Project Deliverable

Entrepreneurial skills
for young social innovators
in an open digital world

DELIVERABLE 6.9

EVALUATION RESULTS PILOT PHASE 2

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“DOIT – Entrepreneurial skills for young social innovators in an open digital world”
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Summary

Deliverable 6.9 describes the evaluation results of the DOIT pilots. While deliverable D6.2 was submitted when only the data of three pilot sites were ready, this deliverable now cumulatively summarises all the pilots in the DOIT action collected in phase 1 and 2. Consequently, this report gives a comprehensive picture on the evaluation of the maker activities and the impact on children, based on the analysis of a combination of quantitative and qualitative data sets. 1,002 children participated in the DOIT Actions of the regional pilots. Overall, 751 data questionnaires of students and 633 creativity tests were analysed. The quantitative evaluation is complemented by qualitative data from 36 interviews with facilitators, a numerous amount of student interviews and all facilitator report files.

Based on this analysis, the deliverable discusses the impact on students and outlines facilitating conditions as well as barriers for maker activities with children from 6 to 16 years. It also draws conclusions on a rather practical level, giving tips and hints for successful maker workshops and activities with this young age group. Further, some recommendations on a strategic level for policymakers are given, that might ease implementation in formal and non-formal education.

Content

1 Introduction

The main aim of this deliverable is to analyse the pilot data of phase 1 and phase 2 comprising qualitative and quantitative data to allow to extract conclusions and formulate recommendations.

While the previous two deliverables, 6.1 and 6.2, detailed the evaluation approach and its instruments and gave first insights based on data of three pilot sites in phase 1, this deliverable constitutes an updated version of 6.2 including all collected evaluative data from phase 1 and phase 2, delivering a more comprehensive picture.

The evaluative approach is based on the definition provided by Eurydice: *"Entrepreneurship education is about learners developing the skills and mind-set to be able to turn creative ideas into entrepreneurial action. This is a key competence for all learners, supporting personal development, active citizenship, social inclusion and employability"* (Eurydice, 2016). Thus, we put skills and attitudes such as creativity, planning or teamwork at the core of our working definition. Lackéus (2015) distinguishes between entrepreneurial attitudes, skills and knowledge in respect to entrepreneurial education. In contrast to traditional entrepreneurship education as it is taught in schools, where entrepreneurial knowledge is at its core with, for instance, teaching how to develop a business plan (Fayolle, 2007), the DOIT programme rather aims at supporting entrepreneurial attitudes and skills and thus is in some way complementary to usual entrepreneurship education. Therefore, we also speak of *entrepreneurial education* instead of *entrepreneurship education*. The design of our evaluation approach was guided by literature review and by co-creation with the practice partners. Already available frameworks such as the EntreComp framework on Entrepreneurship education (Bacigalupo, Kampylis, Punie, & Van den Brande, 2016) have been studied and helped to develop our evaluation approach and respective instruments. None of the frameworks could simply be transferred to our project since a tailored approach was required.

The evaluative dimensions that we agreed upon in a co-creation with the partners, following a theory-driven selection are (c.f. D6.1 for definitions):

creativity, self-efficacy, teamwork and collaboration skills, dealing with uncertainty, perseverance, empathy and knowing others' needs, motivation and sense of initiative and planning and management skills.

To recall (for more details please c.f. D6.1), the evaluation method is based on a mixed-method approach, including quantitative and qualitative measures. For the quantitative measures, we follow a pre-post design, comparing the baseline data before and after the programme to measure the effects of the DOIT action on the participants.

Key questions to be addressed in the evaluation of phase 1 and 2 are the following:

1. Participants: Did the pilots reach the planned target numbers? Were at least 40 percent female participants? Did the pilots include participants as defined (younger age group, older age group, disadvantaged children, children from rural areas, children with disabilities, etc.)? How was the attendance of the participants (drop-outs)?
2. Facilitators: What was the ratio of participants per facilitator? What was the gender ratio among facilitators? What was the attendance rate of facilitators?
3. DOIT workshop framework: What is the duration of the DOIT programmes at the various pilot sites? What did participants like/dislike about the DOIT action?
4. Effect of DOIT action on participants: Did the DOIT action have an impact on participants in terms of entrepreneurial skills and attitudes? Are there any gender differences? Are there any age differences? Are

there differences between the younger and the older age group? Are there differences between children with and without disabilities? Do workshop conditions have an influence? Is there a facilitator effect?

The first three questions are answered in chapters ‘2 - Overview- Pilot phase 1’ and chapter ‘3- Overview- Pilot phase 2’. The subsequent chapter, i.e. chapter 4, presents the formative evaluation and chapter 5 then addresses the fourth research questions, i.e. the DOIT action impact.

The evaluation instruments have been developed after several design iterations to cover all the defined evaluation dimensions to answer the above formulated research questions (c.f. for more details D6.2):

- Attendance sheet with demographic data, reach of kids, description of the action and overall rating (phase 1 and 2)
- Questionnaire for pre- and post-test (phase 1 and 2)
- Creativity test for pre- and post-test (phase 1 and 2)
- Workshop documentation (phase 1)
- Interview guideline with facilitators (phase 1 and 2)
- Interview guideline for students interviewing students (phase 1 and optional in 2)
- Feedback by students (phase 1 and 2)

(see Annex with the evaluation handbook for phase 2, comprising detailed instructions for the practice partners as well as the single instruments).

After the first pilot phase, the evaluation instruments were slightly adapted taking into account the experiences from the first round: the workshop documentation was not necessary in the second round due to overlaps with the documentation for WP 4. Thus, these documentation was used as input.The analysis of the workshop documentation was fed into the toolbox and is not part of the deliverable. For phase 2, the wording in the questionnaire was slightly changed: ‘other girls and boys’ was substituted with ‘other children’ in order to use a more gender neutral language.

Creativity and self-efficacy are measured quantitatively with the TSD-Z (Urban & Jellen, 1995) and the self-efficacy questionnaire that we developed, in a pre-post evaluation design. The remaining evaluative dimensions such as teamwork or dealing with uncertainties are tackled qualitatively. In the qualitative analysis, all qualitative data (facilitator interview, participant interview, feedback by students etc.) are gathered and imported into MAXqDA (Rädiker & Kuckartz, 2018) where in a cross-case analysis approach all materials are coded.

The interviews were recorded and then transcribed for detailed content analysis (e.g. labelling of text snippets according to a coding scheme) (Krippendorff, 2012). In the coding process the researcher is going through the interview material with predefined codes and identifying new topics at the same time (Flick, 2014).

Thus, the transcripts of the interviews, as well as the survey, were analysed (Mayring, 2002, 2014) following a deductive and inductive coding approach and making use of the qualitative analysis software MAXQDA[1], supporting coding across multiple files. The deductive codes were derived from the research questions, whereas inductive codes directly evolved from the qualitative data allowing for the unexpected (Reichertz, 2012). To enhance objectivity two different experts went through all the material. The resulting coding tree allows for easy extraction of text snippets that have been associated with a particular code.
Complementing the quantitative analysis, qualitative analysis targets increasingly with meaning and conditions as well as interpretation and comparison of facts, figures and findings. In the case of DOIT pilot actions, it allowed for further investigation in terms of description of pilots and its actions and the identified impact key dimensions on the

students. Also, we were investigating conditions, barriers as well as facilitators for successful maker workshops with children that identify and address social innovation challenges.

The following figure gives an overview of the evaluative process from phase 1 to phase 4. In Phase 1, we conceptualised and designed the instruments and the research process (c.f. D6.1), followed by phase 2 where we collected qualitative and quantitative data. In Phase 3 we analysed the data using SPSS for the quantitative and MAXQDA for the qualitative analysis. In Phase 4 finally, we describe the results and distil recommendations (D6.9)

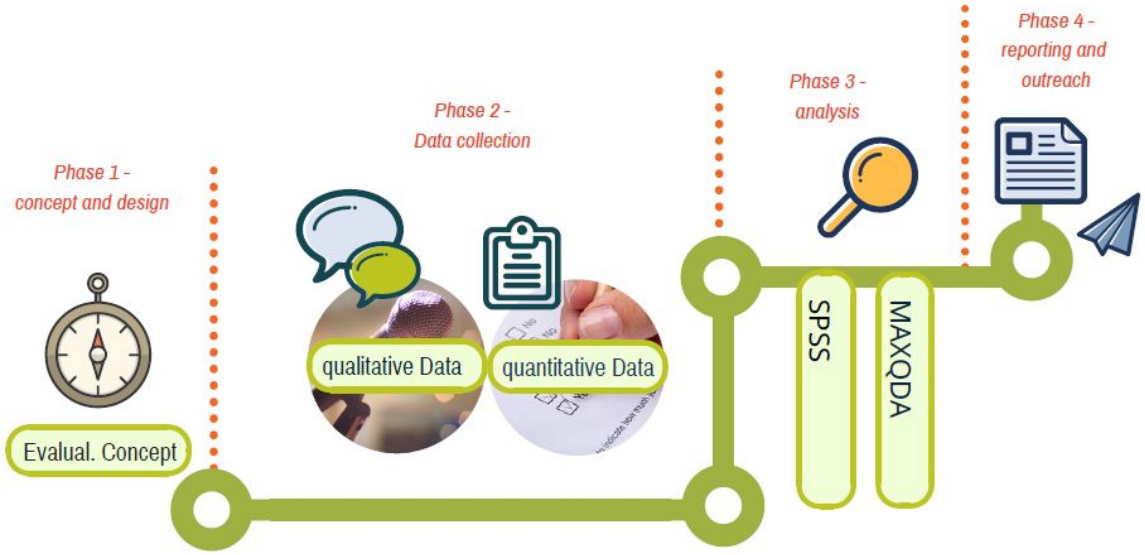

Figure 1: The evaluative research process

In total, 36 interviews were conducted from all 11 pilot action partners. This data represents the majority of information since the feedback by the students was not as fruitful as expected. Besides, the partners had very different formats for collecting feedback from the students that made it extremely difficult to ensure the comparability of the data. Due to this fact, we excluded this tool for the second pilot.
In total 1.197 codings (i.e. text snippets) were identified, captured in 37 code categories (Participants, Facilitators, Effect, Evaluation, Prototypes and Action). Several code categories included sub-codes, thus the identification of themes and issues was organized well-structured in the software. The codes also revealed interrelation of topics and issues that were connected with each other because of sections that had more than one single code. Finally, these insights are captured in the following interpretation (section 6) by creating explanatory accounts to the respective topics.

The data collection process, as well as the data transfer and processing of data, is described in detail in D6.2.

Following the introduction, the next two chapters give an overview of pilot phase 1 and 2. In chapter 4 we describe the accompanying formative evaluation process. Chapter 5 then is dedicated to an in-depth analysis of the DOIT action impact in respect to all evaluative dimensions. The last chapter concludes with a summary and conclusions.

The quantitative data has been analysed with statistical analysis package SPSS (Baur & Fromm, 2008).

2 Overview- Pilot phase 1

In total, 11 pilots were carried out in ten different European countries (Austria, Belgium, Croatia, Denmark, Finland, Germany, the Netherlands, Serbia, Slovenia, Spain). The pilots were quite diverse in terms of duration and time frame. The first one started was carried out already in September 2018 (Austria - ZSI) and the last one finished in May 2019 (Netherlands - WAAG). Also the setting varied, it ranged from weekly workshops with shorter hours to intensive weekend workshops, lasting two entire days. Some partners arranged for several actions in pilot phase 1 (IAAC, MEPF, Poly, WAAG, UZAF), while others didn’t. In total 16 actions were carried out. Several actions in one pilot phase site meant smaller groups with different participants per action but constant participation within the action.

All DOIT actions had a specific goal in line with one of the overarching topics: living together, education and future, health and sports, participation and rights, youth culture and leisure and environment and nature.

The actions took place either at a school location (9 actions) or a public maker space (5 actions) or at another location (university or youth centre). None of the schools was equipped with a maker space.

The technologies used varied also from action to action. Participants of the actions have used the following (digital) technologies:

1. Coding (programming a computer or microcontroller, e.g: python, Microbits)
2. Digital fabrication (hard- and software typically found in a Maker Space, e.g: 3D-printing, laser cutting)
3. Electronics (making electronic circuits, using e.g: copper wire, LEDs, electronic motors, soldering)
4. Craft (manual tools to manipulate and combine materials, e.g: scissors, tape, hot glue guns)
5. Design (making 2D and 3D designs on paper and digitally)
6. Sensors (using sensors to retrieve input in the form of data)

The DOIT actions were organised partly in collaboration with different organisations and professionals that could bring in their expertise and add value to the action. Overall, the actions were realised in cooperation with four entrepreneurial organisations, ten Fablabs or maker spaces, one business network and one library. In total 40 teachers were involved in a DOIT action as well as 26 makers, 11 entrepreneurs and several invited experts.

2.1 Participants

In total in phase one, 538 children participated in the different pilot actions. Of these, 46.5 % were females and 53.5 percent males. The age ranged from 6 to 16 as expected with an average of 11 years. An overview of the age range is represented in the following figure.

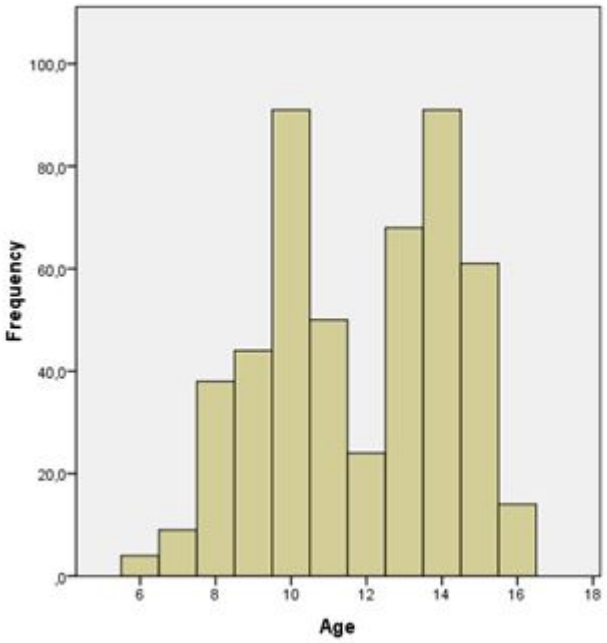

Figure 2: Age distribution pilot 1

The younger age group from 6 to 10 represents 35.7%, while the older age group, from 11 to 16 years, constitutes 64.3% of the participants. This is rather in line with the planned numbers, where a minimum reach of the younger age group was 30%. A detailed overview gives the following table with participant numbers per pilot partner and their gender and age distribution.

