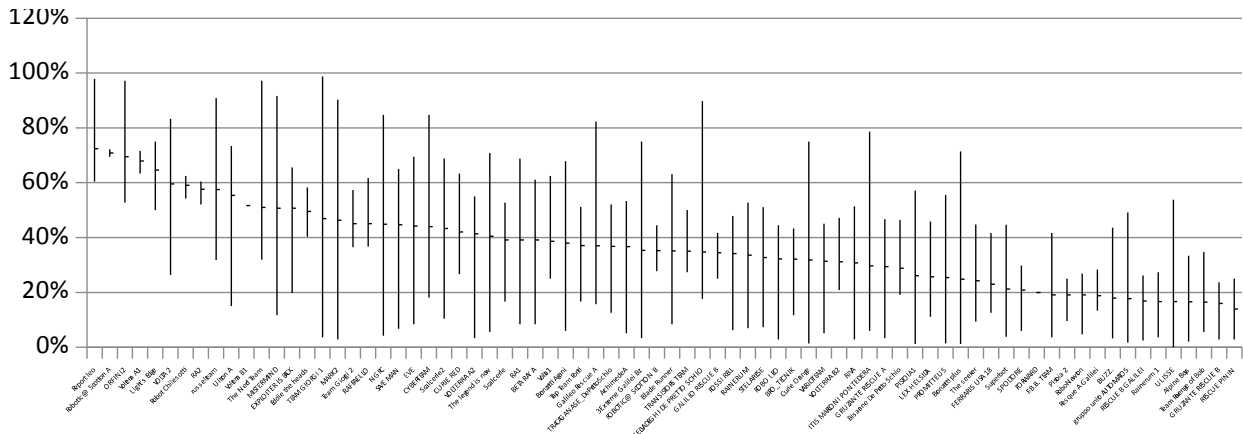
The distribution of skills within a team varies broadly, here represented in a descendent order of the average percentage for each team

d. Distribution of contributions within each team

Average, Min and Max number of X's assigned to the evaluated individuals by the interviewees of each team, assuming 100% when all interviewees gave a X or a O to each of the 12 questions relating to a certain evaluated person.


The distribution of skills within a team varies broadly. Here it is represented in an ascending order of the (max-min) span of contribution within each team, showing:
- a little number of teams where contribution is concentrated in very few individuals;
- A significant number of teams where a wide spread collaboration took place (or at least was perceived like that).

## e. Distribution of (perceived) critical skills

Calculated as the number of times an individual has been considered the most important person relating to a specific competence.
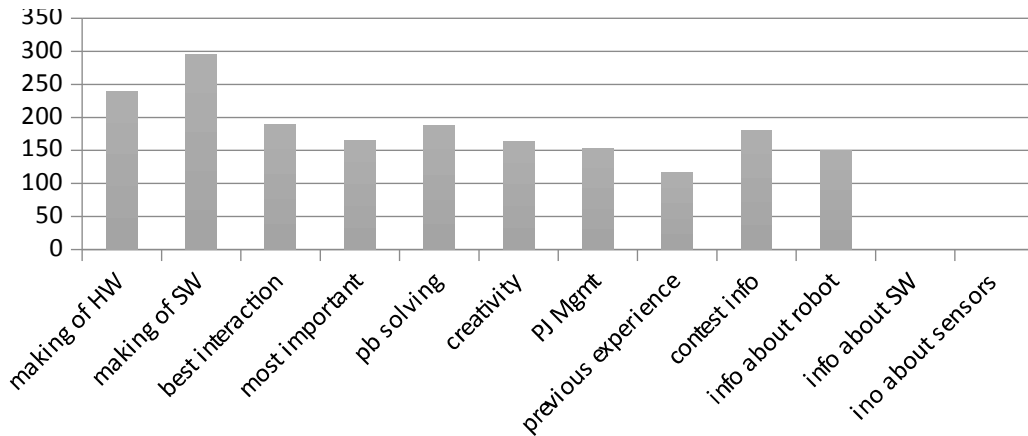
The presence of (or the ability to identify) skills considered very important is not equally distributed. In particular critical skills appear the making (of the hardware and the software), and those related to the software (creating software but also getting info about how to create it).

f. Distribution of (perceived) skills

Calculated as the number of times an individual has been considered important relating to a specific competence.
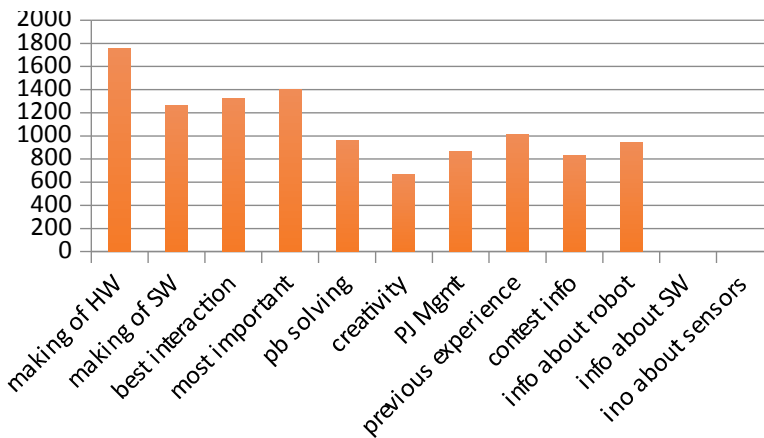
It is interesting to note that the leadership of software-related skills, compared to the previous chart, is lost, and that the most widespread skills are the most concrete ones, related to the "making": building the robot, being creative, solve problems.