StepOn: A tangible tool to support reflection and the development of actively using metacognitive strategies.

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ABSTRACT

While reflection is becoming more and more important due to educational changes. I present StepOn, a hybrid tool to support reflection and the development of metacognitive strategies. The tool allows primary school children aged (11-12) to divide goals up in steps and reflect specifically on them with video and guidance questions. By dividing achieving the goal in steps children train actively and deliberately using metacognitive strategies. One version of StepOn was tested to form design criteria regarding such tool. Clarity, building on the existing foundation, discussions and guidance are key to achieving such tool.

INTRODUCTION

Dutch education is shifting. In 2032 the primary education takes on a more design driven approach with focus on solving problems, critical thinking, 21st century skills, learning strategies and a trans-disciplinary approach. [13] Reflection is a vital part of the educational change. With this newly found focus on reflection comes the need for reflection tools. Current reflection tools are largely based on writing, tip & top carts and posters or lack depth. [17, 18] Those reflection tools are quick and convenient when reflecting in class often. Some examples [20] are 1) the marble jar, after discussing with the children as a class discussion what they did, what they learned, where this can be used and what can go better they can earn a marble for the jar for good work once the jar is full they get to spend an afternoon working on an activity of their choice. 2) Working on a learning line goal (e.g. being a group leader), evaluating in groups how you are doing and if you achieved the goal; the teachers hand out cards to some children with tips on what to work on or how to continue and cards with compliments. 3) The teacher picks out a few children reflects with them, giving them constructive feedback. 4) Children write a reflection after an activity they mainly focus on tips and tops. Reflections moments that are more in depth happen when the teacher stops the class during an activity and asks questions that go more into depth. The downside to this kind of reflection moments is that some children are often not actively involved (e.g. trying to answer a question or listening carefully) and will not learn how to reflect.

My goal is to allow children to achieve a level of more depth in their reflection by making specific what to reflect upon. Observational moments in class showed that some children knew what to do and not do to achieve a certain goal concerning their progress (eg. actively participate in class and not be distracted) but did not always keep all these things in mind. This makes the goal unachievable as a long-term goal considering that as soon as you lose focus on the goal you stop constantly adjusting your attitude and therefore fall back to old behavior. I propose chunking this large and difficult goal up in smaller comprehensible pieces enabling children to learn why they don't show certain behaviors. This way the children can eliminate the factors contributing to these behaviors. When chunking a large and difficult goal up in smaller pieces metacognitive strategies are applied. You thought of what you already know, what you still need to learn, how you can achieve learning this and how you can create a timeline for this work. Metacognitive strategies do not come naturally but need to be thought, children that are able to use metacognitive strategies however perform better in class. [16, 12]

In this paper I present StepOn a hybrid of tangible and digital reflection tool that supports acquiring metacognitive skills and depth in reflection. StepOn consists of a tangible tool that supports children in planning out how to achieve their goal and a digital environment where children record their reflections through video fragments in which they either reflect individually or have a group reflection, both based on personally picked questions by the teacher. They asses their work attitude and the quality of the reflection they delivered and are given constructive feedback on this by the teacher.

I describe the iterative process of StepOn and the evaluation of one of its prototypes in a group 8 class (children aged 11-12). The evaluation consists of a qualitative study determining the main design needs for such tool (supporting the development of metacognitive strategies and achieving depth in reflections) and the preferred way of recording qualitative reflections. This paper presents four main contributions: (1) Lessons from the iterative design process and the evaluation of StepOn 2.0; (2) A new approach to reflection by combining it with actively teaching metacognitive strategies; (3) Findings from an evaluation in a group eight class; (4) Discussion of the design choices that facilitate and constrain developing a tool to support reflection in depth and train metacognitive skills for a primary educational school in group 8.

THEORY AND RELATED WORK

Here I describe the theories that influenced the design choices and relate my design to designs that cover parts of the intended use.

Reflection

Schön [11] defined reflection-on- action as a form of reflection where the subject of the reflection looks back at the materials produced (the result) without manipulating the materials at that moment. I take on this stance to reflection and combine it with metacognitive reflection [12]. This combination results in a reflection-before and a reflection-after action; with the reflection-after the action also leading to possible changes in the planning of the child, made to achieve the desired result. In order to formulate the reflection questions for the children, the following papers are used: Korthagen reflectioncircle [5], Robert Fishers metacognitive reflection questions [12], and Jack Mezirows critical reflection questions [2] were used as a base. Jack Mezirow sees critical reflection (a critical assessment of ones beliefs, judgements, feelings and acts by looking at the influences on these) as uniquely adult. Whereas I agree I also belief that creating awareness of ones beliefs and the influence on decisions (and maybe even the first steps towards this critical reflection) can already be trained by reflection on what assumptions were made.

A constructionist approach

Constructionism (Papert) [10] Talks about how gradual acquisition of actions leads to building knowledge structures particularly when the learner is consciously engaged in creating a public entity (e.g. a tower of bricks or a theory about colors). " StepOn takes on this approach as it attempts to consciously engage the learner in defining and splitting up a goal, structuring the process to achieving the goal. Internalizing the action of working toward a complex result by breaking the achieving of the desired result down in comprehensible smaller pieces and analyzing what you know and need to learn.

Metacognition

In middle childhood (7 to 12) there are great strides in cognitive development. This is impacted by the increase of the attention span, memory and metacognition. Important metacognitive growth children experience is: learning to control what to focus on and because of this focus, children can better remember the content they were focusing on. Metacognition is crucial for learning; students who understand what they know and how they learn do better academically than students who do not. [15] Lessons aiming at teaching students metacognitive strategies are the "Critical and Creative Thinking Lessons"[14] of the Fairfax county public

schools. "Each lesson is structured around a five-stage model which provides students opportunities to connect content to prior knowledge, engage in new ideas, use thinking skills to consider possibilities, reflect on new learning, and connect the lesson to future learning… (e.g.) Using a picture book"

Robert Fisher [12] defined several levels of metacognitive awareness: "1) Tacit use: children make decisions without really thinking about them. 2) Aware use: children become consciously aware of a strategy or decision-making process. 3) Strategic use: children organize their thinking by selecting strategies for decision-making. 4) Reflective use: children reflect on thinking, before, during and after the process pondering on progress and how to improve." He also suggests a set of six strategies for successful learning consisting of asking questions, planning, monitoring, checking, revising and self-testing. This implies that although children grow tremendously in metacognitive skills during their middle childhood this will most likely only be in tacit use. Adopting this stance, I propose a design that involves aware use, strategic use and reflective use by consciously planning out the steps to achieve a goal, asking yourself what you need to learn and know to achieve the goal, monitoring your progress, checking if your plan worked, revising the steps to the goal and an in depth self-reflection.

Tangible interaction
Much research has highlighted the benefits of tangible interaction for learning. [7, 8, 9] However, incorporating tangibles in design for reflection is not common. Tangibles are used when creating narratives that reflect the process, such as Do.Doc [3] which focuses on reflection-in- action or in many planning boards used at primary schools. They are not found when looking at a tool that supports reflection on a specific goal and the process of achieving this goal. Therefore *StepOn* is proposed. The interaction with *StepOn* consists of dividing a goal into smaller steps, analyzing what needs to be done and learned to achieve the goal step by step. This enables students to

reflect on specifics and enables teachers to asses a reflection and the student's progress.

Horn et al. [6] discuss various tangible and non-tangible versions of interactive learning tools; they conclude that a combination or hybrid of the two styles is most effective. Considering the trade-offs between fully tangible and non-tangible systems I decided to make a combination of a tangible and digital system. One of these trade-offs of a fully tangible system being the collection of all reflection material, creating a database of all reflections is desired by schools; collecting a reflection digitally offers this option and offers several alternative ways of recording the reflection (e.g. Picture, writing, video, audio).

According to the CTI Framework [1] cognitive structuring through schema accommodation and assimilation requires both, physical and mental actions. The framework also states that "collaboration and imitation are typical and important ways that children develop schemata. Thus, design requires an understanding of the key factors that a system must embody to successfully facilitate children's collaboration… Tangible systems have space and handles for co-located collaboration without the need to share input devices." Working in groups and therewith collaboration is an integral part of design based learning, considering the educational shift toward this system and the theory above a (partly) tangible tool enables children to have a better quality of interaction.

APPLICATION DOMAIN
StepOn is specifically created to work with the various curriculums based methods schools work with. Meaning that any goal can be translated to the StepOn system to work with and reflect upon. For this research the learning line 'learning to learn' [4] was taken as a base. Children taking part in the research were familiar with the goals of this learning line. The learning line 'Learning to learn' is created to teach children to work together reflect and plan. By taking this learning line as a base it is assured that students are working on

achievable goals for their age-group. Looking at the research it is recommended that only one goal is focused on at a time.

Besides supporting personal goals as seen in the learning line StepOn can also be used when doing a design based learning activity. This design based learning activity can be taken from the curriculum method as done in the research with the method: Wijzer! This method has a week at the end of each chapter where geography, history, biology and tech come together. The first chapter teaches about food and became the subject of the design case. With students having the learning goals: 'What is healthy food' 'what makes healthy food possible' 'how can we stimulate healthy eating' and 'going through a design process'. Looking at the results of the research it is recommended that only one goal is taken as goal to split up and going through a design process is implicit. Materials that were used as inspiration for the children can be found in appendix E Several scenarios for use are proposed and can be found in appendix D.

DESIGN AND LEARNING GOALS

Design goals
The design goals for StepOn are G1) Offer support and clarity in what needs to be achieved, how it can be achieved and the order it needs to be achieved in. G2) Enabling to achieve qualitative reflections by making the subject of the reflection specific and offer in depth questions. G3) Offer children insight in what metacognitive strategy (kind of thinking) works best for them. G4) Conveying the excitement of self-reflection by creating awareness of what the children learned and what method works best for them, creating personal value to the child. G5) Helping children become more aware of their prejudices and that it influences their thinking. G6) Showing children their personal growth. G7) Enabling teachers to create a database of reflections and the feedback they've written. G8) Create a feasible workload for teachers.

Long term learning goals for children
L1) Use (in-depth) reflection as a tool for personal growth. L2) Access and use metacognitive strategies consciously and easily by knowing what you know, what you have to learn and how to learn this; making goals achievable. L3) Learning how to divide a goal in logical smaller steps, which leads to achieving the goal for the remote future.