Table 1: Gender and age group per practice partner in pilot 1

Partner		Freq	%		Freq	%
ZSI	female	5	27.8	younger age	14	77.8
	male	13	72.2	older age	4	22.2
	Sum	18	100.0	Sum	18	100.0
CoC	female	71	52.6	younger age	0	0
	male	64	47.4	older age	135	100
	Sum	135	100.0	Sum	135	100
MEPF	female	11	24.4	younger age	43	95.6
	male	34	75.6	older age	2	4.4
	Sum	45	100.0	Sum	45	100.0
Poly	female	30	46.9	younger age	63	98.4

	male	34	53.1	older age	1	1.6
	Sum	64	100.0	Sum	64	100.0
eduC	female	23	46.0	younger age	22	51.2
	male	27	54.0	older age	21	48.8
	Sum	50	100.0	Sum	50	100.0
LUT	female	17	56.7	younger age	0	0
	male	13	43.3	older age	30	100
	Sum	30	100.0	Sum	30	100
ZAK	female	3	30.0	younger age	4	40.0
	male	7	70.0	older age	6	60.0
	Sum	10	100.0	Sum	10	100.0
SRFG	female	10	50.0	younger age	19	95.0
	male	10	50.0	older age	1	5.0
	Sum	20	100.0	Sum	20	100.0
WAAG	female	13	50.0	younger age	14	73.7
	male	13	50.0	older age	5	26.3
	Sum	26	100.0	Sum	26	100.0
IAAC	female	36	44.6	younger age	0	0
	male	41	55.4	older age	74	100.0
	Sum	77	100.0	Sum	77	100
UZAF	female	34	51.5	younger age	8	12.1
	male	32	48.5	older age	58	87.9
	Sum	66	100.0	Sum	66	100
LUT	female	26	57.7	younger age	0	0
	male	19	42.2	older age	45	100
	Sum	45	100	Sum	45	100

As can be seen in the overview above. the number of participants ranged between 10 (ZAK) and 135 (CoC). In cases with high participant numbers, the DOIT pilot was divided into several different actions.

While overall the ratio of female participants was above 40%. female participants were underrepresented in some cases (marked in blue, left column: MEPF, ZSI, and ZAK).

While some arranged mixed age groups, some pilots covered one age group only (IAAC, LUT, CoC) or had a clear focus on one specific age group (ZSI, MEPF, WAAG, SRFG, UZAF, LUT).

The following table (c.f. Table 2) gives an overview of some more demographic data of the participants and the setting of the DOIT actions respectively.

The majority of the DOIT actions took place in a school setting (63%) and about a fourth happened outside school.

About 31% of the participants stem from a less privileged background according to the pilot organisers, while 7% have a diagnosed disability.

Around a third of the actions took place in a rural setting, and about 3% were considered advanced makers.

Table 2: Demographic information of participants in pilot 1

Setting/participant info	Percent	Number
in school	63%	339
outside school	25%	137
less privileged background	31%	168
special needs	7%	38
rural areas	35%	189
advanced makers	3%	18

2.1.1 Attendance

As described in the D6.1, one of the minimum requirements for a DOIT action agreed by the partners was 15 hours working in workshops with the participants. The programme hours in pilot phase 1 varied considerably between 15 hours (UZAF, ZSI) and 45 hours (ZAK).

In order to measure the constancy of participation we calculated the relative attendance per participant, i.e. the attended hours in relation to the planned hours. As detailed in Table 3, this measure can vary between 0 (i.e. participant did not attend at all) to 1 (i.e. participant was present at all workshops). As can be seen, on the overall complete participation rate is high with 83.1% (see last column, last row), while the overall drop-out right in the beginning is low with 2.6%. These attended only up to a fifth of the total DOIT hours. In the case of the ZSI pilot, 11.1% attended at least 70% of all workshops, the remaining 88.9% completed the programme without any absence.

While there are differences between the different pilot regions in terms of overall attendance rate, it has to be noted that the fluctuation and drop-out rates of participants in all pilots was very minor.

Table 3: Attendance ratio per pilot region in pilot 1

		Partner										All
		ZSI	UCSyd	MEPF	Poly	eduC	ZAK	SRFG	WWG	IAAC	UZAF	
Attendance ratio	0,0-0,19		6,7%	11,1%				9,1%	7,1%		1,5%	2,6%
	0,20-0,29											1,0%
	0,30-0,39				4,7%							,6%
	0,40-0,49										9,2%	1,2%
	0,50-0,59			2,2%	1,6%							,6%
	0,60-0,69				6,3%	2,0%			14,2%	1,4%		1,4%
	0,70-0,79	11,1%				2,0%	10,0%	4,5%	14,3%			1,4%
	0,80-0,89		4,4%			22,0%	40,0%	18,2%	21,4%	1,4%		5,8%
	0,90-0,99						40,0%	31,8%				2,2%
	1,00	88,9%	88,9%	86,7%	87,5%	74,0%	10,0%	36,4%	42,9%	97,3%	89,2%	83,1%

2.2 Facilitators

The characteristics of the facilitator varied a lot between the different pilot sites.

The **average age of the facilitators** ranged from 17.6 years (CoC) to 42.33 years (IAAC). The young age of the facilitators in Denmark is due to the fact that CoC had a specific didactical approach of peer learning, where they first trained teenagers who then acted as facilitators during the DOIT actions. The facilitator age of all other facilitators varied between 29 and 52 years.

Also, the **ratio of participants per facilitator** varied quite a bit with 3 participants per facilitator up to 14.6 children on average per facilitator. In average all over the different pilot actions it was 6.7 children per facilitator. The following table (c.f. Table 4) gives an overview of the participant-facilitator ratio per pilot site. In cases there is more than one number in the right column the ratio has differed in the various actions, all by the same practice partners. For a better overview the highest numbers have been marked in orange, and the lowest in red.

Table 4: Participant-facilitator ratio in pilot 1

Partner	ratio
ZSI	4.05
CoC	4.05
MEPF	4.61; 7.08
Poly	5-6.5
eduC	14.6
LUT	11.89
ZAK	5.05
SRFG	3.04

WAAG	3.5; 3.69
IAAC	8.67; 9.89
UZAF	3.5; 4.8; 7

On average, practice partners arranged for lower numbers of participants per facilitator in the younger age group (6.1 participants vs. 6.9 participants per facilitator in the younger resp. in the older age group).

The **constancy of facilitator support** was calculated based on their presence during the different workshops. The score of '1' would mean constant presence, while a score under that value means that they were not present at all workshops. An average per pilot partner was calculated. The number also reflects the different approach. While some pilot sites had a constant presence of all facilitators (CoC, Poly, UZAF), other partners did not. This can have different reasons. In some cases, they arranged for additional support where they expected more workload or ideally a lower participant-facilitator ratio (c.f. Table 5).

Table 5: Average facilitator constancy in pilot 1

Partner	Constancy
ZSI	0.90
CoC	1
MEPF	0.67; 0.84
Poly	1
eduC	0.73
LUT	0.48
ZAK	0.42
SRFG	0.68
WAAG	0.58; 0.96
IAAC	0.67; 0.94
UZAF	1

The **gender ratio of facilitators** differs between the different pilot sites (c.f. Table 6). However. overall the female facilitator ratio was 45%. The following gives an overview of the female versus male facilitator ratio per pilot site. Again, if there is more than one number per cell, then this is due to the fact that the actions at one pilot site had different ratios.

Table 6: Gender ratio among facilitators in pilot 1

Partner	Female facilitators (%)	Male facilitators (%)
ZSI	45	55
CoC	33	67
MEPF	62; 64	37;35
Poly	50; 40;50	50;60;50
eduC	55	45
LUT	66	34
ZAK	86	14
SRFG	77	22
WAAG	64;37	35;62
IAAC	0;39	100; 61
UZAF	25;100;100	75; 0; 0

In most cases, the gender ratio was fairly balanced with a few exceptions. Female outweighed male facilitators in the ZAK and SRFG pilot (marked in green) and in one case, i.e. action 2 and 3 of UZAF there was a pure female facilitator team. IAAC had a pure male facilitator team in action 1 and UZAF a predominantly male team in action 1 as well (marked in orange).

2.3 DOIT workshop framework

One of the minimum requirements of DOIT action to count as such was 15 hours of programme with the participants. The pilot actions indeed all reached this minimum requirement. They ranged between 15 and 45 hours. Most actions had a duration of 15 to 20 hours (ZSI, CoC, MEPF action 2, Poly, SFRG, WAAG, IAAC action 1, UZAF), some between 20 and 30 hours (MEPF action 1, eduC, LUT, IAAC action 2) and one 45 hours (ZAK).

In the overall **rating of the workshops**, in regards to the facilitator satisfaction with the DOIT actions, most of them indicated that they were happy about it. Of the eleven pilot sites, six indicated that they were very satisfied with the DOIT action, and five rated with 'we are satisfied'. At one pilot site (MEPF), the first action was rated more positively than the second (very satisfied to satisfied). None of the pilot hosts indicated that they were less or not satisfied with their actions. After the first pilot round most pilot hosts indicated they would change parts of the action, seven would change smaller parts, four parts of the action and two the whole structure of the action. No one indicated they wouldn't change anything.

The different practice partners collected the feedback of their participants applying their own methods of collecting feedback (e.g. posters with sticky notes, socio-metrical exercises, verbal feedback round) and reported the gathered feedback.

The analysis of the **participants' feedback** reports shows that recurrent topics in the feedback reports were *'having fun'*, *'interesting topic'* and *'different learning approach'*.

For instance, a participant even sent an email afterwards to share what she liked about the workshop: *"It was educational and at the end it was fun"* (UZAF, email). Aspects of the DOIT action highlighted by different participants were for instance free work: *"Especially the phases of free work and prototyping we enjoyed very much"* (SRFG, student feedback) and working with specific tools such as Lillipad (ZAK, student feedback) and soldering (ZAK, student feedback). Also the final presentation was mentioned a couple of times by the students, that they enjoyed showing what they had done during the DOIT action and that they were so proud of.

That they had learnt something new about a social topic was mentioned recurrently as this statement shows: *"I didn't know so much about recycling and how we can help to protect the nature"* (UZAF, email).

In relation to a different learning approach, participants said that they liked to be in charge of the learning path, that they enjoyed the open setting, the creative learning assignments and to work together with others as this kid said: *"Working with others is very important, that's how people work now and it is good to start early"* (ZAK, student feedback). Working together was sometimes also challenging as some reported, for instance, in case some did more than others. Also to work with the hands and to have a product at the end was very rewarding (CoC, student feedback).

Also some mentioned that they would like to have more of this kind of teaching and learning also at their schools: *"It is also a very interesting topic to consider in school"* (ZAK, student feedback).

To keep the group under control and too much noise were negative aspects identified in the feedback of some pilot actions. Participants asked for more breaks and also the opportunity to move in between working periods e.g. games with movements (CoC and ZSI).

3 Overview- Pilot phase 2

In pilot phase 2, 10 pilots were carried out in 9 European countries (10 European regions). As the pilot team at LUT faced some unexpected hurdles, i.e. one school had to move because mould was detected in their building, the team could not carry out the pilot during the planned pilot timeframe and had to postpone it for several weeks. Thus, the analysis of the pilot phase 2 does include only preliminary data from the LUT pilot. Also it has to be noted that CoC did leave the project consortium at the end of the pilot phase 1 and was substituted by UCSYD, also residing in Denmark.

The timeframe of the pilots ranged from February 2019 (ZSI) until December 2019 (LUT). As in pilot phase 1, the setting varied between the pilots, from weekly meetings to consecutive days in a row. In total fifteen actions were carried out in phase 2, meaning that some practice partners had several separate actions in order to have smaller groups working together.

The topics addressed in phase 2 were (multiple topics possible):

- living together (for example inclusivity, intercultural living, freedom) by 6 actions
- education and future (for example school, vocational ambitions) by 5 actions
- health and sport (for example physical activity, well-being) by 6 actions
- participation and rights (for example political involvement, privacy, mobility) by 8 actions
- environment and nature (for example resource efficiency, sustainability, up-cycling and more) by 11 actions

Thus, the last topic, i.e. environment and nature, was the most prominent topic among the different pilot actions.

The location of the workshops was either at a public maker space/fablab (2 actions) or a room in a school (9 action), or they used both (3 actions). One held their pilot at a youth centre. Again none of the schools had their own maker space.

The technologies used varied from action to action including 3 D printing (7 actions), 3D modelling (5 actions), LED (12 actions), usage of the Internet (7 actions) and a computer (11 actions).

Almost all technologies used in phase 1 were used in Phase 2 too, with the following additional technologies in 5 of the 6 categories

- Artificial Intelligence programming tool for children (Coding)
- Foam cutter (Digital fabrication)
- LilyPad, LittleBits (Electronics)
- LEGO WeDo robots (Design)
- Simple air quality measuring sensor (Sensors)

Again, the DOIT actions were organised partly in collaboration with different organisations and professionals that could bring in their expertise and add value to the action. On the organisation level, in total four entrepreneurial organisations, nine maker spaces/fab labs, fifteen schools and five other organisations such as public libraries were involved in the DOIT actions. Additionally, 56 professionals contributed in person to the DOIT actions: three entrepreneurs, 18 makers and 34 teachers (the remainder not clearly identified).

3.1 Participants

In the second phase 464 children participated in the DOIT actions adding to a total of 1,002 children overall in the two pilot phases together.

There were slightly fewer females with a percentage of 45.6 and more males with 54.2 percent participating in pilot phase, again reaching more than the minimum ratio of 40% females as we had planned.

The age ranged from 7 to 17 years (with an average of 11.7 years) as can be seen in the following figure. This time, we did not have any six years olds among the participants. One of the participants was turned 17 during the pilot action.

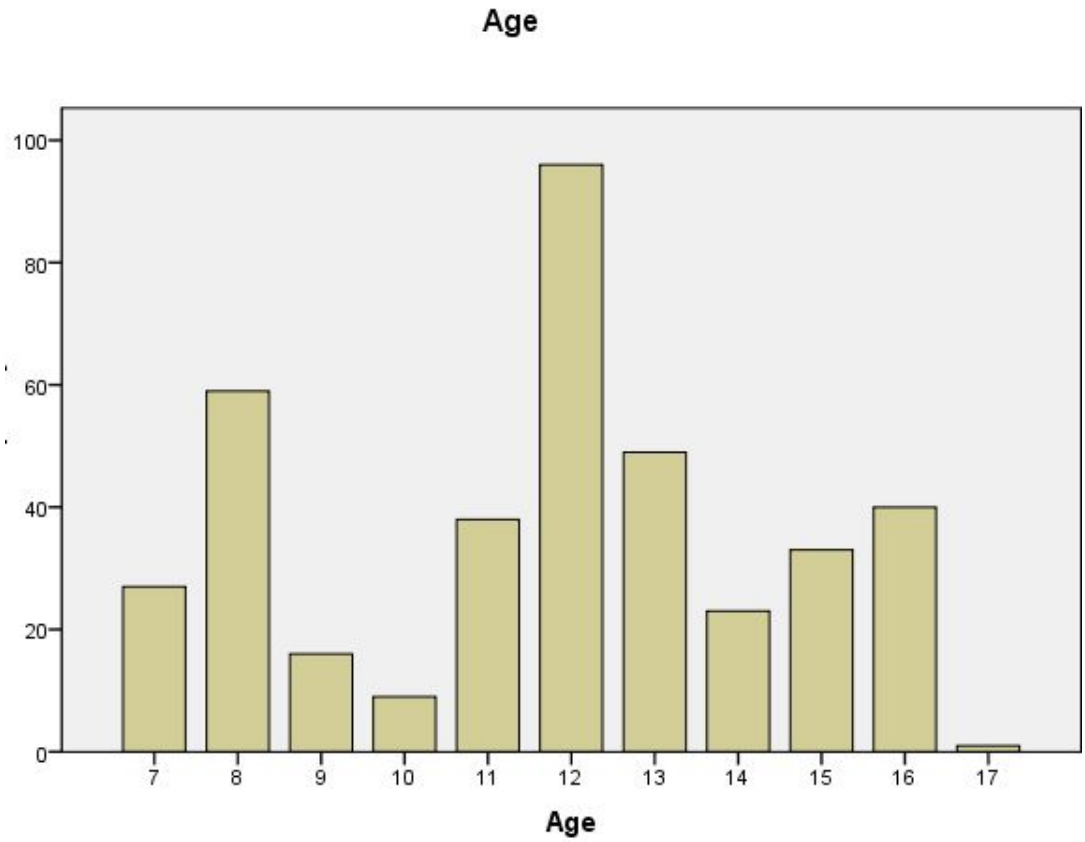

Figure 3: Age distribution pilot 2

Again, the younger age group, from 6 to 10 years, represents around a third of the participants (28.4%) and the older age group roughly two thirds (66.8%). Thus, the younger age group is very slightly underrepresented in pilot phase 2 as the reach was defined with 30%.

A detailed overview gives the following table with participant numbers per pilot partner and their gender and age distribution.

Table 7: Gender and age group per practice partner in pilot 2

Partner		Freq	%		Freq	%
ZSI	female	16	61.5	younger age	0	0
	male	10	38.5	older age	26	100
	Sum	26	100	Sum	26	100
UCSYD	female	49	57.6	younger age	84	98.8
	male	36	42.4	older age	1	1.2
	Sum	85	100	Sum	85	100

MEPF	female	12	33.3	younger age	10	27.8
	male	24	66.7	older age	26	72.2
	Sum	36	100	Sum	36	55.6
Poly	female	25	48.1	younger age	0	0
	male	27	51.9	older age	52	100
	Sum	52	100	Sum	52	100
eduC	female	21	36.8	younger age	0	0
	male	35	61.4	older age	57	100
	Sum[1]	57	100	Sum	57	100
ZAK	female	4	40	younger age	1	10
	male	6	60	older age	9	90
	Sum	10	100	Sum	10	100
SRFG	female	12	57.1	younger age	0	0
	male	9	42.9	older age	21	100
	Sum	21	100	Sum	21	100
WAAG	female	18	30.5	younger age	11	18.6
	male	41	69.5	older age	38	64.4
	Sum	59	100	Sum[2]	49	83.1
IAAC	female	10	45.5	younger age	3	13.6
	male	12	54.5	older age	17	77.3
	Sum	22	100	Sum[3]	20	90.9
UZAF	female	23	46	younger age	1	2
	male	27	54	older age	49	98
	Sum	50	100	Sum	50	100

As can be seen in the overview above, the number of participants ranged again considerably between 10 (ZAK) and 85 (UCSYD). In cases with high participant numbers, the DOIT pilot was divided into several different actions.

While overall the ratio of female participants was above 40%, female participants were underrepresented in some cases (c.f. Table 7: marked in red, left column: MEPF, eduC and WAAG). As the practice partners this partly has to deal

with the setting of the action. In the in-school-setting they had no influence on the gender ratio as entire classes participated. In the outside-school settings partners were more challenged in some regions to attract girls although they had acted gender sensitively in their invitations for instance. We can also see that in comparison to pilot phase 1, at the pilot sites with lower female participation (ZAK and ZSI), they were able to have at least 40% females this time. Also MEPF attracted more females this time reaching almost the mark of 40%. WAAG this time, had less females than in pilot phase 1.

While some arranged mixed age groups, some pilots covered one age group only (ZSI, Poly, EduC, SRFG) or had a clear focus on one specific age group (UCSYD, ZAK, UZAF). Compared to pilot phase 1, many partners changed the focus from one age group to the other (ZSI, COC – UCSYD, MEPF, Poly, SRFG), a few kept the same focus (IAAC, UZAF).

The following table (c.f. Table 8) gives an overview of some more demographic data of the participants and the setting of the DOIT actions respectively.

Similar to pilot phase 1, the majority of the DOIT actions took place in a school setting (66%) and about a fourth in outside school.

About 27% of the participants stem from a less privileged background according to the pilot organisers, while about 5% have a diagnosed disability.

Around 20% of the actions took place in a rural setting, and about 1% were considered advanced makers.

Table 8: Demographic information of participants in pilot 2

Setting/participant info	Percent	Number
in school	66%	277
outside school	14%	59
less privileged background	27%	113
special needs	4.7%	20
rural areas	21%	88
advanced makers	1.2%	5

In comparison to pilot 1, we have about the same ratio of in-school and outside-school settings. Thus around two thirds of the actions were carried out in a school setting. Also a similar percentage of children came from a less

privileged background and slightly fewer participants had a disability. Also slightly fewer children came from a rural area and less advanced makers were identified among the participants in pilot 2.

3.1.1 Attendance

The following table shows the attendance ratio per pilot partner. The % in each category means this percentage of the total participants group participated this % of the time. If 100% is in category 1,00 it means that the complete pilot was attended and if 100% should be in category 0-0.19, it means that the participants only attended up to 19% of the entire workshop.

As can be seen in Table 9, the overall complete participation percentage is again rather high with 71.6% (compared to 83.1% in pilot phase 1; see last column, last row), while the overall drop-out right in the beginning is low with 1.4%. While there are differences between the different pilot regions in terms of overall attendance rate, it has to be noted that the fluctuation and drop-out rates of participants in all pilots was very minor.

Table 9: Attendance ratio per pilot region in pilot 2

		Partner										All
		ZSI	UC Syd	MEPF	Poly	eduC	ZAK	SRFG	WAAG	IAAC	UZAF	
Attendance ratio	0,0-0,19		4,8%			3,6%						1,4%
	0,20-0,29							4,8%			4,0%	,7%
	0,30-0,39					15,8%				9,1%		2,6%
	0,40-0,49										8,0%	1,0%
	0,50-0,59		3,5%			1,8%			1,7%	4,5%		1,4%
	0,60-0,69		5,9%			3,5%	10,0%		5,1%	18,2%		3,6%
	0,70-0,79	7,6%	5,9%			1,8%	20,0%		6,8%	27,3%		4,8%
	0,80-0,89	7,7%	12,9%			8,8%	20,0%		8,5%	9,1%		6,4%
	0,90-0,99		5,9%				50,0%					2,4%
	1,00	84,6%	61,2%	56,8%	100,0%	64,9%		95,2%	78,0%	31,8%	88,0%	71,6%

3.2 Facilitators

The variation in characteristics of the facilitating teams between the different pilot sites was significant. These characteristics are taken into account in analysing framework conditions of the DOIT action and how these influence the impact.

The **average age of the facilitators** ranged from 26.25 years (UCSYD) to 43.50 years (UZAF).

The **ratio of participants per facilitator** varied quite a bit with two participants per facilitator up to 11.49 children in average per facilitator, in average practice partners reduced the number of participants per facilitator slightly from 6.7 to 6.6 children per facilitator. The following table (c.f. Table 10) gives an overview of the participant-facilitator ratio per pilot site. In cases there is more than one number in the right column the ratio has differed in the various

actions, all by the same practice partners. For a better overview the highest numbers have been marked in orange, and the lowest in red.

Table 10: Participant-facilitator ratio in pilot 2

Partner	ratio
ZSI	7.97
UCSYD	3.47; 6.6; 10.75
MEPF	4.8; 5.5
Poly	2; 2.25; 2.5; 2.6; 4.5
eduC	11.49
ZAK	3.98
SRFG	6.01
WAAG	5.19; 8.48; 9.48
IAAC	3.83
UZAF	2.5; 2.83; 2.9

In contrast to the previous pilot, practice partners had more participants per facilitator in the younger age group and less in the older one (on average 7.2 children per facilitator vs. 6.3 in the older age group).

The **constancy of facilitator support** was calculated based on their presence during the different workshops. The score of '1' would mean constant presence, while a score under that value means that they were not present at all workshops. While some pilot sites had a constant presence of all facilitators (Poly, UZAF in one action), other partners did not. This can have different reasons. In some cases, they arranged for additional support where they expected more workload or ideally a lower participant-facilitator ratio (c.f.Table 11).

Table 11: Average facilitator constancy in pilot 2

Partner	Constancy
ZSI	0.53
UCSYD	0.77;0.85; 0.87
MEPF	0.75; 0.90; -

Poly	1
eduC	0.73
ZAK	0.46
SRFG	0.61
WAAG	0.55; 0.60; 0.83
IAAC	0.79
UZAF	0.65; 1

The **gender ratio of facilitators** differs again between the different pilot sites (c.f. Table 12). However, overall the female facilitator ratio was 47.6%. The following gives an overview of the female versus male facilitator ratio per pilot site. Again, if there is more than one number per cell, then this is due to the fact that the actions at one pilot site had different ratios.

Table 12: Gender ratio among facilitators in pilot 2

Partner	Female facilitators (%)	Male facilitators (%)
ZSI	15	85
UCSYD	0; 48; 56	100; 52; 44
MEPF	100; -	0; -
Poly	33; 50; 100	67; 50; 0
eduC	18	82
ZAK	89	11
SRFG	83	17
WAAG	7; 58; 83	93; 42; 17
IAAC	23	77
UZAF	62; 83	38; 17

At many pilot sites, the gender ratio was fairly balanced with a few exceptions. Female outweighed male facilitators in the ZAK and SRFG pilots and one action by WAAG and one by UZAF (marked in green). One action by MEPF and one by Poly there was a pure female facilitator team. One action of UZAF had a pure male facilitator team (marked in orange).

3.3 DOIT workshop framework

All pilot actions again fulfilled the minimum requirement of 15 hours. The actions ranged from 15 hours (UZAF – one action, WAAG – one action, UCSYD – 1 action) up to 42 hours (ZAK). Most actions had again a duration between 15 and 20 hours (ZSI, UCSYD – one action, MEPF, Poly, SRFG, WAAG- two actions, IAAC, UZAF – one action). The action duration of EduCentrum was 24 hours long.

In the overall **rating of the workshops**, in regards to the facilitator satisfaction with the DOIT actions, the majority indicated that they were very satisfied with their DOIT actions. About three actions the ratings showed that the facilitators were satisfied and none showed a rating of "less satisfied" and "not satisfied". As a result, they would change only parts or even only smaller parts in the actions but not the whole structure of the pilot action.

4 Formative evaluation

In order to formatively evaluate the pilots and to continuously learn from each other, while still being able to adapt plans, we organised a workshop during the consortium meeting in Vienna in February 2019 (M17), where we shared and discussed the results of D6.2 and further gathered experiences and recommendations by the still-ongoing pilots (see results in 4.1). During the Consortium Meeting in Berlin in September 2019 (M 24), we organised yet another reflection workshop.

In regular practice partner calls, organised by WP4, we further shared results from the ongoing analysis of already gathered data. Also, all insights were communicated to the WP 4 leader in order to steer participants' recruitment strategies for phase 2 to compensate for eventual over or underrepresentation of certain populations.

4.1 Evaluation workshop during Vienna consortium meeting

We prepared three questions and asked all practice partners to discuss these in pairs and write down the main insights on coloured cards.

The first question was: What have you personally learnt in the pilot?

The answers noted down by the practice partners can be categorised mainly into two different aspects: the pedagogical approach and inter-relations and group dynamics.

Pedagogical approach

- Preparation: being well prepared, knowing which tools can be used in which situation and for which step is important.. Make sure that all the needed material is ready.
- Expect the unexpected and operate flexibly: Being open to new situations and demands
- Trust the wisdom of the group and the creativity of children: find solutions as a group; children have a great capacity in many ways
- Agile approaches such as brainstorming, Kanban Board or Scrum work also with young children
- It is important to adapt complex terminology to participants' context
- Dismantling things, opening back boxes, can be very enlightening for all but there is a thin line between punk and curiosity
- Need for pedagogy and didactics training among facilitators

Inter-relations and group dynamics

- Establishing trust is co-facilitators for operating as a team is crucial.
- Have become more confident in working with bigger groups (25+).
- There is no optimal number of participants; it depends very much on the nature of the pilot.
- Teenagers have already strong opinions on big issues and their opinion should be taken seriously.
- It can be challenging to motivate the children to take the creativity test seriously.

The second question was, what they would make differently in pilot phase 2. Many found that they were struggling with timing issues and would like to develop longer pilots (e.g. at least 19 hours). Also, many partners wanted to have a different time frame in the second pilot (e.g. a week between the single DOIT workshops or vice versa have an intensive week). In terms of support, practice partners thought of hiring more facilitators and recruit them well in advance in order to equip them better for the DOIT actions. Some desired for more goal orientation and focus. E.g. structured use of materials, or make a stocklist beforehand, rather than leaving participants totally free to choose as this caused logistic trouble for the team which had to arrange for the workshop preparations. To better steer group dynamics, practice partners wanted a behavioural codex established together with the participants as some already had done in the phase 1. Also, providing for breaks and especially to allow for physical activities like going outside was something practice partners wanted to establish in the second phase.

The last question was about recommendations for DOIT facilitators:

The recommendations comprised the pedagogical approach such as encountering the participants on eye-level not as teachers, not being afraid of phases of chaos in-between, but having a final goal in mind and think of what children actually will take home. To trust the group and to use the knowledge in the group and enhancing discussions among the groups was regarded as a good recommendation. The facilitators' job is to provide the structure and the framing of all sessions but allow for flexibility to adapt to the children's ideas and needs. It was also agreed upon, that facilitators should know the DOIT concept and approach well before and should be briefed and trained accordingly. To keep the motivation up, facilitators should provide sufficient breaks and probably also use different locations which helps them to switch between different activities. In general, facilitators should "Keep calm, ask, discuss, don't suggest" and "Don't teach, but inspire!".