DESIGN ITTERATIONS AND RATIONALE

### StepOn 3.0 (final prototype)
The design decisions of StepOn 3.0 are informed by the design goals, the learning goals and the results of the test with StepOn 2.0.

The tangible part (constructing a goal)
The tangible interface of StepOn 3.0 allows to come up with an own goal or use existing goals from several methods, writing them down on the part in the middle. The steps to achieving the goal can either be picked from pre-proposed steps or written down entirely by the child-users themselves. The steps towards achieving the goal are placed around the middle part looking at the numbers 1 to 6. This is done in order to help children with remembering that there is an order and achieving a goal is a process (step two cannot be achieved if step one is not achieved yet). There are two variants of pre-proposed steps, steps that contain a what and a how (e.g. I will compare children in my class that are often leaders and compose a list with at least five characteristics they have in common) and steps that only contain a what (e.g. I will compose a list of characteristics that leaders have). In the last case the how, describing how the child will compose this list, can be added by the child.

Steps build up in difficulty level. Working with the tool more often allows children to eventually compose the steps themselves instead of using pre-proposed or half pre-proposed steps.

A filled in'StepOn' the steps are interchangeable, turning the process of achieving the goal into an individual experience and teaching children about their preferences of approaches and possible approaches.
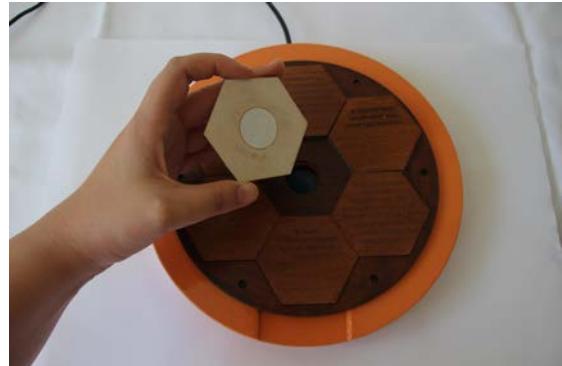
The middle part contains an RFID chip making the goals linked to a particular student or group.

The middle part, where the goal is written on, contains an RFID chip making the goal child or group bound. After assimilating a goal the child closes the transparent cap and puts the goal in the station on the teacher's desk and pushes the button. The station takes a picture and loads this onto the teacher's part of the reflection website and database.

The station at the teachers desk.

The reflection part
The reflection part consists of a website with a login for the teacher and a login for the

children. The children's' login shows a few options consisting of reflecting (group or individual), looking back, growth and earnings. When the child presses reflecting they can record a video and click through the questions one by one. This way the children do not know the next question and the effect of probing questions is created. Whereas other children do not necessarily need this effect and therefore get less questions (as they answer the question of the next question in the first question already) or harder questions. After reflecting the children judge if they reflected well and worked good in class.
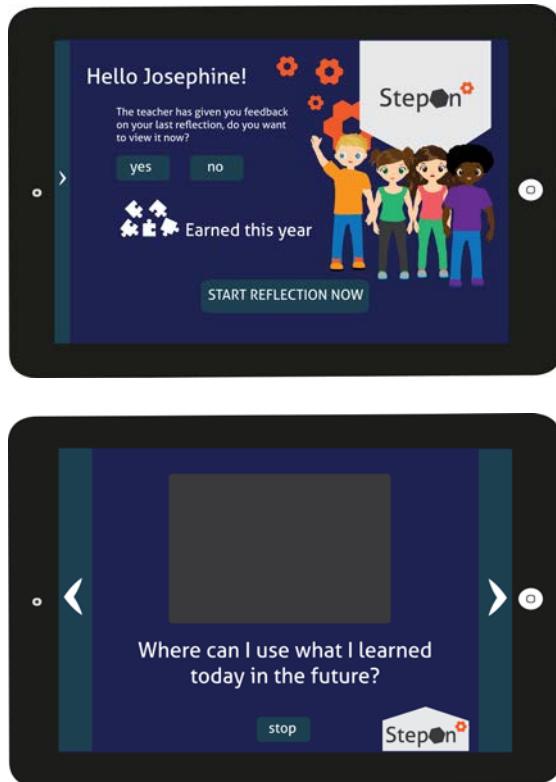
When the reflection is started, the screen will have nothing but the questions and the camera view on it. The next question is loaded when the arrow is pressed creating a seeming intelligent interaction where the program probes questions.

The teacher's part of the site is more elaborate offering options to handpick questions for groups and individuals. The teacher is able to change formulation of questions or create standard question cases that they can use (simple, medium, hard). The teacher sees an overview of the goal and how the steps to achieve it change (or stay the same) over time. The teacher has an overview of the reflections uploaded by the children and can add feedback to a reflection, in a reflection-film (at the time something happens) with a text box; or about the reflection-film. The teacher judges if the child indeed reflected well and worked good in class. When the child succeeded at this (s)he can earn part of a puzzle made together with the whole class. The teacher and the children can both access this puzzle.

Overview of a child's division of the steps and the reflections on the teacher site.

More pictures and design decisions of StepOn 3.0 can be found in Appendix C. Several scenarios for use cases are proposed and can be found in appendix D.

StepOn 1.0

Inspired by a pressure cooker that involved us comparing different kinds of reflection (reflection-in-action, critical reflection-on-action and 'normal' reflection-on-action). StepOn 1.0 aims to create more depth in reflection combining the different methods. Observations during this experiment showed that children did not naturally think beyond normal reflection-on-action and switch from reflection to critical reflection. A short overview of the pressure cooker can be found in appendix A

Based on a lecture about design in primary school (ICT driven) given by Helle Skovbjerg [23] at the TU/e a few needs for reflection tools at the primary school are highlighted: 1) A proactive role for the children using the tool. 2) Simplicity. 3) Guidance. 4) Communication of the goals and access to the goals. 5) Visualization of the process to achieving goals.

6) Use of understandable language. 7) A balance between 'teacher goals' and 'children goals'.

StepOn 1.0 is started with an intention to create a physical goal that is split up into steps, one for each class to work on. Children divide the goal in steps either (1) on the physical representation of the goal or (2) online. When working with the (1) physical goal a short description can be audio-recorded by the goal. A time limit is set when audio recording to limit the time the teacher has to spend assessing and to train children to get to the crux of their goal. When working (2) online a short description can be added here. In both cases there is a physical goal as a reminder for the child but in one case the goal is planned out online in the other case it is planned out on the goal itself. At the end of the lesson children report on their progress again either by recording it or by writing it down online. They answer five questions (What did you do? Why did you think your plan for this week would work? Did it work? What did work not too well? And what went very well?) After this, the children make a physical representation of their progress by adding a metaphorical white leaf to a little plant on their desk. If the teacher agrees with this progress the leaf is switched out for a colored leaf. When a leaf is not colored a child can go to the teacher and ask why it is not colored shifting part of the responsibility for the learning process of the child to the child him/her-self.

First idea; having a physical subdivision of a goal vs having a digital subdivision of a goal; form explorations.

Considering the research done on tangible interactions and how this benefits cognitive development a version that focuses more on these tangible interactions and deepens out the interactions is desired.

Filtering the most important intentions of StepOn 1.0 to the following intentions: 1) A Physical goal that can be split up into steps that plan out the process of achieving it. 2) The use of a reflection recording method other than writing. 3) An awarding method is in place where children also asses their selves. 4) Creating a concept with a feasible workload for teachers to asses.

Intention 1) can be seen in design goal G1) Offer support and clarity in what needs to be achieved, how it can be achieved and the order it needs to be achieved in. intention 3) can be seen as part of design goal G6) Showing children their personal growth. And intention 4) is the same as design goal G8) Create a feasible workload for teachers.

StepOn 2.0

Designing StepOn 2.0, the intentions of StepOn 1.0 are used as a base with the addition of the other design goals. StepOn 2.0 consists of a hypothetical site that collects and saves the reflections. The tangible goal-blocks themselves contain a screen showing reflection questions and offer a reflection-recording method. The reflection-recording method that should be chosen eventually has to be evaluated in the research. StepOn 2.0 offers three options: video recording, audio recording and taking pictures with the addition of text. In all three methods the same list of reflection questions is answered. On the next page some explorations of StepOn2.0 are shown in the pictures.
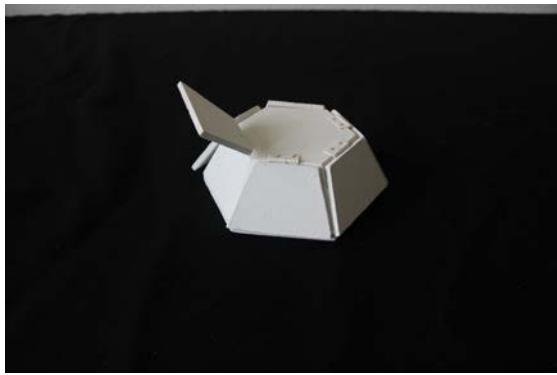
Showing progress by putting a piece of the block in the air or revealing extra information.

Fully embodied prototype, including screen. - Pressing a step button to show the step on the touch screen.

Prototype shaped to hand, voice recorder or camera is situated inside the block
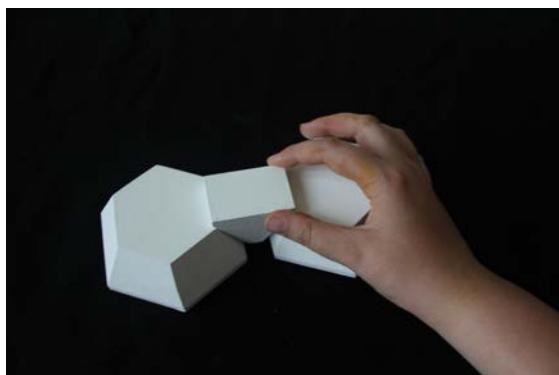
Connecting related goals.

Visualize at which step you are.

Starting the design of StepOn 2.0 the goal was to create a fully embodied interaction. Integrating displays and cameras enables creating an experience that is fully embodied in the prototype itself. But due to limited recourses for schools to spent, the goal blocks would become too expensive for the amount of blocks needed. The added value of embedding the sensors in the block and the price of adding these would not balance out considering schools are more and more working with tablets [19] that contain these sensors already. At the same time a larger system was needed beside the interaction with the goal-block, as the teachers input is crucial for the children that are underachieving or working toward a lower level of high school education. Therefore tablets are used to record the reflection as part of the system, this way the reflections can be saved in an online database and constructive feedback can be given through the same system.