4.2 Reflection and consolidation workshop during consortium meeting, Berlin, September 2019

During the project partner meeting, held in Berlin in September 2019, we presented the results of qualitative and quantitative analysis. This presentation was followed by a session that was dedicated to further discuss and reflect on these results and in specifically to draw conclusions and recommendations for policy makers and educational stakeholders. These conclusions are captured in chapter 6 of this report and further serve as basis for D6.4, the DOIT policy recommendations delivered in month 30.

5 DOIT action impact

Chapter 5 outlines the DOIT action impact on individuals’ level on all defined evaluative dimensions, i.e. in terms of creativity, self-efficacy, teamwork, etc. We will also analyse gender and age differences as well as whether workshop conditions have an impact on the results. While creativity and self-efficacy are measured quantitatively in the pre-post design, the other evaluative dimensions are addressed by qualitative means. In the following, results from both the qualitative and quantitative analysis are integrated were feasible.

5.1 The participants

As in all activities that are done with children, the variety of different characters and types of children was high. Many facilitators reported that they had a very heterogeneous group of participants.

5.1.1 Team up

Interesting in this aspect was the grouping of children. While some facilitators determined the groups according to their abilities, other pilot facilitators let the students choose freely which group they would like to join. The background of this decision lies mainly in their observation that those children who could choose freely were highly motivated since many of them joined friends or siblings. Having a friend or brother/sister in the same group was for some kids very important and had an effect on their motivation and integration in the group. While for other facilitators it was more important to have a mixed group for integrative reasons (pl. see also DOIT Deliverable 2.5 “Report on issues to reach special requirements for special target groups and settings” section 7.2 Needs of the target group and requirements) and/or social reasons: *“We made the groups for them – it was one of the facilitators from the library so after the first two introductory classes we divided them in groups and this was based on the idea of what would be the best groups to work together and I think it worked quite well in the end because we separated some of the kids hat were a bit too distracted while together, and we had one group of two quieter boys and we put them into a group with relatively quiet children, so they wouldn’t be ‘overshouted’ by the other children”* (FI8, male, 30 years, pilot 1).

While some facilitators report that the integration of children that could not take part for some hours was no issue, others observed that it influenced the teamwork. *"We merged two groups into this one and they had a lot of problems with self-motivation and motivation because the boy who was (...) their group leader was really charismatic and the*

oldest. When he once or twice didn't show up, they were really lost and they were struggling with this a lot. But then, in the end, they did finish it ..." (FI26, female, 39 years, pilot 2). Thus, it can be concluded that missing hours or days might have an impact especially on the group dynamics of the teams when trying to replace or compensate roles that were already taken.

5.1.2 Age

Obviously, there are differences in age groups when performing the pilots. Many facilitators reported that younger children were more easily distracted and the concentration span on a topic was often much shorter than the ones of older kids. Asking for the ideal age to start with this type of maker activities, many of the facilitators answered with the age of eight, although earlier starts are of course possible.

Considering this fact, facilitators recommend that younger children need more breaks and if possible also some physical exercises connected to the topic. Consequently, the programme needs a strong consideration of the age group.


Figure 3: Offering space for (individual) breaks and physical exercises combined with entrepreneurship exercises

Also there seemed to be a unison opinion that younger children need more support from the facilitators since older kids can work more independently, can manage already better their tasks, are more capable to handle potentially dangerous tools and are sometimes already good in teamwork and communication: *" (...) I noticed it a little bit when they are really young, it's difficult for them because they cannot picture what the other person means, then they* (comment – children, age 8) *just want to go fast, so it's taking too long and they just give in 'ok it's fine'. After that* (comment – age 12) *they become very specific about what they want to make and they find it a bit hard to let go again."* (FI9, female, 39 years, pilot 1).

But the facilitators reported two facts where younger students have a clear advantage. For once they are less caught in the social structure of teens: *"It's a lot more social. They (comment: kids aged 12-16) are motivated if something is 'cool' (...). They are in their teens and at this age I feel they don't really become too aware of social challenges but are more focused on their personal-emotional challenges*" (FI6, male, 32 years, pilot 2). Secondly, some facilitators reported that young students are less caught in the educational schooling system, thus would be easier to guide them towards a thinking 'out of the box' or unconventional solutions.

5.1.3 Gender

Quite many codes from the qualitative analysis were connected to gender issues. Many observations dealt with a somewhat gender stereotype pattern and task division that some girls and boys followed when working on their prototypes. While females tended to overtake design issues, meaning the look and aesthetics of the prototype, some of the boys focused more on functionality and the improvement of it (i.e. stronger batteries, faster prototype).

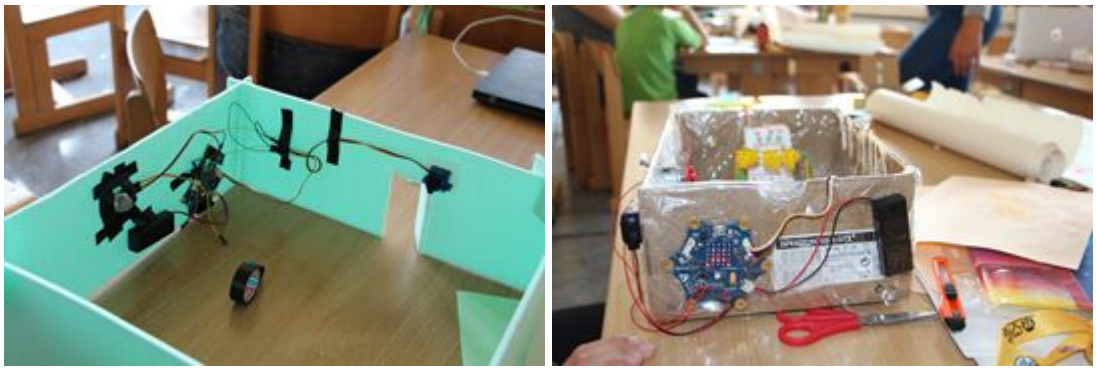

Figure 4: Boys prototype of automatic fire door vs. girls footed cellar incl. washing machine and clothes drying

While boys often seemed to be attracted initially to attend the workshop, many facilitators were astonished by the way of working of the girls in the maker activities: *"In our experience, contrary to what we expected, in some cases the girls took over the charge more often than not. I do believe if the girls were not presented to what a girl should be interested in, as it happens in our school, we would have much more women engineers in electrical, mechanical and basically any technical university"* (FI22, male, 27 years, pilot 1). Because of this reason - as well as for reasons of creativity - several pilots took action and focused on making things work by fostering only plain and colourless prototyping so that the focus would move towards function. This resulted in the fact that also girls focused more on the functionalities.

5.1.4 Special Needs

Several pilots integrated children with special needs. Facilitators of those pilots mentioned that it is important for the children to have dedicated spaces to open up and (further) develop skills within teams. In addition, working in pairs or teams is a good way of helping each other. Some facilitators reported that several of them needed more coaching than others, due to the disability. Depending on their individual needs, different actions and support needed to be provided. After all, the integration of children with disabilities in maker workshops had a high positive influence on their learning, their integration in society and in consequence as well on their self-confidence, as the facilitators argued.

Nearly all of the pilots had children included that had issues or (social) challenges, many of them in terms of socialisation, learning difficulties, difficult behaviour or issues with school, family or friends: *" (...) I noticed that they are just a lot of troubled kids. They don't know how to ask for help. So instead of asking me for help they kicked their neighbour, they gave him a slap on the head. Slowly I noticed that there's just a lot behind these kids. They're not just nasty kids but they have really different challenges than the kids I had before. So I need to approach them in a different way"* (FI9, female, 39 years, pilot 1). Thus integration requires much flexibility from the facilitators, but

applying this flexibility supports also children with special needs to gain best results: many facilitators reported that the pilots were a great opportunity for children with issues to gain more self-confidence by creating great prototypes and ideas valued by others if the needed space, flexibility and mind-set is provided.

Thus it is to be recommended to open up schools for maker activities that last several consecutive hours, giving sufficient physical space with a broadest mindset for creation of unconventional and creative solutions for self-identified issues. This way, also troubled kids could develop their full potential.

5.1.4 Background

Some facilitators also noticed a gap between children from different backgrounds and living environments. *"I think it really gave us an opportunity to look at the different demographic groups because we have maker spaces (...). So in different neighbourhoods with very different populations. And it was really a learning point for us to notice that something that you know works very well in one location actually doesn't work in another location which we think it has to do with the kind of people who live in the neighbourhood. So it's highly educated somewhat richer people versus somewhat less highly educated less rich people"* (FI9, female, 39 years, pilot 2).

In the opinion of this facilitator, the focus of the pilot's aim changed from fostering creativity and solution-oriented working towards raising students' self-esteem and confidence as well as their own belief in the ability to make a change in society. One of the pilots in the second phase even used the workshop to specifically foster the community building for less privileged children since they had noted that the DOIT pilots can well be used also for this purpose, specifically to *"... create this community and develop these soft skills to work by teams"* (FI19 and FI20, both male, 38 years and 41 years, pilot 2).

5.2 Facilitators

Before starting the pilots, the partners had discussed methods, potential tools and reflected on the maker pedagogical approach and mindset. However, by analysing the interviews it became obvious that a major ability for a facilitator is to ensure flexibility towards the development of each kid. This flexibility is even more important for children with special needs. Having a well-planned and structured pilot, and at the same time providing flexibility, is an art of its own, but implicitly necessary. In the course of the pilot facilitators need to understand when support is really needed, how to foster each child's creativity, problem solving and self-esteem as well as competences like team-work and communication. This requires a high degree of flexibility. By noticing the needs of the children, he/she might have to adapt at the same time his/her planning, (re-)action, language, a.s.o.

Another issue that has appeared is that the social aspect of dealing with the kids – especially kids with troubled background – might become challenging for facilitators. Realising that some -mostly social – needs cannot be served in this framework is troublesome for some facilitators: *"I still feel a little bit bad – I really wanted to help him"* (FI9, female, age 31, pilot 2).

5.3 Problem identification and problem solving

An utmost crucial step of each DOIT pilot action was the identification of challenges and issues by the children that would then lead to the next further steps. The pilots solved this with many different methods, many of them by explaining and discussing issues and problems (ie. environmental issues), animating children to think and report from their own perspective. An important finding in this respect is, that the identification of issues and problems is easy for children if the examples are in direct relation to their own living environment. The more complex a problem is and used tools to familiarise them with these problems are, the more difficult it is for children to make this direct connection. Thus, the more difficult it is to get into the process of indentation of own issues and in consequence also producing creative solutions: *"Yes, it was difficult at the beginning. Possibly not because of the social challenge, but rather with the smart design challenge* (comment: IoT cardboard) *that we introduced. (...) At the beginning we had four seating heaters out of six groups"* (FI2, female, age 27, pilot2).

One of the most often mentioned learning effects by the facilitators was that students learned how to solve a problem. Most of them were facilitating the children by launching questions and giving hints where to find solutions.

The ratio facilitators/students might have an effect on the problem solving competence acquisition: *"... and then they tried to ask us as much as they could, but I think the good and the bad thing with it is that we had like 55 students and we were 3 instructors from (institution) and 2 from the school, so 5. So we could give them a limited amount of time. So instead of helping them we were just supporting and trying to tell them where to search and how to try to solve it instead of solving it for them"* (FI17, female, 45 years, pilot 1). Several facilitators also supported group work by pointing at some teams that had worked already with tools or that had already found a solution for the same or similar problem.

Interesting in this respect is also, that facilitators reported that social challenges and knowing others' needs is an educational process and that there were differences in the pilots. *"That was I think completely new for them that idea that you could actually be someone who makes something that makes a difference. I think that this is also one of the main differences between this group and the first group we did. For the first group that was not new. They're used to think that '...Oh we could actually solve this problem or that problem'. But in this group that was completely new"* (FI9, female, 39 years, pilot 2).

5.4 Creativity

In the pre-test at the beginning of the DOIT programme, participants worked on the creative drawing test TSD-Z (Urban & Jellen, 2010), form A and at the end of the programme on form B. It consists of drawn fragments which the participant is asked to complete. The drawing is analysed quantitatively following detailed instructions, e.g. number of fragments taken into account, the number of connections between fragments, etc. resulting in a summative score (for more details please have a look D6.2).

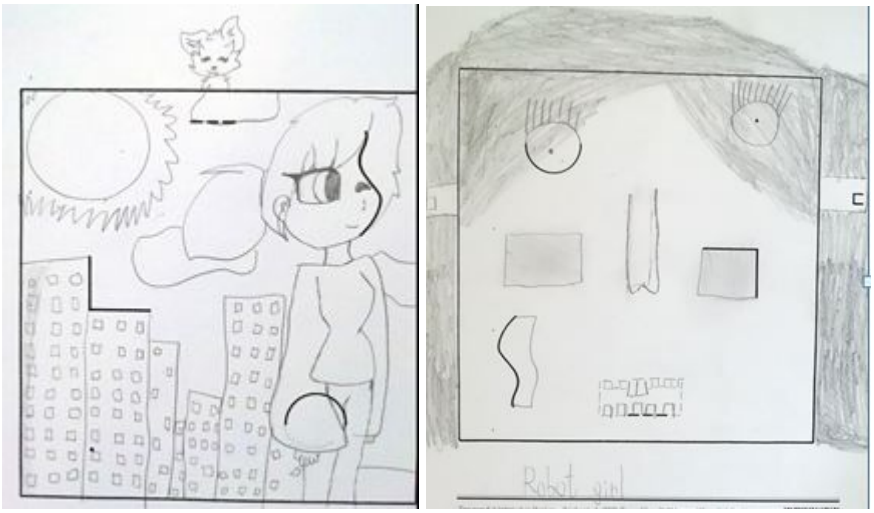

Figure 5: Creativity test – Form A (le), Form B (ri) , two impressions: le: girl in the city, ri: robot girl

Figure 5 shows two examples of the creativity drawing exercise.

The administration of the creativity test was sometimes challenging as a standardised procedure had to be followed, which was not always possible. Participants should have used only a pencil or a black felt, no additional tools such as rulers, rubbers or coloured pens. Drawings were this was not the case had to be excluded from the analysis.

Additionally, missing data resulted from the fact that not all participants were there both at the beginning and the end of the DOIT programme, resulting in 404 valid forms in pilot phase 1 of pre and post-test that were used for the following analyses. If only those are kept, who fulfilled the minimum attendance of 15 hours, the analysis comprises 633 complete forms. The following analyses are based on pilot phase 1 and complemented with results from pilot phase 2 in case contrasting findings could be detected.

General effect and effect size

As the sample paired T-Test shows there is indeed a significant difference between the pre and the post-test (T=-4,706, df=393, p=0,000). While the average raw score in the pre-test was 18,61, the score in the post-test is significantly higher with 20,43. In other words, creativity as measured via the TSD-Z is higher at the end than at the beginning of the DOIT action.

The argument that the progress is related to the repetition of the exercise is not valid because it was two different forms participants had to work on. In the pre-test they worked on Form A, and in the post-test on form B, which is a parallel version of the former one.

For the calculation of the effect size only the samples with complete pre- and post-test as well as fulfilling the minimum condition of being present for 15 hours have been retained.

The effect size with a score of 0,243 and a confidence interval ranging from 0,103 to 0,383 is moderate according to Cohen (2013) and can further be interpreted as so called teacher effect following the categorisation by Hattie (2012).

Age

As the analysis shows, the older age group has benefitted even more from the DOIT action as they could increase their raw score more significantly than the younger ones. While in the pre-test there is no significant difference in the score between the two age groups (t=-1.496, df=414, p=0.135), there are significant differences in the post test (t=-4.662, df=399, p=0.000). Not surprisingly, the score difference between pre and post-test correlates moderately with age (r=0.117) and slightly higher if gender is controlled in a partial correlation (r=0.141). Thus, strikingly, there is no difference in the creativity score between the younger and the older age group in the beginning but the age groups differ after the training. The fact that at the beginning there is no difference in the measured creativity is line with findings from other studies (Furnham & Bachtiar, 2008; Furnham & Nederstrom, 2010).

Taking into account the changing of the scores, we can assume that the creativity of the younger age group was not influenced a lot by the DOIT action as can be seen in Figure 6. While the average score for the younger age group remains constant over the two measurement time points, the score of the older age group gains some points.

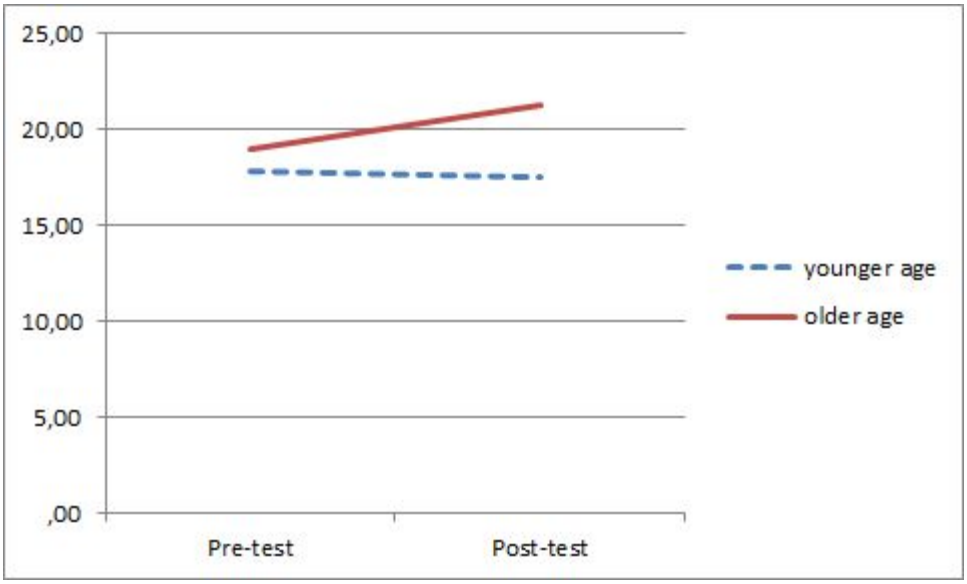

Figure 6: Pre-Post average creativity score comparison by age group

Gender

Overall, females and males started with more or less the same creativity score in the pre-test (t=0.691, df=392, p= 0.490) but in the post-test, females reached higher scores (t=2.810, df=, df=392; p=0.005). Thus, while both genders increased the scores, the females increased their scores more significantly as shown in Figure 7. The gender difference however is not as robust as it might seem, since this finding could not be found in the overall sample comprising both pilots of phase 1 and 2.

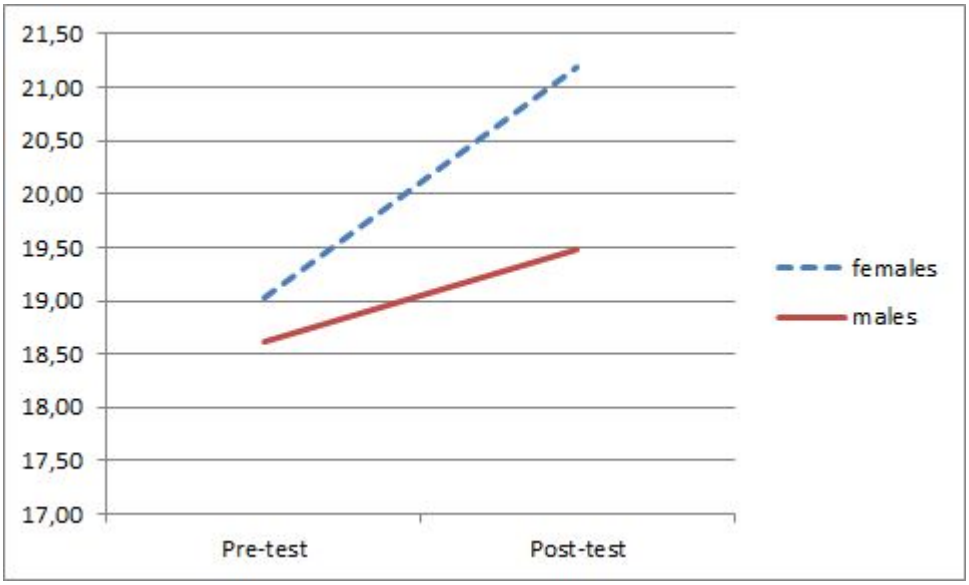

Figure 7: Pre-Post average creativity score comparison by gender

Participants with disabilities

Although the real number of participants with disabilities is higher, only in 15 cases the disability has been documented ad personam. Thus, when we compare the scores of participants with disabilities and participants without disabilities, we have very different sample sizes. Therefore, non-parametric tests had to be applied (Mann-Whitney-U-Test). Participants without disabilities score higher both in the pre (U=1904, Z=-3.358, p=0.001) and in the post-test (U=1582, Z=-3.084, p=0.002). As can be seen in Figure 8, both groups gained higher scores in the post-test, resulting in similar "learning curves".

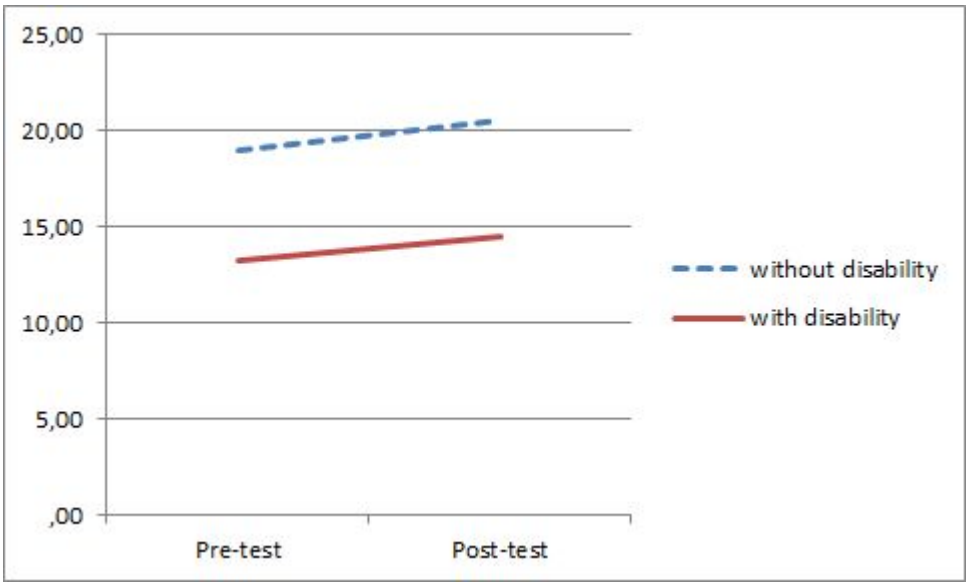

Figure 8: Pre-Post average creativity score comparison by disability

Workshop conditions

To understand which impact the workshop framework has, in terms of participant attendance in workshop hours, we have performed a linear regression model. This shows a slight correlation of r=0.170 explaining 0.029 of the overall variance. This means, with the attendance rate of the participants, the creativity score also increase slightly. However, the drop-ou rate in general was rather low and thus the variance is limited.

Facilitator effect

In contrast to the hypothesis, that a low participant-facilitator rate might be beneficial for developing one's creativity, this was not the case as there is no correlation between the two variables. Thus, whether or not there were many participants per facilitator or only a few did not have an impact on the creativity development.

The creativity gain does not correlate with the constancy of facilitators present during the workshops. As described in section 3.2, there is quite a range between facilitators being constantly present and fluctuating presence. As the analysis shows, a stable constant support does not correlate with the creativity score.

We could also identify a small, yet significant, facilitator gender effect with female participants. The score gains in the creativity test correlate slightly with a male facilitators ratio (r=0.167) and negatively with the female facilitators ratio. With male participants there was no effect in this respect. Also the facilitator age correlates negatively, although only to a small degree with the creativity score gain (r=-0.240). Thus, we could detect that the younger the facilitators the higher the score gain, which would speak for the peer-tutor approach in respect to creativity. However, this rather small correlation is an indicator for the effect but explains only 5% of the overall variance.

The qualitative data analysis confirms the quantitative findings. All of the facilitators agree that the majority of children were creative in finding solutions and creating their prototypes. *"The students were very creative and had no difficulties in engaging fully with the prototyping activities. It was great to see the ideas they came up with. While most of them were very creative, they tended to replicate to some extent existing solutions. However, in some cases, the ideas were much more novel and could really be made into a good product"* (FI7, male, 32 years, pilot 1).

This statement refers also to the observation that children tended to connect to things and solutions they knew already but new approaches and solutions appeared as well at the same time. Many facilitators report that they motivated kids to 'think outside the box' and that creative solutions need time, space, self-confidence and a specific attitude towards creating: it is essentially important to make children understand that this time is not a classical school-time, thus that there is no 'right or wrong', that failing is o.k. and even necessary to make it better the next time.

Interesting in this respect is that several facilitators reported a lack of material fosters creativity. While some pilots limited the material (ie. only cardboards or white material), others facilitated a creative process by giving kids materials for actions that they would not usually be used (up- or recycling). Answering the question of what the children gained from the workshop one facilitator answered: *"Of course creativity because they had to find a solution with limited resources they had. We didn't give them a lot of things, so they had to figure out what to do with what they had"* (FI17, female, 45 years, pilot 1).

5.5 Self-efficacy and entrepreneurial intention

General effect and effect size

Again due to some missing data as not all participants filled in the questionnaire both at the beginning and the end of the DOIT programme, 471 complete data-sets could be kept for the analysis. In total, 751 complete forms could be kept overall, pilot phase 1 and 2 together, if only those are kept, which fulfilled the minimum condition of attending for 15 hours and who filled in all questions. Again, the analysis is based on the pilot phase 1 sample but complemented with results from pilot phase in case there are inconsistent findings.

The overall difference between the self-efficacy score between the pre and the post-test is significant (t=-4.238, df=470, p=0.000). While the average score in the beginning was 54.56 it increased slightly to an average of 55.51.

Also the subscores of the self-efficacy scale increased significantly. However, only two of the three subscores were significant differences: 'Self-efficacy in relation to others' increased from an average of 16.95 to 17.34; the "Self-concept of own capabilities" only marginally but yet significantly from 20.19 to 20.49 and similarly the 'Self-Concept regarding problem solving/uncertainty" from 17.41 to 17.67.

The question nr 16 ("Do you want to become your own boss?"), which was added as an indicator for entrepreneurial intention, did not change significantly between the pre and post-test (t=-1.284, df=477, p=0.200).

Similar to the creativity effect, the effect size in terms of self-efficacy is moderate with 0.207 (confidence interval from 0.079 to 0.335).

Age

Age does not correlate with an increase in the self-efficacy score. In other words, the equation the older you are, the higher the score in the post-test does not apply. On the contrary, when divided by age group, we can see (c.f. Figure 9) that both age groups' score is significantly higher in the post-test but interestingly the younger age group starts already in the pre-test with a higher score (U=18837, Z=-5.296, p=0.000) and scores also higher in the post-test (15655, Z=61711, p=0.000).

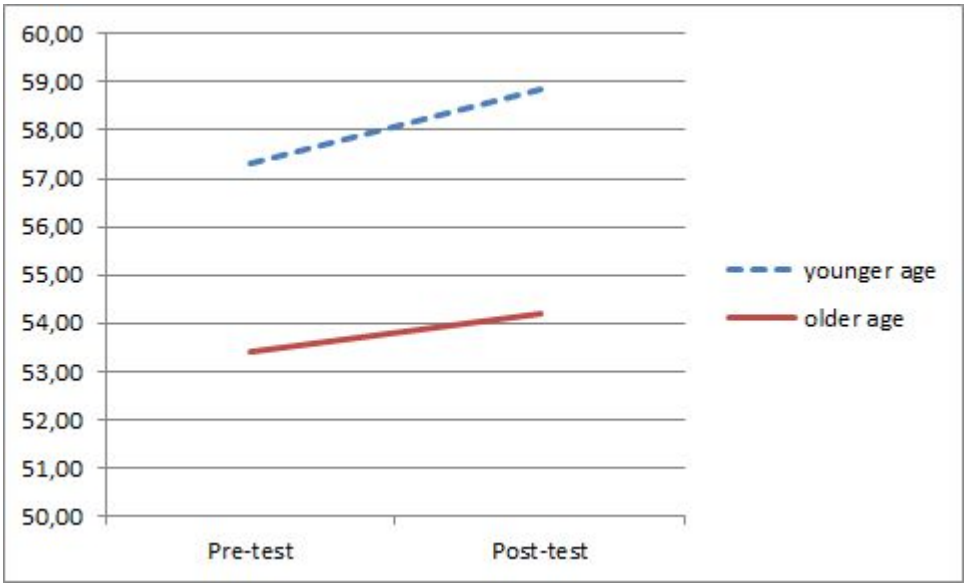

Figure 9: Pre-Post average self-efficacy score comparison by age group

In respect to the Self-efficacy subscores, there are also interesting age group differences as can be seen in Figure 10. The score 'self-efficacy in relation to others' and 'self-concept regarding problem solving' are higher in the younger age group, both in the pre and the post-test. The 'self-concept of own capabilities' does not differ significantly between the older and younger age group in the pre-test but differs in the post-test: Again the younger age group has slightly higher scores.