Whereas the methaphorical plant of StepOn 1.0 still exists in StepOn 2.0 with the same

purpose this next version has better formulated and more in depth reflection questions based on [2, 5, 12] more over the approach can be read in the "Theory and related work" section of this paper. The reflection questions can be found in Appendix F.

QUALITATIVE OBSERVATIONAL STUDY

The main goal of the observational study was to explore how the possible design decisions regarding the manner of collecting reflections, affected the quality of the reflections and the workload of the teachers. With the workload being evaluated by two factors, F1) the duration of the assessment of the reflection (measured) and F2) the preference of the teacher (which way of capturing the reflection was the easiest to asses and would they prefer to always asses). The quality of the reflection was measured by 'grading items on a list'. The secondary goal was to evaluate the difficulties of working with the blocks and reflection questions and define the opportunities and needs for a redesign (StepOn 3.0).

Initial research set up

The research is conducted in a primary education group 8 (children aged 11-12). Since the primary school has two groups 8 there are 57 children involved in the research. The research is conducted over 6 days. Each day the children work on a design project for forty minutes (without explanation or set up time) and they reflect upon the progress for 15-20 minutes (including handing out iPads and sending the reflections etc.) The first day the children work on the project half an hour longer as there is a theme introduction. The same holds for the last day as we planned to have an evaluation of the tool.

GROUPS AND LEVELS

The children are divided in groups based on the educational level they will follow the next year in high school. The 'citroen' groups being the children going to the highest level of education (havo and vwo); the 'appel' groups being the children going to the lowest levels of education (vmbo basis, vmbo kader) and the 'bosbes' groups consisting of the children going to the education in-between (vmbo gemengt en theoretisch). There are thee appel groups, four bosbes groups and seven citroen groups (adding up to fourteen groups).

Making all children work on their own level assures that all children have to engage in the project and actively participate. There are no children that can lift on the efforts of others and it assures that the level of reflection is not just held up by the one student that has a talent for it.

RECORDING THE REFLECTION

The three different ways of recording the reflection are randomly assigned to the groups. Each of the levels (appel, bosbes, citroen) have at least one group recording with video, one with audio and one with the photo method.

Children reflecting together on an iPad.

THE DESIGN CASE AND HAND OUTS

In several co-creation sessions with group 8 teachers a design-based learning activity was set up. The activity is based on a method taken from the curriculum: Wijzer! [21] This method proposes a week at the end of each chapter where geography, history, biology and tech come together. The first chapter teaches about food and was used as the subject of the design case. After an introduction to healthy food and the new "schijf van vijf" (a tool to help eat healthy) the children were introduced to the design case: Having more people buy healthy food. Every group had the following learning goals: 'What is healthy food' 'what makes healthy food possible' 'how can we stimulate healthy eating' and 'going through a design process' as group goals. The children got an introduction to the design process, in which they were also shown solutions created by TU/e students who worked on almost the same design case (stimulating healthy eating) at the end they were explained how to work with the tangible goals.

Children working on the healthy food project.

After the introduction the children get to pick an individual goal their selves. Most children picked a goal from the learning line "leren leren"[4] that they had to work on.

This means that each child has to monitor and reflect upon five goals. (Four group goals and one individual goal).

The design process followed is based upon a combination of the process described in Design-a-thon (Beamer, 2014) including introducing a theme, research, idea time, sketch & prototype, present & reflect; the process described by the d.school group at Stanford using the steps: empathizing, defining, ideating, prototyping and testing; and lastly the process described in Leidraad onderzoekend en ontwerpend leren [22]. Combining the described processes results in a process that consists of: 1) introducing a theme, dividing the goals in steps and formulating the problem 2) think of ideas 3) select ideas and make a plan 4) build a prototype 5) test 6) present or redesign. After every step the children reflect.

The children get the following materials handed out: 1) Inspirational sites and movies to look at for inspiration (the amount of information given is based on the group level). These can be found in appendix E 2) Brainstorm techniques (handed out on day two. These can be found in appendix G. 3) Reflection questions which can be found in appendix F. 4) Evaluation forms which can be found in appendix I.

PROTOCOL FOR INTERVENTION

When there are difficulties and the children need support the protocol for interventions can be used: The teacher can always step in to explain something again or to help children out in their project. A teacher cannot intervene during a reflection but can explain reflection questions or used terms so the children understand them better. Questions can always be answered.

ASSESMENT AND DATA COLLECTION
The teachers and researcher asses the quality of the group reflections by using the forms found in appendix H(2). The form used for the individual reflection assessment can be found in appendix H(1). Evaluation forms used for qualitative analysis of the tool are filled in after the last lesson and can be found in appendix I. An annotated photo-report of the study and design choices regarding StepOn2.0 and StepOn1.0 can be found in appendix B.

Alterations in research set up

REDUCING THE FIVE GOALS TO ONE GOAL
During the first day of the research many children experienced a lot of difficulty. When speculating about why this is possibly, it can be due to the newness of everything (e.g. a design approach, the goals and a different way of reflecting). And the amount of information they had to process on top of that.

Splitting up the goals in smaller parts (not being parts you have to keep in mind but steps that you help work towards achieving the goal) was very difficult and took more time than expected. Therefore the first day we decided to have no reflection time. (As can be seen in the results, solutions are proposed to this problem). The second day it turned out that monitoring all five goals at the same time was even more difficult. Therefore it was decided to continue with one goal. 'Going through a design process' and having children reflect and focus only on this goal and those steps.

Consequently everyday (4 days) only the group reflections on this goal were assessed; two teachers and one researcher asses the same 14 groups comparing the results and averaging them out. Therefore only the assessment form found in appendix H(2) is used.

ALTERING REFLECTION QUESTIONS
The reflection questions were altered after day two as well. Especially the reflection questions about assumptions were very hard for the children to understand. Although the children understood the meaning because of an explanation of the questions the words didn't offer any support. Reformulating the questions could offer this support. The new reflection questions can be found in appendix J. An annotated photo-report of the study and design choices regarding StepOn2.0 and StepOn1.0 can be found in appendix B.

After the alterations the experiment ran smoothly.

RESULTS

Reflection quality
The grades children get for their reflection in this assessment are based on the filled out assessment forms by both teacher and observer. Both forms are averaged to come up with a grade. The assessment form consists of ten questions that can be graded 1 to 10. This creates overall grades for the children ranging from 1 to 10, and specific grades for parts of the reflection. Reflections are assessed on apprehensibility, overall strength, balance in positive and negative aspects, recognition towards preconceptions, ability to recognize learning strategy, adaption of the planning when needed, personal assessment of current task and looking to the future, teamwork on reflection, discussion of reflection. Figure 1 summarizes the overall reflection grades the children got.

Average score quality
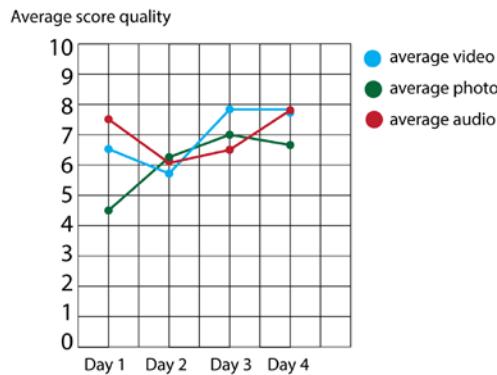
Figure 1

A drop can be seen on day two in the video and audio group, this drop is due to lack of time the children had to reflect that day. This influences the quality of the reflection drastically. Not taking this day into account the video seems to be the best option considering the quality is highest 2 out of the 3 remaining days. It is interesting that the photo group gained quality when there was a lack of time to reflect.


Overall strenght reflection
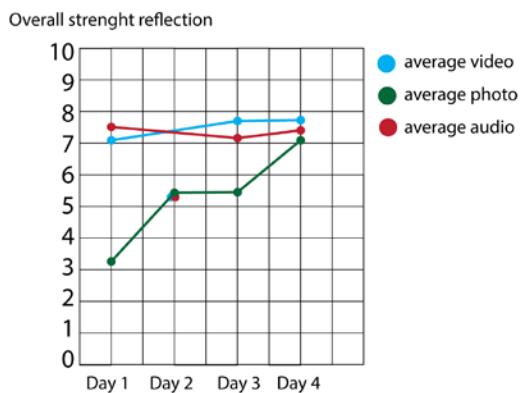
Figure 2

Taking a closer look at the overall strength of the reflection confirms this assumption. See Figure 2. The video group exceeds in reflecting in depth but the audio group comes close to achieving the same quality.

Looking at the score of each group individually, figure 3, logical continuation of growth can be found for the video group. The audio group seems to have trouble performing and achieving the same quality each day. The reflections of the photo group vary extremely in quality from day to day.

Average score quality video

Average score quality audio

Average score quality photo
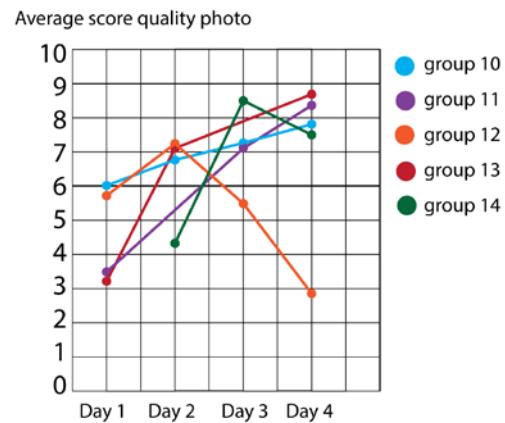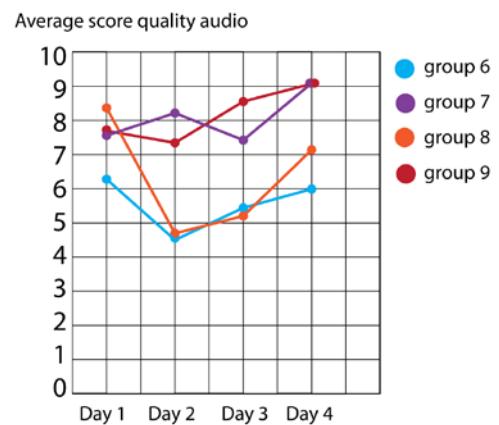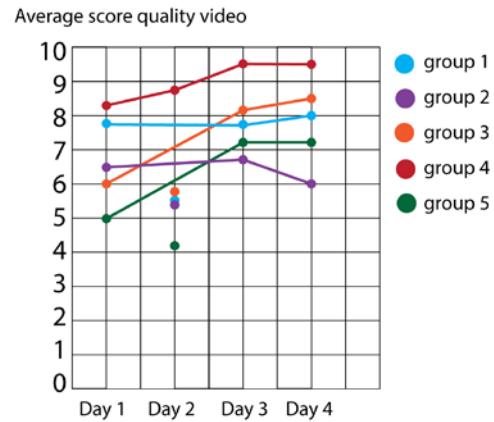
Figure 3

Laying these graphs over each other I create an overview. In this overview it can be seen that the video group scores constantly higher than other groups. See figure 4.