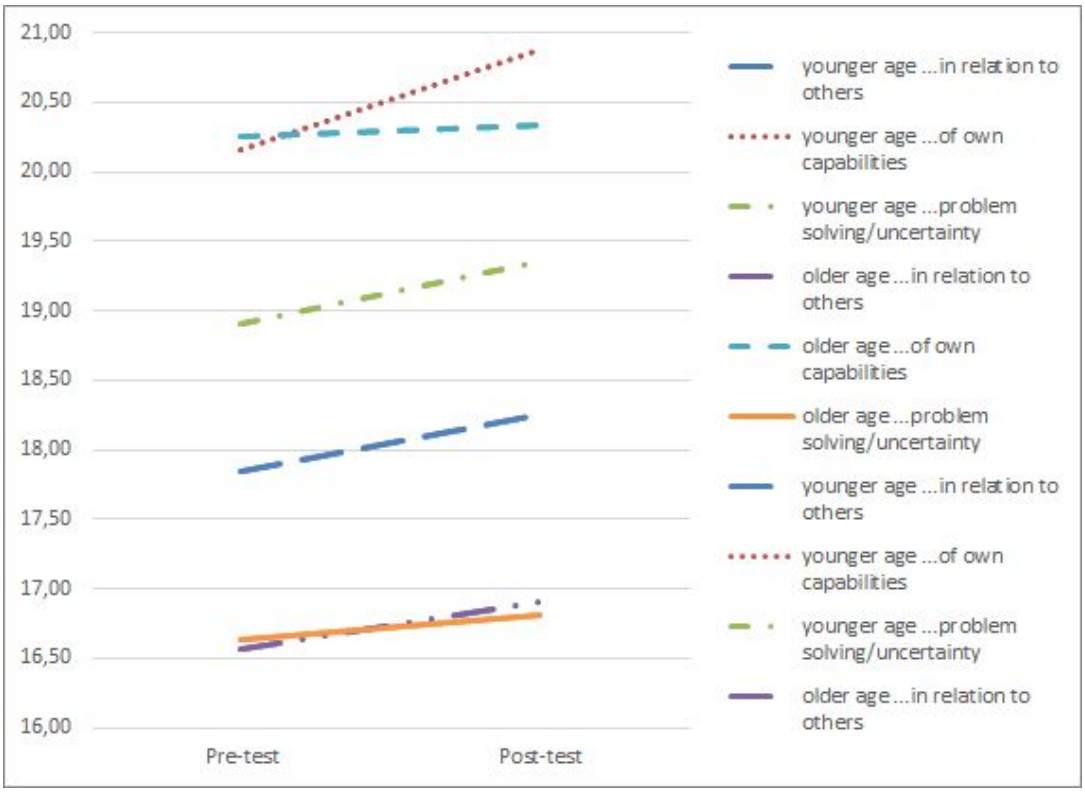

Figure 10: Pre-Post average self-efficacy subscores comparison by age group

As shown in the above figure, the highest scores in both the pre and post test is 'self-concept of own capabilities' for both age groups, in the middle of the field are the subscores 'self-concept regarding problem solving' for the younger age group and 'self-efficacy in relation to others' for the older owns. The lowest scores result in 'self-efficacy in relation to others' in the younger ones and 'self-concept regarding problem solving' for the older ones.

However, some of these age group differences are not as robust as not all could be detected in the overall sample. A robust finding is that the younger age group consistently attests themselves higher scores regarding the Self-concept regarding problem-solving and dealing with uncertainty.

Gender

There are no significant gender differences both in the pre-test (t=-1.634, df=469, p=0.103) and in the post-test (t=-1.867, df=469, p=0.556). Also on subscore-level no significant differences could be identified.

Both genders increased their self-efficacy score slightly but yet significantly: females from an average of 54.01 to 54.82 and males from an average of 55.04 to 56.11 as can be seen in Figure 11.

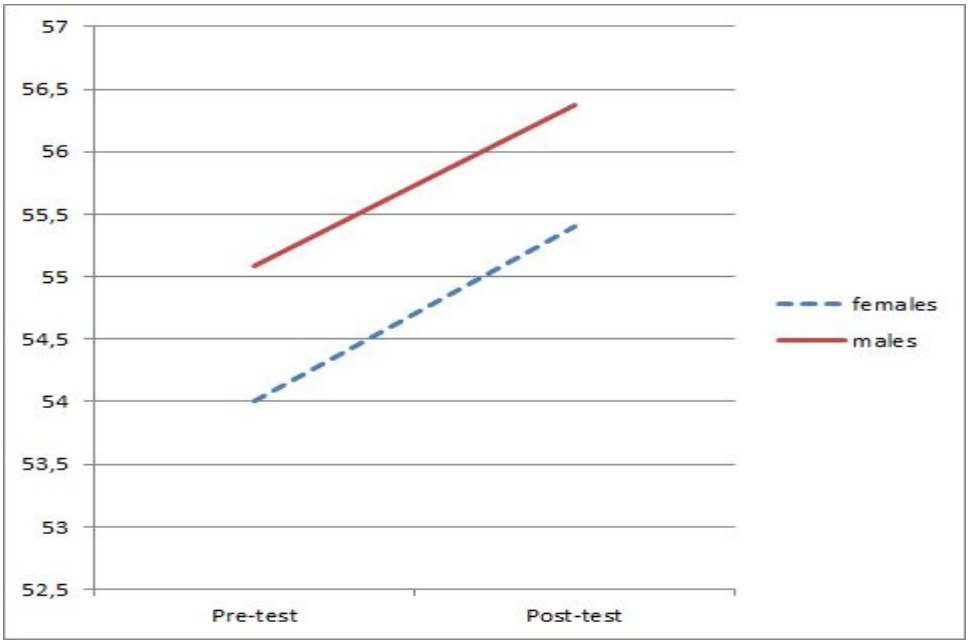

Figure 11: Pre-Post average self-efficacy score comparison by gender

Participants with disabilities

As shown in Figure 12, persons without disabilities score significantly higher in terms of self-efficacy in both pre (U=2200,5, Z=-3.469, p=0.001) and post-test (U=2157.5, Z=-2.060, p=0.039). As can be seen in Figure 12, both groups gained higher scores in the post-test, although the increase in people with disabilities is not significant.

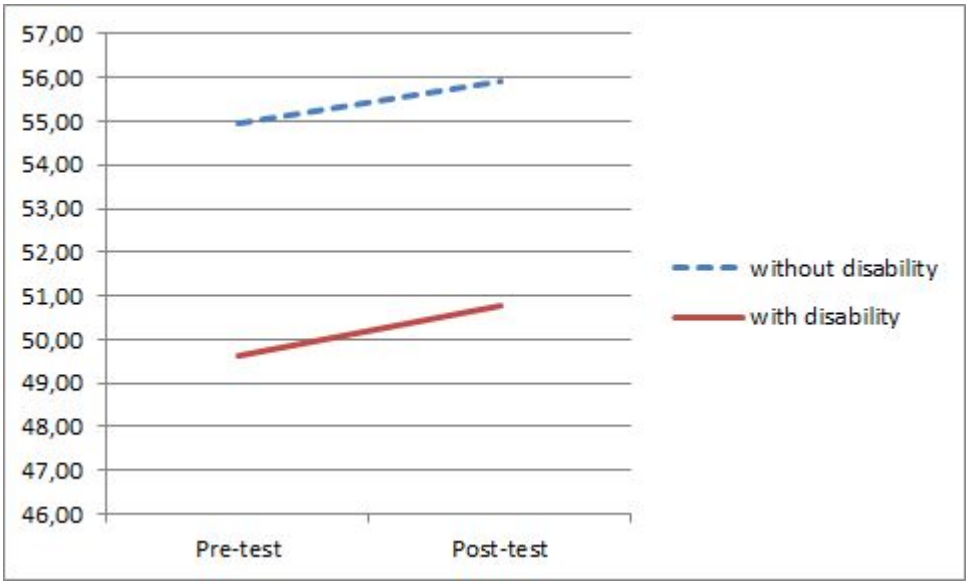

Figure 12: Pre-Post average self-efficacy score comparison by disability

Workshop framework

Overall, the score difference between the post- and the pre-test in self-efficacy, thus the self-efficacy gain, does not correlate significantly with the relative attendance in participants. It does only correlate slightly in the older age group (r=0.146).

Facilitator effect

Overall, facilitator effects could not be detected in relation to the self-efficacy scores of the participants. Neither does the self-efficacy gain correlate with the gender composition of the facilitator team nor with their age. Also, the facilitator participant ratio does not correlate and the same applies also to the constancy of facilitator presence.

The findings from the qualitative analysis indicate how important the facilitator role is in contributing to raising self-efficacy and confidence: *"The general feel about kids is they are not encouraged enough to think for themselves or to have the self-confidence to individually explore whatever field they are interested in. If they were given the chance to do something with their hands, the imagination would then take over and build their personality far better than any self-improvement book later in life would"* (FI28, male, age 27, pilot1). Facilitators reported that the DOIT hands-on activities support the self-confidence of the participating children: *"During the weeks it developed more into the feeling that it was their idea and that their ideas are valuable and good, rather than they need our approval."* (FI18, male, age 23, pilot1) and *"I also think they had more confidence that some of the things they find or they see as a problem, they actually are able to find a solution for by themselves, they don't have to wait for grown-ups or something, they are perfectly capable of finding their own solutions and even building them or at least make a start and show people how they want something done and maybe help them with it"* (FI23, male, age 46, pilot1).

Facilitators reported that they had the impression that the embedding of external experts and their positive feedback on their ideas and solutions contributed to the self-efficacy of the children: *"Yes, it definitely contributed to the*

self-esteem of the children (…) because it was the first time that somebody, who is an expert on this field, told them that their ideas were great" (FI1, female, age 43, pilot2).

Many facilitators stated that there seemed to be a very high personal identification with the end product and at the same time being proud, especially among younger children: *"… students were proud of their final product and about their underlying ideas"* (FI5, female, pilot 1) and *"I think they were very tired but proud, because they did well"* (FI27, female, 43 years, pilot 1). Important in this respect is the fact that the children see that their prototype can actually be used in real life and that they are able to create it themselves *"I have learned that you can build something if you want to … "* (Student interviews CoC) and *"You can learn whatever you want, if you want!"* (Student interview UZAF). Also, running through the making process allows a student to understand what he/she is good at, which again increases their self-confidence.

Facilitators also reported that especially kids with rather problematic background and difficult social behaviour seemed to adapt well to the DOIT pilot activities by increasing their self-efficacy: *"They are very conflictive kids in the classroom, they always create problems like this and during the pilot there was one more and they were working normally without any problems"* (FI17, female, 45 years, pilot 1).

5.6 Teamwork and collaboration skills

All of the facilitators and many students agreed that the DOIT actions had a great impact on the ability of teamwork: *"Definitely – that was actually one of the goals as well, to communicate, to join, to bring in all their opinions and find out if they could make something work, when everybody thinks it's a good idea. So that was one of the foci we also had with the students"* (FI27, female, 43 years, pilot 1). Concretely, facilitators reported that the students got to know teamwork in practice, specifically how to communicate and to find a compromise. But also to develop strategies on how to divide tasks and roles was mentioned, as well as the fact that they learned about leadership and what it means to be able to count on each other.

Of course the success of the teamwork differed from group to group, depending on the group dynamics, social behaviour including communication, tolerance and empathy towards other group members and fulfilling and accepting roles and tasks in the group as well as their previous team work experience in school. However, many facilitators reported initial issues in teams: *"So teamwork didn't go well at the beginning, but after a while, when they go to the same line, they are just dealing fine with it"* (FI15, male, 23 years, pilot2). For the students it is an important lesson learnt to agree in groups, to understand their changing roles (rom sometimes being in charge,support other team members,…)

As regards the teamwork, the pilot facilitators chose different strategies. Some pilots let the students form their own groups. Usually the kids would then form teams with their siblings or friends. Thus the primary factor for forming teams was family and friends or other kids they knew already from school. In this respect, age does not play a major role but again gender does (if not sibling or friend available): several facilitators reported that children formed often gender homogenic groups (girls and boys gathered in separate groups). Groups that form on their own have a second phase where they choose their tasks according to their preference: *"… or rather the second phase that I was actually watching over and trying to help them with organizing, was the roles within the group. So for example I would say 'for this kind of thing you need a designer, like an architect, and then you need technical people, you need a programmer' and then I would observe how they took up their roles and this was like, there were some kids that were very into the technical stuff and they immediately took up the technical positions and jobs – they were responsible for cabling for*

example or positioning of the ventilator" (FI6, male, 32 years, pilot 1). The big advantage to let the students choose their own groups is that the motivation keeps up at the beginning and child feels more comfortable to deal with uncertainty when they are together with well-known kids. The disadvantage is obviously that there might be a lack of competence in the team. Consequently, several pilots chose the second option to form the teams as recommended by the facilitators that formed the groups by abilities and preferences as well as social aspects. *"They didn't have problems – it's true that some of them maybe had less skills for stuff like certain tasks but this is the good thing about how we planned the pilot, that the group should be compensated in terms of necessary skills to solve the problem, so any of these kids or any kid felt under capacitated to solve the problem they had to trust in the potential of the group to finish everything"* (FI17, female, 45 years, pilot 1).

However, compelled group forming needs a very thoughtful preparation beforehand, so that the students still feel self-driven.

In most pilot actions, working teams consisted of 3 to 4 children, with some exceptions that had more children (up to seven students). However, some facilitators commented also on the ideal size of teams: *"So I think there's a magic number of working together and it's two. It's just easy. But three is a challenge and it's better to challenge them because then they can learn. They have an extra layer of things they have to keep in mind: Did you include everyone? And it's difficult if everyone wants to do something different. But you can only make one thing so you have to compromise. And I think for young children to learn how to compromise that's important. It's really a skill"* (FI9, female, 31 years, pilot 1).

5.7 Dealing with uncertainty

When asked how the children dealt with uncertainties, facilitators identified several levels and areas that related to this issue: new topics and new abilities that are needed and a different kind of learning, as well as different rules than in school settings creates uncertainty for kids. Uncertainty creates fear and doubts, but once overcome, kids become aware of their own abilities:

"For the majority this was their first time they worked with electronics, electric circuit (which can be quite scary and abstract, with sewing, prototyping, soldering (which demands dexterity and especially patience, which youngsters often lack), so sometimes they had to overcome their fears, self-doubt and uncertainties about their capabilities. Some of them soldered for the first time in their life, some were afraid they will get burnt or burn each other, but soon they couldn't wait for their next chance to do it again and again" (FI26, female, 39 years, pilot1).

Most of the facilitators reported that usually the children -if confronted with uncertainty - would go and seek for the help of facilitators, provided that the children had established trust in their support. The DOIT pilots and actions are designed in a way that facilitators should convey the message that the children are allowed to experiment and that, even if they fail, it is a success for their learning. Facilitators reported that it was very important to communicate this approach to the children: the fact that they were not in school and not judged or graded for their experiments but rather valued for what they created. Many of the facilitators stated that, especially for older children, it was more difficult to drag them away from their typical school environment thinking in terms of mistakes and grades. Making them feel comfortable with this approach is a condition for fostering creativity and new solutions. Still, many students had issues with this 'open learning' because they felt insecure, since they were facing different rules than they were used to at school: "*Yes, the learning process is different and therefore for some (kids) difficult to be in because it has*

a lot of activities and it's difficult for some students to be in that room of navigating in that chaos – even though it's not chaos, for some it seems like it" (FI27, female, 43 years, pilot 1).

However, one facilitator supporting a pilot with rather underprivileged children reported that as soon as the children felt insecure - because they felt a lack of knowledge on a topic or lacking skills- these children immediately blocked, but felt comfortable in the making process itself, creating their prototype. Thus, one can conclude that facilitators have to be aware that uncertainty (independently from the concerned areas like lacking knowledge, different settings and/or rules) might cause difficult situations for some children. Mostly they can be solved by communication during the action itself, but also the correct adaptation of challenges in the preparation phase of the action has to be considered. It is important to give children in this situation the feeling that they can feel safe in the sense that whatever they create is o.k. – even if it is not working –that testing and experimenting and failing are part of the learning and development process.

5.8 Perseverance

Obviously, perseverance depends highly on the age, the personality of the children and their physical condition as well as on the initial motivation. While young children need more breaks and also physical exercises in between, older children can focus on their tasks for a longer period of time. Ideally, physical exercises are combined with knowledge acquisition (e.g. analogue programming exercise 'rabbit field'). These exercises help children to concentrate again on the following tasks.

Generally speaking, children prefer "... *quick wins*" meaning *"... they prefer to do practical things, with easy tasks, no, not easy, rather a fast objective and/or result, an attractive result"* (FI19 and FI20, both male, 38 years and 41 years, pilot 2).

Also group dynamics and learning from each other plays an important role in maker activities: *"I think some of them were actually quite good at adjusting and trying over and going back and try once more, while others just needed help to get over that obstacle that didn't work and they just became frustrated. But also I think they learned about each other, if they were watching someone else dealing with an obstacle or something like that and saw their frustration going away – it gave them more motivation to jump in and the more they had success with adjusting and finding other ways to get to their goal, it helped them."* and *"... watching others managing frustration and finding their way around a problem was motivating"* (FI27, female, 43 years, pilot 1).

Children with lack of perseverance need more support from the facilitators by communicating individually with them and encouraging them to find help for solutions.

Also, older children seemed to know better how to continue working for a longer period of time since they are more used to project work already (FI6, male, 32 years, pilot2).

5.9 Other interpersonal skills

Next to the interpersonal skills like working in teams and communication, there were other skills named that are related to this category of interpersonal skill acquisition.

One of the most mentioned acquired skills was the way of working and the understanding of a more open learning approach: *"I think work habits is probably one of the biggest things, because we encouraged them to really be independent. We showed them where the materials are and they really had to stand up and get the stuff that they need and help each other, know how to ask for help (...)"* (FI26, female, 39 years, pilot 2).

As mentioned, many facilitators observed that children struggled with failing. It is a new concept for them to have failing as part of the process and to understand failures as a step forward to their goals: *" (...) like realising that failure is only part of the process; that failing is actually a good thing"* (FI26, female, 39 years, pilot 2). However, DOIT and its facilitators consider failing as important step towards learning. Especially in the context of schooling, this paradigm was rather difficult for the facilitators to communicate and to break up existing expectations and mindsets of students.

5.10 Empathy and knowing others' needs

Many facilitators reported that the identification of social needs was a tricky phase in the pilot. Asking for the reason, many facilitators identified the lack of knowledge on the entire system that usually lies behind an issue or problem (ie. waste reduction): *"They are so young and they don't realise many problems in our country and our social challenges. And I think they're kids, really small kids and because of that they realise some problems but from that child perspective and I don't think they are thinking about the social challenges problem"* (FI21, female, 38 years, pilot 1).

Most facilitators solved this issue by asking questions to the kids, thus launched discussions with them, taking examples from their daily life and making a connection to their living environment. By discussing, the children got increasingly aware of the beneath system, thus could understand the value of solutions they then provided. Especially less experienced facilitators reported that they underestimated the time that was needed to complete this step.

Consequently, one can summarise that the closer the issue or problem is connected to the child's direct living environment and the less detailed a system needs to be understood, the easier the identification of other's needs and solution is.

One impact that was mentioned several times by the facilitators was the awareness that even if they are children, they still can have an influence on their own (and on others) life , meaning that *"... they can have an influence on things"* (FI9, female, 31 years, pilot 2). Participating children got an *"... understanding that it makes a change if you do something"* (FI18, male, 50 years, pilot 1).

5.11 Motivation and sense of initiative

Although motivation differed from student to student, the overall motivation during the pilots was very high. Some of the facilitators were even surprised that there were no dropouts during the intense working days. Motivation and keeping it high depends – accordingly to the facilitators – on several factors:

- High identification with own product: Many facilitators reported that a very high identification with their prototype contributed to a high level of motivation. Especially the motivation of younger kids seemed to depend on the fact that they were prototyping a solution that they developed themselves for a problem that

they had identified. It is not surprising that some facilitators report that kids have issues with iteration, so making or improving their first prototype: *"I experience that very often that kids have issues with re-making their prototype"* (FI1, female, 43 years, pilot2).

- Self-driven: In addition, the DOIT activities are self-driven, which on one hand challenges the kids – some more, some less – but which contributes to the motivation of children.
- Success: Having small 'success experiences' early on (or 'quick wins' as mentioned earlier) when experimenting (ie. little programming parts finally work out) is especially important for the motivation of smaller children since they still lack perseverance.
- Fun: Students also need the element of fun. Usually the activities take quite some time and keeping up the motivation depends also on fun activities. Obviously the kind of activities depend on the age, type and character of the students. Facilitators need a good understanding of their target group to embed this element in the activities.
- Variety of exercises and tools: offering a broad variety of exercises and new tools prevents children from getting bored. In addition, the facilitators have to consider that children have different preferences, so enabling them to engage in different exercises keeps the motivation up.
- Feedback by externals: A highly motivating fact is feedback by external experts or visitors *"We really believe that making all of this public and including an external expert was really an incredible driver"* (FI1, female, age 43, pilot2). All of the facilitators that included the feedback by externals reported that the children had an extremely high motivational push by the positive opinions and enriching discussions with externals or even experts from outside.
- Theory vs. practice: a good balance between theory and practice is essential. According to the facilitators the practical part of constructing and making is usually very motivating for children, but on the other hand theory is necessary. Thus, a good balance between both should be aimed for.
- Physical condition: Not surprisingly, but nonetheless an important aspect is the physical condition of a child. Breaks that allow children to recover or eating snacks are really important to keep up motivation. The physical condition, especially being tired or hungry, has a great impact on the motivation of the children. Thus the (individual) timing of the activity is an important motivational success factor.
- Existing initial interest: A certain initial interest in making and problem solving is essential since methods or tools seemed insufficient to compensate for a lack of interest. Also, making things easier does not generate interest and motivation: *"I think that just to make things simple won't be enough to motivate those who have no own interest to learn more about the topics"* (FI7, male, 37 years, pilot 1). But still, adapting the topic's difficulty to the age of the students keeps motivation up.
- Choosing the working groups themselves raises (or keeps up) motivation, while pre-defined groups is challenging at first for the kids. However, most of them overcome this first disappointment and work well in teams (see section 5.6)

5.12 Planning and management skills

During the DOIT actions children were motivated to develop their own solutions for issues and problems they see in their environment and understanding. Thus all of them launched (small) projects that they had to develop step-by-step.

Not surprisingly, the facilitators mentioned in order to handle these projects older kids needed less support than the younger age group. Many children were already confronted with project work in school, thus had already developed

planning and management skills. In terms of planning and management skills, younger kids need mainly support in timing of tasks and also lack experience in preparatory work that might have been needed (ie. important of understanding concepts behind an issue or problem) or of how to keep track of the project (FI8, male, 50 years, pilot 1). Also, very often young kids are not aware when a break is necessary for continuing working focused.

Obviously, already existing pre-knowledge on planning and management skills but also individual abilities determine how well the work on the prototypes in the teams worked, thus not all groups *" ... were able to organize themselves equally good"* (FI10, female, 29 years, pilot 1).

Nonetheless many facilitators as well as students reported that they have gained management skills and got insights on the planning of projects, not at least due to the efforts of facilitators and (partly) also because of management tools like the Kanban Board or brainstorming sessions, booklets and webpages where they were asked to keep a sort of diary.

Figure 13: Brainstorming session in MonsterLab– MPFL 2nd pilot

5.13 Acquired Skills and other learning/awareness

Obviously, depending on the focus of the pilots, students as well as facilitators reported different kinds of skills that were acquired and which could be classified as pure maker skills, skills that were related to the process itself and knowledge gain that is connected to the topic that was addressed.

Among the named maker skills there were electricity including sensors and LEDs, programming (working with MicroBits and Calliopes), soldering, 3D printing, taking exact measures, constructing cardboard buildings, dealing with different kinds of glue, correct handling of cutters and hot guns, sewing, the re-use of materials (garbage), also the basics about e-textiles (tools, materials, techniques). *„They learned the most about programming. Before the pilot it was a black box to the children. Now they used it as a tool to solve problems. They practiced programming and*

experimented with AI. They learned that a computer can create fast solutions based on data input. They learned 'decision making' with computer, from a social perspective" (FI7, male, 39 years, pilot 1*).*

Many children became skilled in searching the internet for information, possible solutions or actual issues and gained insights and awareness about personal data safety.

Facilitators reported that the children definitely gained insight in the design process itself. Children naturally build and construct for play, but usually they don't construct and create prototypes that solve a real-life issue or problem*: "Design process, they learned that something is not just there by clicking your fingers. It takes work and experimentation"* (FI24, female, 32 years, pilot 1).

Several facilitators mentioned that students understood that by experimenting and testing, improving and iterating they achieved better results. Also, students got aware that they can approach new things without being an expert in this topic and by experimenting they can learn more in this topic (FI4, male, 47 years, pilot 2).

In this respect they also realised that the basics like Maths, Physics, Chemistry, Biology a.s.o. they learn in school help them to create and prototype their solutions. *"Afterwards they realized that they were actually doing maths instead of just some cardboard prototyping which was nice that they realize that they can use the things they learn in school in order to actually build something"* (FI23, male, 46, pilot 1). Thus, the connection to school curricula or the embedding of maker activities could be a realistic goal for educational change policy. Especially since all of the DOIT actions have starting points that address issues in science like nature and environment, health, security, etc. Addressing issues means also that often one needs to go back to understand the entire system behind and the connected problems *("...breaking up 'black boxes"* and *"... understanding connections"* (FI10, female, 29 years, pilot 1). Some makers pointed out that this is a crucial part in making and that sometimes children have issues to gain this insight, given the rather short time of the DOIT action.

Consequently, we conclude that a very good connection between curriculum topics in schools and maker spaces can be approached at every age. However, facilitators and/or teachers will need to decide the topic and the level of depth that is appropriate for the target group and give sufficient time to develop an understanding of the system behind.

Next to these three skills (maker skills, process skills and knowledge acquisition), several other awareness items were named by students and facilitators like the awareness of protection of nature and resources, the re-use of resources (*„We don't need to throw away old stuff. Instead of that we may use it for something interesting.")* and the awareness of roles in society („*Children also have a right to speak and sometimes people like politicians could listen to them.*")

5.14 Entrepreneurship

As mentioned, many different aspects connect to an entrepreneurial impact (like creativity, perseverance, self-efficacy, a.s.o.). However, the facilitators included activities in their pilots that would explicitly foster entrepreneurial thoughts or ideas. Depending on the topic, activities included aspects of design and marketing, calculation of costs, steps of production and sale or business canvas adapted for children and small budget limits available for the children' activities. Like all the other methods, also the entrepreneurship element required an adaptation to the age group of the children. Accordingly to the facilitators, the younger the children the simpler production/sale/marketing needs to be approached.

At the end of the pilot, none of the prototypes were produced for a real market. However, many facilitators mentioned that they believe that they (at least) started to make children understand some aspects of entrepreneurship. During the interviews with the facilitators it became obvious, that the entrepreneurial aspect was not a major, stand-alone aspect for them, but rather an integrated element within the whole DOIT concept. Therefore, it was difficult for them to estimate the possible impact on the students. *"I think - I hope they will take home that this is a way of changing things, that they can change things - they have the methods, they have the ideas, they have these strengths to change their everyday life if they want to"* (FI27, female, 43 years, pilot1).

Other facilitators concretely emphasised that the students gained some sort of *"...financial literacy as well, because it means a lot for them, like handling money and how to realise your project even if you don't have enough money. Like being creative and finding your way, even if you don't have enough money."* (FI26, female, 39 years, pilot 2).

As mentioned earlier, one question in the quantitative survey tackled entrepreneurial intention more directly by asking whether they wanted to be their own boss, the score slightly increased from 3,52 to 3,55 but the difference is not statistically significant.

6 Summary and Conclusions

The conceptual framework for guiding the evaluation is built upon the generic DOIT framework and the main objectives stated in the DOIT proposal. We have applied a mixed method approach combining qualitative and quantitative instruments. For the quantitative instruments on creativity and self-efficacy we rely on a pre-post evaluation design. The other evaluation dimensions are addressed by qualitative means such as interviews with facilitators, students interviewing other students, feedback reporting, etc.

In the following the main insights are shared and for a better overview structured in different categories.

6.1 Participants

In phase 1, more children were reached than originally planned: 538 instead of 500. In phase 2, the analysis is based on 419 children (lacking 50 children from the Finland pilot which had to be postponed). Thus, overall the DOIT actions have involved 957 children in total at the time of writing (with around 50 more to be involved in the Finland pilot).