Score of all groups

- group 1
- group 2
- group 3
- group 4
- group 5
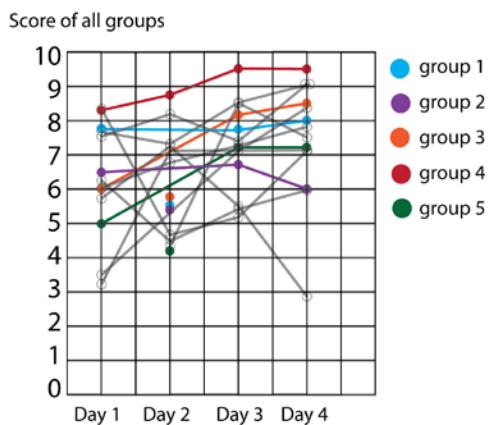
Figure 4

Children in the video and audio group also score higher on the discussing their decisions and reflections with each other; with no significant difference between the groups.

Numbered results can be found in appendix K.

The child perspective on the tool
In 'Alterations in research set up' I talked about two changes that were made during the research. Almost all children named the change in this set-up in their evaluation. They reckoned that the changes that were made increased the project's understandability (Only working with one goal to monitor and using easily formulated reflection questions that divide bigger questions in more steps).

At the evaluation forms 72,0% (n =54) of the children expressed to like splitting up a goal in steps due to the clarity it created.

81,4% (n =54) of the children enjoyed working like this because they had to work in teams and collaborate.

14,8% (n =54) of the children reported the reflecting as very difficult. The children reporting this were not particularly coming from one level but rather spread out through the three levels. The reasons for this difficulty vary from finding answering the questions difficult and finding it hard to concentrate on

the reflection for such a long time. Most children answer the question with an answer more related to the second reason. 18,5% (n=54) also pointed to the reflection as being the best thing about the tool, as it was more elaborate and guiding the subject of the reflection.

59,2% (n =54) of the children reported to feel as if they learned a lot, while 37,5% of this 59,2% (with 59,2% being the 100%) does not have this feeling often when participating in other courses.

To improve working with the tool they offered the two unique suggestions: decorating the goal stone, trying out different ways of recording the reflection so they could decide which way they liked best. Another, more named, suggestion being to only reflect using video as they expected to like this better.

'When you look at what you do normally, did you approach this project differently?' 'I worked in steps, I never work in steps. I learned that I have to do that more often, I stress a lot less if I do.' – Child in group 8

The teacher perspective on the tool
Teachers named the tool as intensive, modern/ using new thinking, informative for teacher and child, stimulating autonomy and teaching executive functions. They recognized more depth in the reflections and believed the tool to have stimulated this.

The time the teachers spend assessing from shortest to longest are as follows: 1) photo & text 2) audio and 3) video. They recommend video as this gives more information such as reactions, involvement and attitude. The children went more into discussions using the video reflection resulting in deeper reflections and more insights.

Weaknesses of the tool were 1) The time the teacher spends on it, mostly collecting the reflections, sorting them out and trying to understand the topic of the reflection (specific part of the goal the children were reflecting on). 2) Difficulty for the children; thinking of

the steps the goal should be divided in. 3) The lack of different levels in reflection. 4) The missing option of awarding children as a group not only based on their performance but on their attitude as well. 5) The absence of an option to ask supplementary questions.

They recommended to use video for elaborate and in depth reflections and use other ways of reflecting in between. Using this approach teachers can intervene during class and reflect on what they are doing at that moment, children can reflect short in small groups or teachers can reflect centrally with the whole group. This saves time as the in-depth reflection is not always necessary and time is scarce in group 8.

Both teachers enjoyed working with the tool and indicated that they would like to work with the tool again.

Observation
Observing the children let to an insight regarding the ease of changeability of the goal. With the paper cards it takes a lot of time to change a step and the children made changes in their planning on paper rather than in their planning on the blocks. This means the steps should be easily changeable while maintaining to discourage playing with the tool.

During a collective session where we showed a good video reflection, on day 3, the class responded immediately naming positive and negative aspects of the reflection. The children seemed to have really learned from the reflection and most children implemented this knowledge immediately in their reflection. Whereas the group that was discussed scored one whole grade higher on the overall assessment of their next reflection. The collective feedback sessions are therefore very valuable and need to be part of the use of the tool.

Overview
In short the results tell us that: 1) Video reflection leads to the best qualitative reflection. 2) Video and audio reflections lead to discussions and more in depth insights. 3)

Guidance is needed to learn how to subdivide a goal. 4) The word choice for reflections should be changeable as it is school dependent (which words do they use). 5) The tool should build up in difficulty. 6) Supplementary questions are needed for some groups to increase depth in the reflection. 7) Reflections should be shorter and only sometimes in depth and long. 8) There should be different levels in reflection. 9) The class should be able to be rewarded as a class and the children as individuals. 10) Awarding should be both performance and attitude based. 11) The reflections should be easy to collect and there should be an overview of the goals and the steps that is easily accessible. 12) Collective sessions of reflection discussions and recaps during class are still needed and should work together with the tool. 13) The tool should be easily changeable but not inviting to play.

Final prototype of one of the groups: a helathy MacDonnalds

Final prototype of one of the groups: a grocery store cart that subdivides products according to the 'schijf van 5'.

DISCUSSION

I presented stepOn3.0 and studied stepOn2.0, both tools aiming at supporting the development of meta-cognitive strategies and creating depth in reflections. I was particularly interested in how the possible design decisions regarding the manner of collecting reflections, affected the quality of the reflections and the workload of the teachers. And the design criteria stepOn3.0 had to follow to be effective in supporting this development in meta-cognitive strategies and achieving depth in reflections.

I found that using video as a recording strategy for the reflections helped to achieve the most qualitative and in-depth reflection. Possibly due to the discussions children had when reflecting and the ability to convey more information in little time. There had to be enough time to reflect otherwise the quality dropped in all reflections but the photo-reflections. This could mean that the photo-reflection is a smart choice when wanting to reflect very short. But this should be determined though further research.

Whereas time reserved for reflecting influenced my results so did the rigidness of the teacher and observer when scoring the reflections; as the reflections were scored at different days.

The teachers scored the reflections according to the level of the child and took the expected quality into account (sometimes consciously and sometimes unconsciously) this could explain that there is only little difference between the highest and lowest quality of reflection.

After day one of the study the reflection questions were changed to simpler questions, this could have influenced the growth after this day. This growth can also be due to the growing more accustomed to the tool and working with the tool.

The children who were the testsubjects had pre-knowledge about reflection as they follow the learning line 'leren leren' [4] The strategies they normally use to reflect can be found in the introduction. This could have influenced the overall quality of the reflections but influences this for every child the same. It should however be taken into account when designing for children with little to no knowledge about reflection. The same holds for the teachers. As both teachers came from one school this means the results cannot automatically be generalized to all children aged 11-12 and group 8 teachers. But one could assume that the design needs are largely the same for both groups as both groups eventually follow the same curriculum everywhere in the Netherlands.

CONCLUSSION AND FUTURE WORK

Reflection is a vital part of the change in primary education that is ongoing in Europe and especially the Netherlands. I presented StepOn, a tool that supports the development of meta-cognitive strategies and achieving more depth in reflections and lessons learned about the design of a reflection and metacognitive strategy support tool. Clarity, guidance, combining different ways of reflection, dispersion of levels and time are keywords. Video recording seems to be the best strategy for achieving qualitative reflections. Future work should include testing StepOn3.0 and verifying the claims, regarding the design needs, which were made in a new situation.

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Appendices

StepOn

Reflection

This semester I strategically implemented my technology and realization skills throughout the prototyping process considering different perspectives and considering when it adds value and when it does not. I deepened my user study and approach knowledge and skills looked at my prototype from a business perspective and developed math, data and computing skills by analyzing user study data. I learned to understand the value of my prototype using research strategies and learned how to state thorough design criteria.

I believe a good design process should involve the user in a meaningful way. This project I did this by defining a very specific target group and using experts about this target group in my design process. But even more important I did a proper user study. **Testing for a longer time with many participants helped me understand the needs of my user and the value of my prototype for the user.** Understanding the value was very important for me because it helped me look at my work from a third-person perspective rather than a first-person perspective. This third-person perspective is critical as **more perspectives than yours need to be highlighted to create value for society and add meaning to design**.