In line with the original planning, about 30% of the participants belong to the younger group with ages between 6 and 10 years and 70% were between 11 and 16 years old.

Female participants accounted for above 40% overall, while the gender ratio varied considerably between the different pilot sites. Although pilot partners very considerately tried to engage as many females as males by sending out gender sensitive information and creating material, it was obviously more difficult in some regions compared to others and especially outside school settings.

All defined groups could be reached as planned: about 30% from a less privileged background, slightly fewer children with special needs (6% instead of planned 7%), about 30% from rural areas and roughly 2% advanced makers.

The drop-out rate was quite low as the overall completion rate is above 80% in pilot phase 1 and 72% in pilot phase 2, i.e. the majority of participants was present the entire time of the DOIT action.

6.2 Facilitators

In pilot phase 1 one practice partners applied a peer facilitation approach with facilitators who were on average 17 years old. The facilitators’ age at other pilot sites varied but most of them were below the age of 40. The age of the facilitators did not play a role in terms of raising the level of self-efficacy but interestingly there is a weak correlation between the young facilitators and a marginal gain in creativity among the participants, which would speak for a positive peer-tutor effect in terms of creativity.

The gender composition of the facilitator team varied quite a bit between the different pilot sites, from solely male to solely female teams to quite gender-balanced teams. In terms of creativity, a marginal gender effect could be detected among female participants who gained some creativity points more if the facilitator team was mainly male. However, the correlation is very weak and should not be overestimated. Self-efficacy among participants did not correlate with the gender composition of the facilitator team.

Neither creativity not self-efficacy gain does correlate with constancy of facilitators present during the workshops. Also the number of participants per facilitator does not correlate with creativity score and self-efficacy score gain.

6.3 DOIT pilot framework

The agreed minimum requirements for a DOIT pilot action is 15 hours working in workshops with the participants. However, some practice partners extended the programme, one even up to 45 hours. While with creativity score gain there is a slight correlation with the programme duration, meaning that participants with more attended hours also had higher scores in the post-test no workshop duration effect could be detected in terms of developing higher self-efficacy scores.

6.4 Impact

Participants towards the end of the DOIT action showed significantly higher scores in both the creativity test as well as the in the self-efficacy survey. The effect size is moderate with around 0.2 for both.

In our sample creativity and self-efficacy do not correlate, thus a creative person can have high self-efficacy scores and vice-versa.

Creativity

Interestingly there is no difference in terms of creativity between the younger and older age group at the beginning of the DOIT action, only afterwards older children reach higher scores, which leads to the assumption that older children have benefited more from the action in their creativity. Participants with disabilities had overall lower scores, both in the pre- and post-test but had about the same creativity gain as other participants.

Self-efficacy

Both age groups have about the same level of self-efficacy in the beginning of the DOIT action but younger ones tend to have higher scores afterwards. Thus, in contrast to creativity where the older ones gained higher scores in the post-test, it is the younger ones who outscore the older ones in the self-efficacy survey..

No gender differences could be found in relation to self-efficacy. Significant differences were identified between children with and without disabilities, while children with disabilities show lower levels of self-efficacy both in the pre- and post test. Notably, their increase is steeper.

Teamwork and collaboration skills

Teamwork and collaboration skills highly depend on the age group, already existing or gained working skills as well as the individual personality of children. During the DOIT pilots, facilitators choose different strategies (predetermined groups or self-determined groups) on how to form the teams. The different strategies rather had an influence on the motivation, focusing on the different task and communication. Independently from the strategy, facilitators agreed that the DOIT action had a positive impact on the ability to work in teams and increased the kids' collaboration skills.

Dealing with uncertainty

The most common strategy for dealing with uncertainty is to ask the facilitator for help. However, many facilitators tried to communicate that uncertainty is part of the design process, that he or she would not know and that investigating, trying and testing is a good way to get results. Many children have issues with failing, meaning that they consider failing as a mistake, especially in the school context. It takes quite some time to get children understanding that failing is part of learning and knowledge gain.

Perseverance

Obviously, perseverance depends highly on the age, physical condition and personality of the children as well as on the initial motivation. Young children need more breaks and more variety of activities and also physical exercises while older children can focus on their tasks for longer time. It seems that it lies in the nature of humans, that children are keen to experience success soon in form of attractive results without putting too much effort in the work. Thus, a mixture of early success tasks in order not to lose motivation and tasks that challenge them should be aimed for.

Empathy and knowing others’ needs

Empathy and the understanding of others' needs depends highly on the topic and how close this topic is connected to the direct living environment of the participating children. The closer the topic to the direct living environment, the easier it is for the participating children to accomodate to other one’s needs and issues.

Motivation and sense of initiative

Motivation can be influenced by many different factors. In general, the motivation was very high during the DOIT action, with some single exceptions. However, one of the most motivating phases during the DOIT actions was the making process on own ideas itself. The physical making of a prototype by hand as well as the fact that it was an own solution for an identified issue had a very high positive motivational effect.

Planning and management skills

Generally speaking, we might conclude that planning and management is especially for younger kids a challenging task. Thus, the younger the children, the more support the children might need with timing and planning. However, projects like DOIT foster the ability to plan within a team and elaborate management skills.

Other skills

Obviously the children gained increased maker skills when crafting their prototypes. Depending on the focus of the pilots, students as well as facilitators reported other different kinds of skills that were acquired and which could be classified as skills that were related to the process itself, cognitive knowledge on topic incl. finding information that is connected to the topic that was addressed (i.e. environment), and other interpersonal skills like communication, problem solving, etc.

6.4 Limitations of findings

In order to prove that the score gain in the creativity test and the self-efficacy survey can be attributed to the DOIT action and not to other confounding variables the comparison of the scores with a control group would make the findings more sound (Bortz & Döring, 2013). The control group and the experimental group have to be parallel groups, meaning that they share the same characteristics in terms of points in time of measurement, age, gender ratio and setting (e.g. same school, same neighbourhood).

Although control groups were not originally planned (c.f. D61.), we aimed at arranging for a control group in pilot phase 2. It was clear that control groups could not be organised in outside school settings as children would rather not be interested in coming to the maker space or to other events just to work on the creativity test and the survey. So we aimed for the school setting but unfortunately none of the practice partners was able to organise a control group for different reasons: the schools found the scientific argument not convincing enough to have a class go through both instruments two times, others brought forward ethical arguments bringing in a divide between those who can actually participate in the DOIT actions and the others who cannot directly participate. The challenge to set up control groups is quite common in quasi-experimental settings as DOIT is operating in.

As setting up a control group in this sense was not possible, we have created a “quasi” control group within our data set. We split the data in a sample that fulfilled the minimum requirement of attending at least 15 hours of the programme (which represents the experiential group) and another sample who did not (representing the control group). When we compare the creativity test of these two groups then we see that the experimental group increases their score significantly while the control group does not. The same applies to the self-efficacy survey: Again, the experimental group in the post-test has a higher score as in the pre-test, the scores of the control group do not differ significantly.

Besides comparing with a parallel group there are some more arguments that speak for a DOIT effect. The creativity test does have two different parallel forms, Form A for the pre-test and Form B for the post-test. These have been designed exactly for this kind of pre-post-evaluation where learning effects due to the simple repetition of tasks shall be controlled. There are numerous studies that have made use of the test in a similar way (e.g. Greb, Faust, & Lipowsky, 2007; Karwowski & Soszynski, 2008; Maksić & Tenjović, 2008).

Furthermore, the creativity score and the self-efficacy score do not correlate which further speaks against a simple learning effect due to the repetition of tasks.

Although the didactical settings was organisationally and content-wise an open learning setting,

each pilot site was assessed with the same measuring instrument and positive effects could be found in all pilot actions. This open learning setting however makes comparisons between the different pilot sites impossible since the variety and diversity of variables that can not be controlled (like in a real experiment in a lab). The DOIT actions varied from pilot site to pilot site in terms of programme duration, technologies used, setting, language and culture. Although the DOIT elements were followed in all pilot sites, the concrete operationalisation of these steps differed considerably. Thus, we merged the data of pilot 1 and 2 in order to understand whether participants benefit from the DOIT actions overall irrespective of these different variables. So in the end, we are able to recognise the value in terms of all evaluative dimensions, from creativity to maker skills but aside from some framework conditions we cannot make a concrete recommendation on which technologies to use for instance. However, we perceive this also as secondary as it is not the technology to make the change but rather the DOIT approach overall.

6.5 Conclusions and Recommendations

The analysis of the qualitative and quantitative data obtained in this study revealed that the DOIT approach with young students does have an impact on several aspects. Skills such as problem identification and solving, good communication and interpersonal skills in teamwork and creativity are more than ever required if entrepreneurial thinking and education is aimed for.

However, it remains the question on how to transfer these pilot findings on a broad basis in education for the youngest of our society. Given the very different organisational and structural differences in Europeans educational systems, we can give general practical recommendations for the implementation of activities building upon the DOIT programme in and outside of schools.

On rather practical level, we recommend strongly to get to know your target group well and highly adapt to their needs and interests. Thorough planning and considerations on the organisation of the action is required, as well as a highly adaptive attitude in facilitators on the spot, to meet participants' needs and personalities. Consequently we conclude that a very good connection between curriculum topics in schools and maker activities can be addressed at every age. However, facilitators will need to decide on the topic and the level of depth that is appropriate for the target group.

During the pilot activities many different insights and recommendations were discussed and elaborated. These insights will be outlined in D4.4. However, these DOIT action recommendations that can directly deviated from the qualitative and quantitative data, are shortly listed in the following section. This short list can help to identify **issues to consider** when organizing a DOIT action, supporting the facilitation of a successful workshop based on the DOIT programme with children.

- Although no correlation between number of facilitators and creativity could be confirmed, facilitators themselves recommend a high number of facilitators supporting activity (3 to 4 children per group),
- Teaming up: free choice fosters motivation, predetermined groups complement each other in abilities
- Not surprisingly, the DOIT evaluation data revealed that the younger the children...
    - ... the more easily distracted
    - ... the more breaks and physical exercises are needed
    - ... the higher the facilitator/student rate (for helping with tools)
    - ... the fewer they are caught in the social structure of teens (‚being cool')

    - ... the less planning and management skills
- Special needs / generally speaking following effects were observed if the needed space, flexibility and mind set is provided
    - Good working and learning in teams
    - Positive effect on social integration and self confidence, if sufficient freedom is given
    - Gaining more self-confidence since ideas and prototypes are valued by others
- ‚Challenging kids' / generally speaking
    - Several facilitators report that several ‚challenging' kids seem to adapt extremely well with the activity,
    - ... whiles good students sometimes have difficulties to adapt to the free maker space setting
    - Social background of kids needs to be considered (might cause a change in focus ie. from creativity towards confidence building and self-esteem)
- Facilitators need to well plan and structure pilots, but provide at the same time high flexibility
- The social interaction, especially with troubled kids, is challenging for facilitators
- Creativity, teamwork and problem solving were the two most frequently named competencies gained by kids
- Creative solutions need time, space, self-confidence and a specific attitude towards creating (no right/wrong)
- Very high personal identification with the developed prototype or project result (especially younger children)
- It is highly motivating for children to see that their prototype can actually be used in real life
- Teamwork is extremely important to shape social behaviour including communication, tolerance and empathy, fulfilling and accepting of roles
- Clear communication to kids is important to avoid uncertainties
- Perseverance depends on initial motivation and personality of kids
- Motivational factors:
    - Ownership (idea, prototype, ...)
    - Achieving small steps of success
    - Fun
    - Diversity of activities
    - Good balance between theory (initiation) and practice (making)
    - Timing with breaks
    - Existing initial interest
    - Perseverance depends on initial motivation and personality of kids
    - Physical condition of children (hunger, being tired, ...)

At a **strategic level,** the results of this analysis allow for the following recommendations:

1. Even though short term activities are highly motivating opportunities for kids, ideally maker activities are not embedded in short time limited actions. A better, and more sustainable option is to offer making activities as an integrated part of school education that gives free room for development by fostering creativity, problem solving and self-esteem.

2. Learning in maker activities should be held under the premises of 'failing is necessary to become better' or 'failing forward'. This expression imparts that making mistakes is necessary for learning by understanding what to improve.

3. Having a DOIT action in a school environment, it is important to set a creative space that does not necessarily follow a traditional school system (‘right and wrong’) where experimentation is explicitly fostered.

4. Vital for successful implementation of the DOIT approach is to train facilitators and teachers, especially to impart the spirit of making that grounds in thinking out of the box, experimenting and testing, failing and improving, encouraging youths to help each other (peer-to-peer support) consideration of options and entrepreneurship. The understanding of the role as facilitator is essential: being supportive, but not solving problems that occur in the process of their making activities.

5. At the same time, apart from the required preparation time, the integration of maker activities does not necessarily call for additional hours within the curriculum or materials. It can be connected well to scientific curriculums since many social issues ground in understanding of maths, physics, chemistry or biology. Cross-curriculum plans are already embedded in many school systems. However maker activities can enrich a cross-curriculum by maker skills (electronics, prototyping, production, working with different materials, programming...) and embed well with STEAM.

6. It is also highly recommended to build or revive existing partnerships with external partners for several reasons. Firstly, the facilitators have the option to bring in expertise and knowledge or tools that might be required. Facilitators might not cover all skills or knowledge, thus external support from companies, SMEs, public institutions, universities, museums or Maker Labs themselves eases maker activities. Secondly, the clear feedback and input from practice pushes the entrepreneurial spirit and thinking of children and motivates them for further improvements.

7. Maker activities develop full potential in teamwork on both sides, children as well as facilitators. As mentioned, a team of facilitators with mixed skills and knowledge covers the needed support that can highly differ by each child. The children maker do activities in teams on the other hand, generate interpersonal skills that are highly relevant for future workers or entrepreneurs. Maker activities that are embedded in an autonomous working environment foster communication, creativity, problem solving, empathy and tolerance, acceptance of roles and different opinions.

8. Especially students with disabilities or challenged students might profit to a great amount, since they can develop – if sufficient freedom and space is provided – individual abilities and skills. Consequently, we need to work towards more accessible maker spaces for students with disabilities.

9. It is also recommended to support the spirit of makers of the re-use and up-cycling of materials and thereby foster a sustainable consumer habit and the careful re-production of waste. A positive side effect is that the costs for materials can be kept rather low. Still, providing sufficient physical space to allow teamwork and experimentation with different materials is highly recommended.

10. Girls are more difficult to attract in out-of-school settings. It is recommended, to particularly pay attention to the design and working of the invitation, as to make feel girls also attend.

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