I integrated research in my design process and this was a strategy that worked really well for me. Although the research itself could be improved using validating strategies such as the standard deviation in the analysis next to my own interpretation of the analysis; it worked really well to **use more observers to validate and explain the results**. I started the semester wanting to combine qualitative and quantitative research and design but ended up with a more qualitative approach when researching. I preferred this approach as this also meant **changing the set-up when it was needed to get results that could inform my design choices.** The quantitative approach came in through the measurement methods. **Using both helped tremendously in explaining the outcome of the design.** The most important was the amount of participants this makes the conclusions more believable. Whereas I expected that more tests would help me make hard conclusions it was o**ne more intensive test that helped me make those conclusions**. In the future I **want to keep combining both research and design with the focus on the design but with research as a supporting strategy**. Therefore I will choose the master track in constructive research at the TU/e. This direction is not only my preferred way of designing but also a big expertise area of the department of Industrial Design.
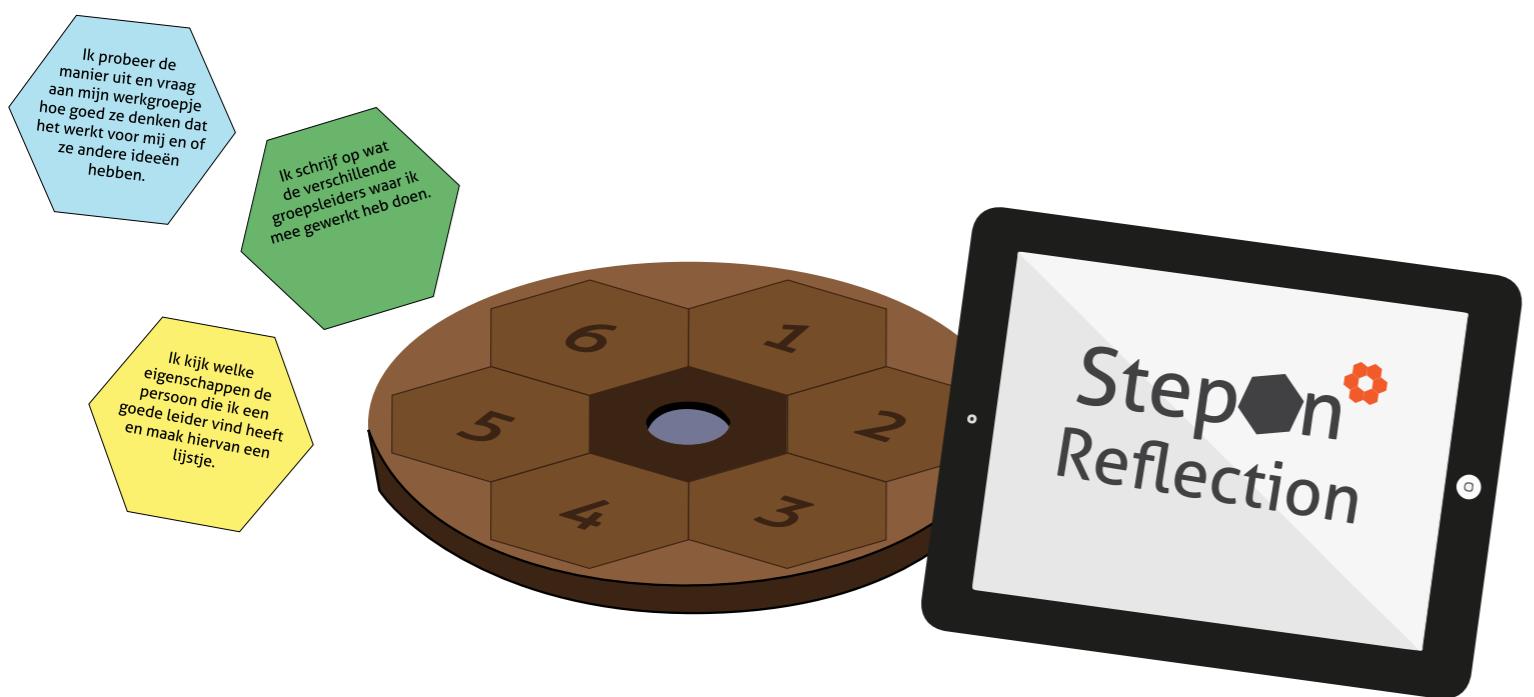
At the start of the project **I defined design criteria based on my vision on reflection and on my overall vision**. These guided me through the process; **I used research and expert meetings to adapt these criteria and used the different perspectives to add depth to these criteria.** I acted as a **design mediator** keeping in mind costs, value and needs while still using my own vision and approach. I **am most content about how I defined an opportunity where I could innovate in the research paradigm 'reflection'.** Using previous research as guidelines helped me be **more convinced of my own knowing and skills** and therefore is most definitely a way of working that I need to continue. On the other hand I started making quite late while this **making helps me think and deepen interaction now the interaction of the prototype is quite boring;** therefore I need to combine the two in the beginning

Pressure cooker

REFLECTION TECHNIQUES AND LEARNING RESULTS

WITH ELEMENTARY SCHOOL STUDENTS

Deborah Pelders
Michelle van Lieshout
Bernice d'Anjou
Dennis Rietveld

Materials

> **What's the difference in direct learning results of a design-based learning activity between reflection-on-action and reflection-in-action within the target group of children from 10 to 12 years old?**

REFLECTION-ON-ACTION

☐ **Reflection**
'Investigating one's own action, analyzing causes and effects, and planning future steps'[1]

☑ **Critical reflection**
'Questioning of contextual aspects taken-for-granted' [2]
'Assumption-hunting' [3]

REFLECTION-IN-ACTION

■ **Reflection-in-action**
'An on-the-spot process of surfacing, testing and evaluating understandings, intrinsic to experience'4

1. EXPLANATION/ DESIGN CASE

2. MAKING & TESTING

3. EVALUATION & RESULTS

CASE: A new skyscraper is going to be build in Dubai. This skyscraper is provided with an airport at the roof. You are going to build the first model of this tower. Make it as high as possible and ensure that it is strong enough to hold the airport.

SCENARIO 1:

| Building reflection-in-action | Building reflection-in-action | Final Build. reflection-in-action |

SCENARIO 2:

| Building reflection-in-action | Reflection reflection-on-action | Final Build. reflection-in-action |

SCENARIO 3:

| Building reflection-in-action | Critical Refl. reflection-on-action | Final Build. reflection-in-action |

KNOWLEDGE ←————————————————→ SKILLS

| Critical-reflection | Reflection | Reflection-in-action |

Critical Reflection

» Welke vormen heb je gebruikt en waarom heb je die gebruikt?

» Welke vormen denk je dat het sterkste zullen zijn? Waarom denk je dat deze het sterkste zijn?

» Waren er vormen die niet zo sterk waren? Zo ja, waarom denk je dat deze niet zo sterk waren?

» Was je toren hoog / viel hij om…, had je dit van tevoren verwacht? Waarom?

» Heb je vormen gebruikt die je al eens eerder in het echt hebt ge zien? Zo ja, welke? (en daarna waarom?)

» Wat vonden jullie van het samenwerken? Wat ging er goed en wat ging er fout? Waarom ging het fout/goed?

Reflection

» Wat hebben jullie gedaan / hoe ben je begonnen?

» Is er iets fout gegaan of gaat het juist heel goed?

» Welke vormen hebben jullie gebruikt? Zouden jullie er andere kunnen bedenken?

» Wat zou je nu anders doen / hoe ga je het dadelijk beter doen?

» Toen jij … deed, wat gebeurde er toen? Waarom denk je dat dat gebeurde?

» Wat vonden jullie van het samenwerken? Hoe kan het beter de volgende keer?

Hulpvragen

Noem eens 4 vormen. Probeer deze 4 vormen eens na te bouwen met papier. Bouw nu een hoge toren die stevig genoeg is.

TV time als inspiratie:

https://www.youtube.com/watch?v=Wp5lzvzQy2g

REFLECTION TECHNIQUES AND LEARNING RESULTS

WITH ELEMENTARY SCHOOL STUDENTS

Deborah Pelders
Michelle van Lieshout
Bernice d'Anjou
Dennis Rietveld

CONTENT RESULTS

SCENARIO 1 - BUILD, BUILD, BUILD

- Highest tower at the end
- Merely focussed on reflection-in-action (unconscious reflection)
- Answered all quiz question correctly

This method is a very natural way of reflecting. The children changed concepts and eventually showed that they reflected on several decisions through trial and error.

"Waarom we niet met driehoeken gebouwd hebben? Rondjes waren even sterk en veel sneller te maken."

SCENARIO 2 - BUILD, REFLECT, BUILD

- Lowest tower at the end
- Focussed both on reflection-in-action and reflection-on-action
- Answered all quiz question correctly

The method of reflection was to vague. We assume that children are not aware of their own learning and therefore are not triggered to further reflect upon actions.

Waneer viel jullie toren om? "Na 2 minuten ongeveer"

SCENARIO 3 - BUILD - CRIT. REFL., BUILD

- Second highest tower.
- Focussed both on reflection-in-action and reflection-on-action
- Answered all quiz question correctly

This method gave a substantiated learning result. Children could explain their decisions. They were however not able to connect this knowledge back to practice.

"kleine cilinders zijn sterker want die kun je minder makkelijk induwen"

FINDINGS

#1 Within the last round, all groups had created a higher building than their previous try

#2 No conclusions on the area of knowledge and practical implementation

#3 We received valuable insights, but can not draw conclusions. We do however have interesting directions for future work

#4 Every group got the maximum score from the quiz. We therefore can't draw any conclusions on the area of 'knowledge'.

RESEARCH RESULTS

The groups could see each others work and profited from each others reflections. More reliable results can be achieved through screening.

Clear explanation to the class; what are we going to do and what is the learning goal of this activity? Make sure this explanation is the same for all groups.

Enough knowledge about your targetgroup is important. We wrongly estimated the students, as we were given a higly intelligent group.

Within the setup of the experiment, a clear 'desired result' needs to be determined. In our test we underestimated the importance of this which led to less trustworthy results

A starting test could help to determine the learning result at the end. We were eventually not able to tell whether they already knew information that they presented after the test.

A B

What did we learn from doing this research?

Take-away from the pressure cooker to take into account the next user test / study;

- Evaluating the characters of the children in the group to be able to include or exclude certain conclusions.
- Look for a different explanation for what you see, how can you belie your own hypothesis. You do this to look more critical towards your work.
- What is new? Why is it important that you research this (find a new area to cover). And show what is known already to substantiate this claim.
- Detail the research question so you leave out all possibilities of misinterpretation.
- What is not happening that you might have expected? This is an important question that can give you insights in what is missing in your research / definitions or interpretations.
- Take the environment into account; let groups not see each other.
- Explain your plan clearly to the children and that the explanation is the same every time.
- Use pre-knowledge of your target group to design the experiment as this can make or break your design. And also, know what they know beforehand.

I observed some things that did or did not happen which interested me;

- Children did not link the 'why' to the 'what' their selves, in other words they did not go from reflection to critical reflection their selves.
- Children responded differently to different ways of reflecting.

StepOn 1.0 and 2.0

StepOn 1.0

Shape explorations regarding StepOn 1.0 can be found here. I explored interactions you could create by combining shapes and various simple shapes that could be a basis for the goal-shape. I looked at goals with only the goal itself having a physical version and at goals with the goal and the steps having being part of the physical version.

On the next page I looked at vacuüm forming and a few more shapes.

Cool base if only the goal itself is visible, asks attention, goal itself is very visible because of the not 90 degree edge.

You go with your hand through your own writing and wipe it away / out.

Top is very visible, quite big for only the goal and writing round for the steps is not too handy.

Opening up a goal to reveal it's steps.

Not all steps are too visible and writing round is quite hard.

Vacuum forming

Very bendable! Not too handy, a strong material that last long is needed. Thicker plastic might work.

Easy to write on, a bit boring.

I like the shape as it has seven easy visible sides (1 for the goal and 6 for each of the steps to achieve the goal) 6 steps are also the amount of steps of the various design processes described in the paper have which seems a smart choice. The sides are not too visible when the block is placed on a table (90 degree edges).

StepOn 2.0

I explored various interactions and a few more shapes for StepOn 2.0. I used the basic shape for the study / user test I carried out.

Indicating which step you are at.

Integrating camera or audio and a screen. Making the sides buttons that can be pressed to see the steps on the screen. Using the screen as touch screen to write or draw.
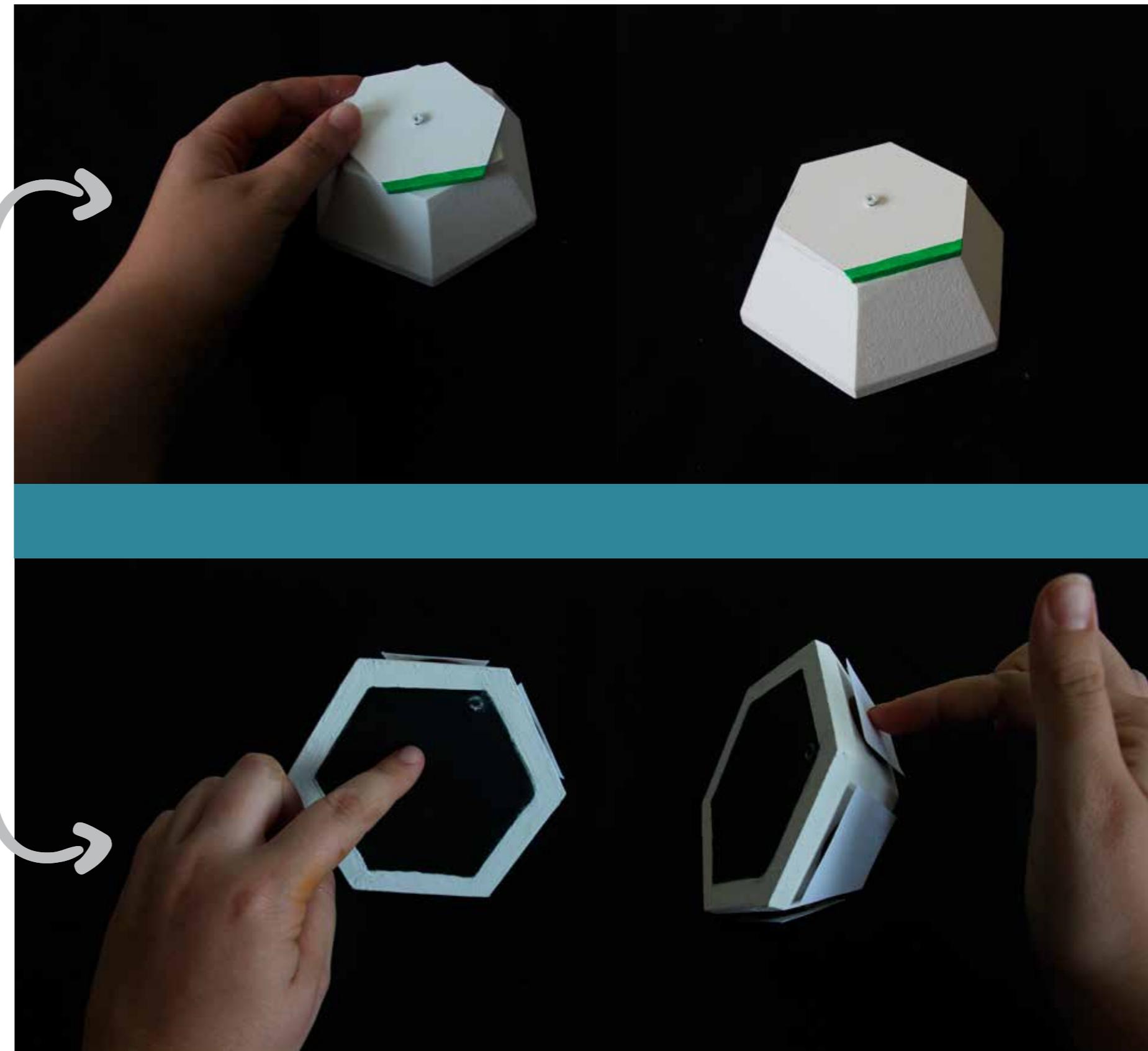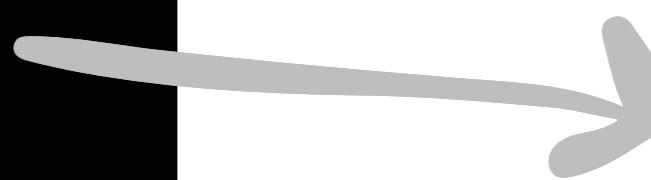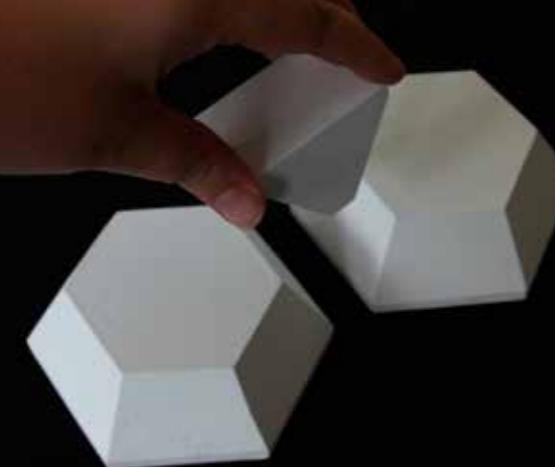
Indicating connections between goals or steps.
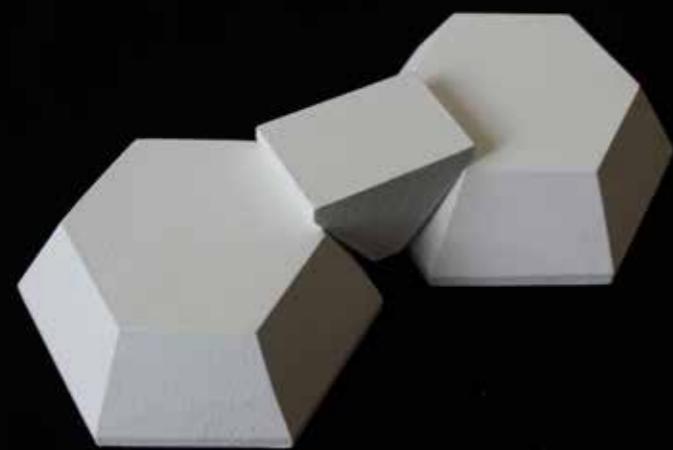
Opening up a side to reveal more information or to show your progress (open means done).

Trying out different holds.

Puzzle style combining shapes to create a goal and the steps. Turning the wheel to indicate the time you will spend doing it.

Shaping the tool to create a better hold when actually filming / recording.
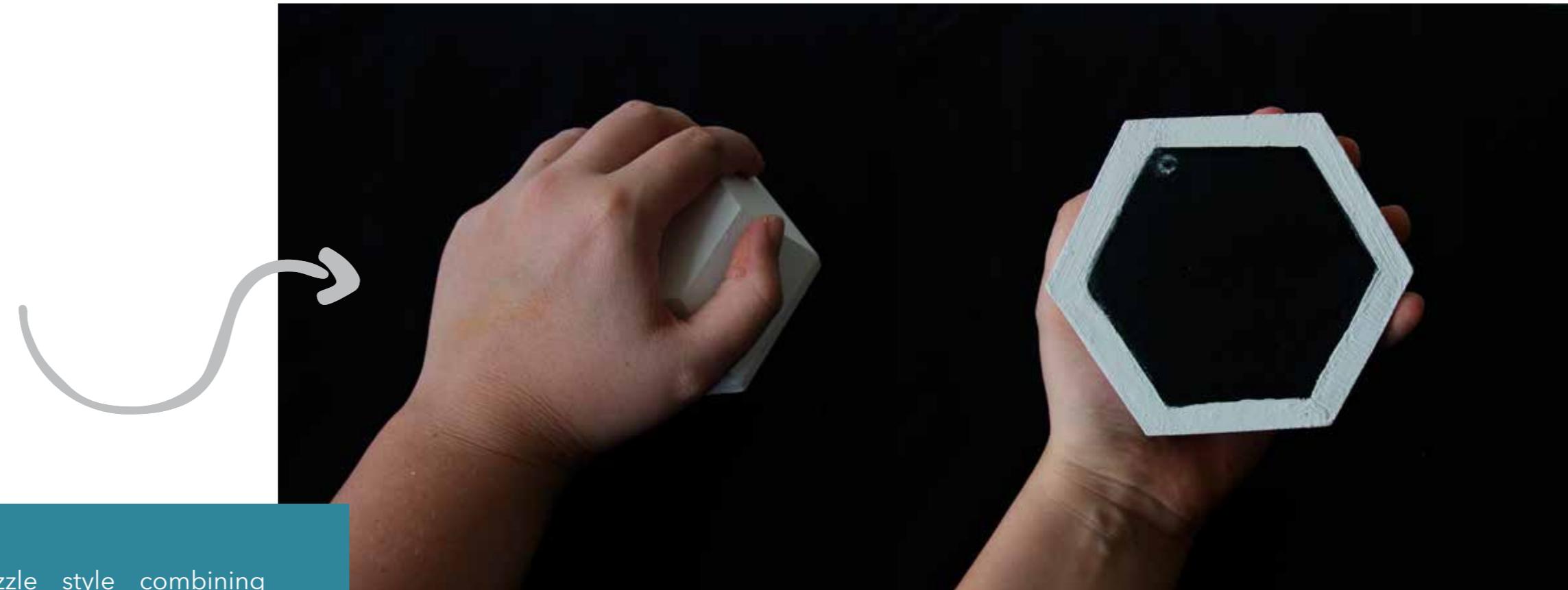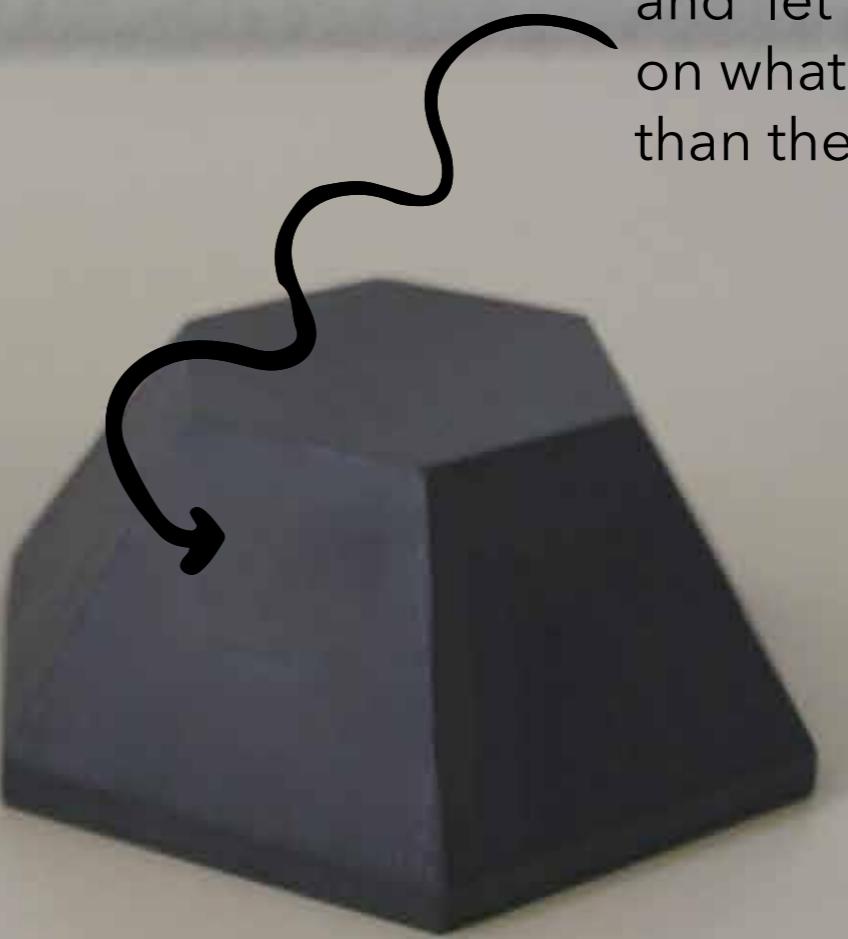
Grey to not ask for attention and let the children focus on what is on the too rather than the tool itself.

When the children split up the goals their selves the steps they split it up in are indeed necessary to be what they want to be but not to become what they want to be. The steps do not work on the long term. An indication or choice of steps is needed to learn to work this way.

Making
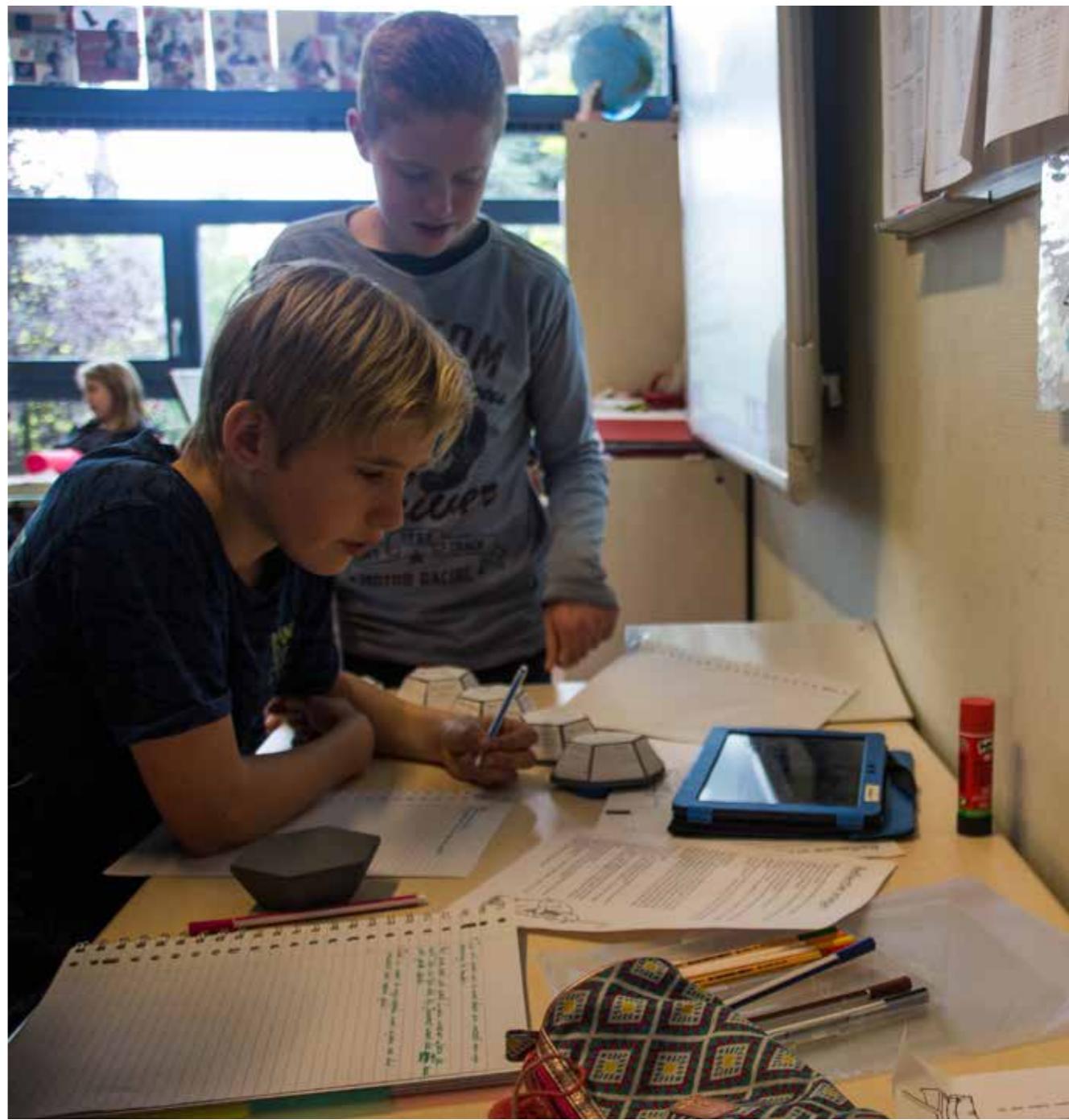
Reflecting

Prototypes

Test & Present

StepOn 3.0

New idea prototype

New idea prototype

Write on the white part with half of the goal steps already written out on the coloured part.
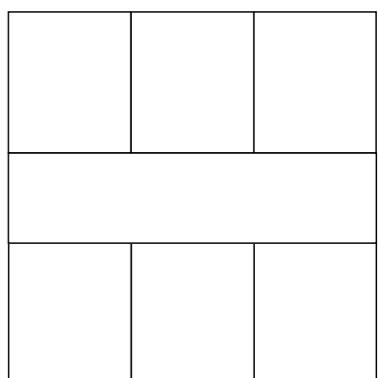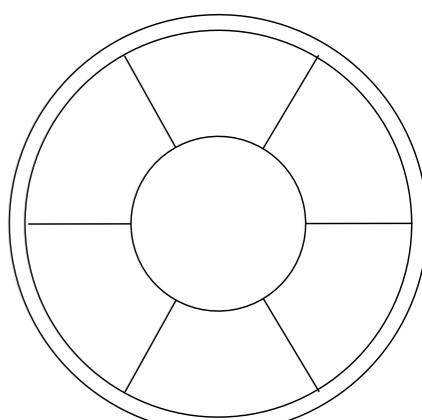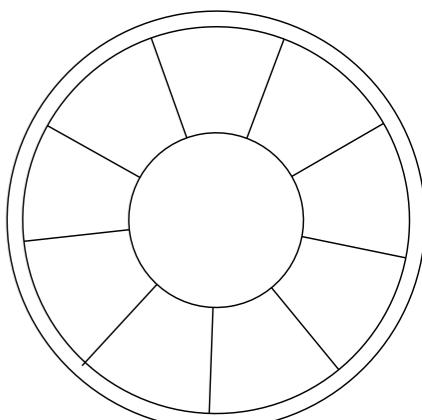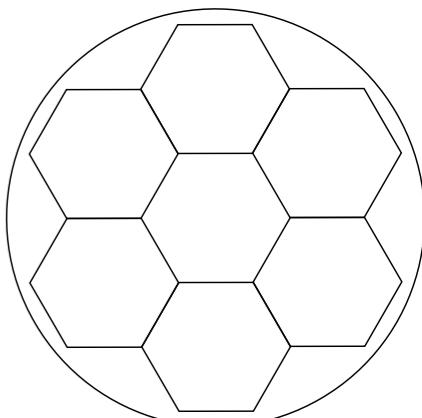
Prototype before (re)painting

Ik wil een goede groepsleider worden

Ik vraag advies aan een goede leider, wat doet hij of zij normaal?

Ik beantwoord de vraag: welke eigenschappen moet ik ontwikkelen of welke eigenschappen ik moet inzetten om een groepsleider te zijn.

Ik schrijf op wat de verschillende groepsleiders waar ik mee gewerkt heb doen.

Ik kijk waar het lijstje met mijn eigenschappen hetzelfde is als die van een groepsleider.

Ik kijk welke overeenkomsten goede groepsleiders hebben.

Ik vraag advies aan een goede leider, wat doet hij of zij normaal?

Ik beantwoord de vraag: welke eigenschappen moet ik ontwikkelen of welke eigenschappen ik moet inzetten om een groepsleider te zijn.

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Ik kijk welke overeenkomsten goede groepsleiders hebben.

Ik kijk waar het lijstje met mijn eigenschappen hetzelfde is als die van een groepsleider.

Ik kijk welke eigenschappen de persoon die ik een goede leider vind heeft en maak hiervan een lijstje.

Ik maak een lijstje met mijn goede en slechte eigenschappen.

Ik wil een goede groepsleider worden

Change
the
goal-steps

Explore treatments and coloring

Ik test het idee door een interview met 5 mensen.

Ik wil ♡ een ontwerpend proces doorlopen met als richting een muizen overlast bij bejaarden

Ik ga samen met de mensen waarvoor mijn idee bedoeld is kijken over de belangrijkste dingen zijn waar ik dan moet denken die zij nodig hebben

Ik maak tekeningen van het idee om het uit te leggen

Ik bedenk veel ideeën door te brainstormen

Ik bedenk veel ideeën door de cherry picking brainstorm variant te

RFID chip recognised by the base. Knowing of which child or group the goal is.

Gradual build up in difficulty. The goal will first be split up in steps that are already written out. Later, when a child to work this way, the goal step is partly proposed. Until children can all do it on their own.

Logo exploration

Reflection part

Teacher

Child

Puzzle | New reflections | Children | Averages | Question selection

Overview Sam Janssen

Stepon

view feedback

6

Hello Josephine!

The teacher has given you feedback on your last reflection, do you want to view it now?

yes | no

Earned this year

START REFLECTION NOW

Stepon

Where can I use what I learned today in the future?

stop

Stepon
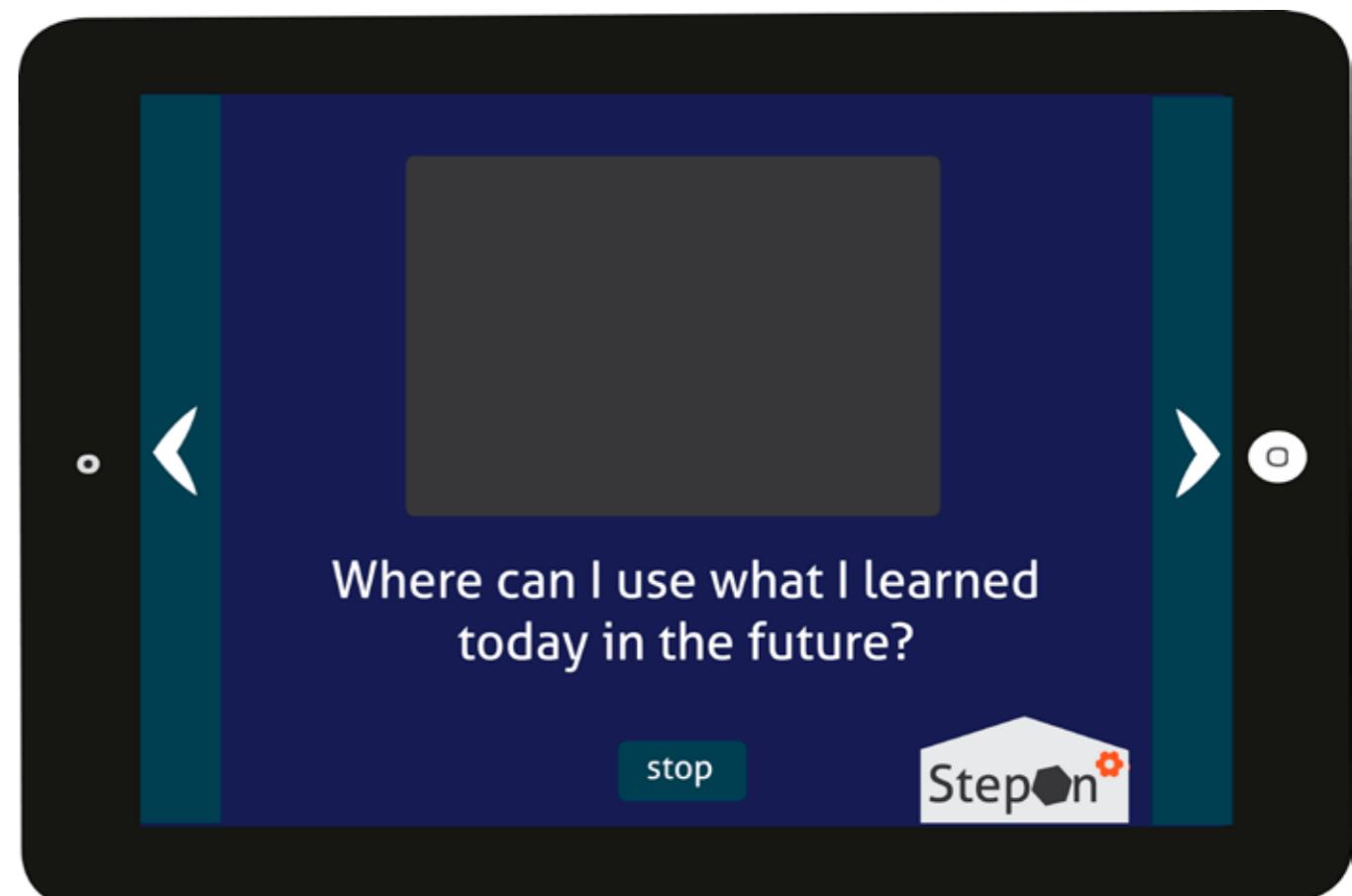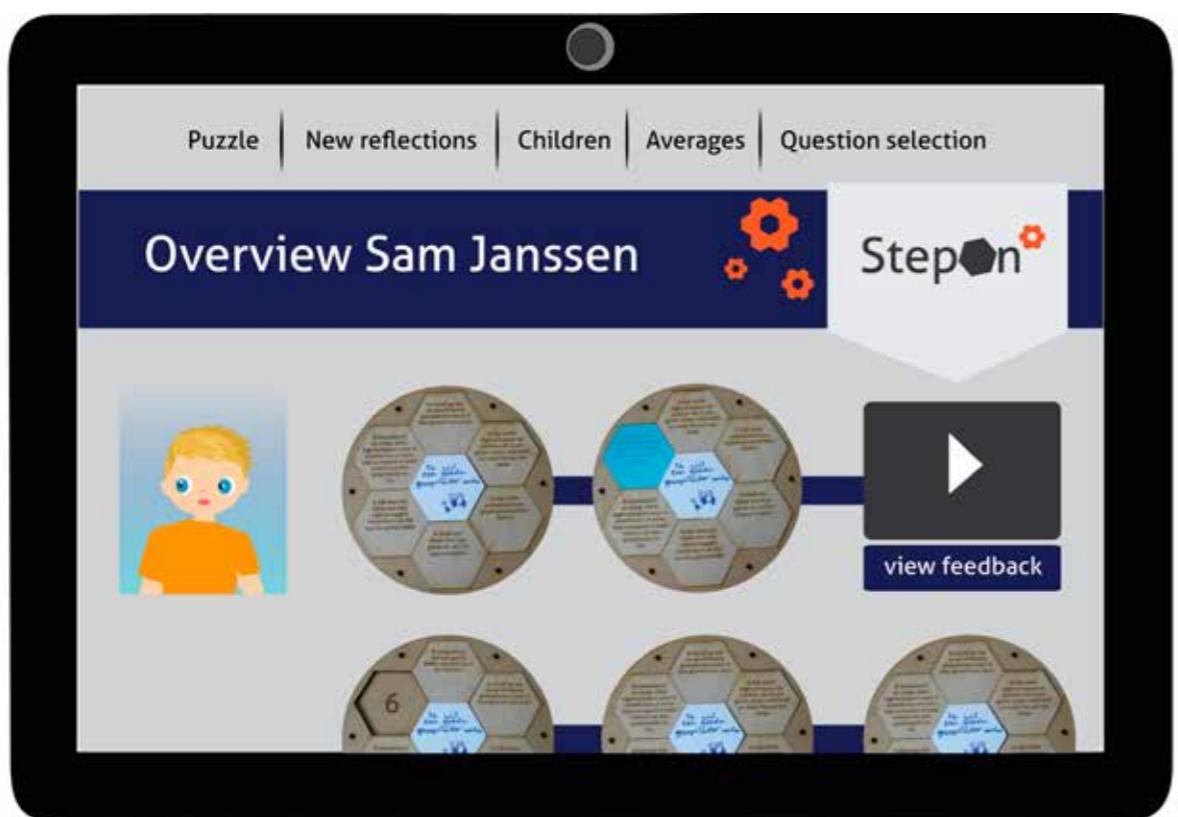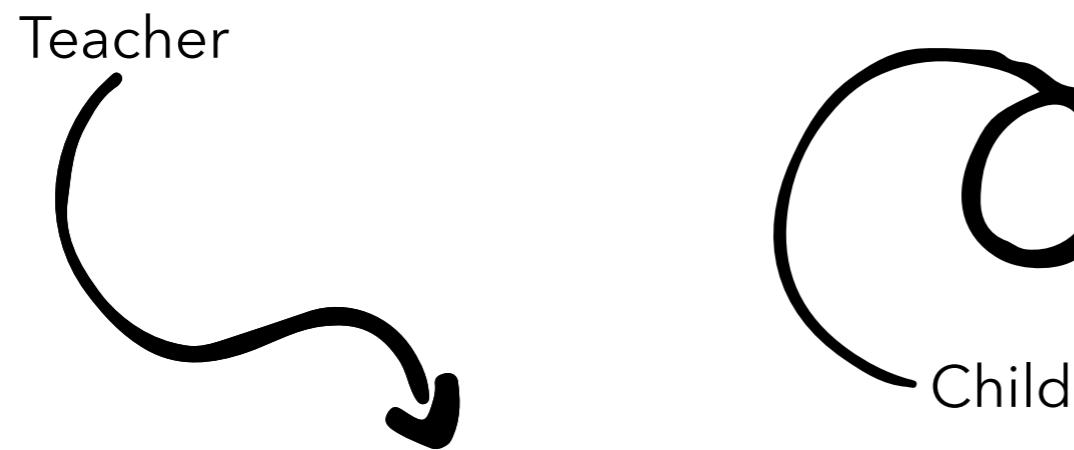
Find a better readable version and close of the goal and steps with a lid so the written block steps do net get wiped out.

Add colour for easier recognition.

```
// Coded by Michelle van Lieshout, student at
Carnegie Mellon University and Eindhoven Uni-
versity of Technology.
// The sketch reads out a received UIC code that
is received in the serial port (send there by ardui-
no code) and is developed as part of the StepOn
design project.
// StepOn is a design project for children to
support metacognitive strategie learning and
reflection as part of my final bachelor project at
the TU/e.
// The code combines names that should be
shown on the screen with RFID tags. And the
code takes 'pictures' with a webcam of something
students filled in.
// This code is last revised on 3 June 2016

import processing.video.*;
import processing.serial.*;

Capture webcamFeed;
boolean takePicture = false;
int x = 0;

PImage bg;

Serial myPort;
String readSerialNumber = "00 00 00 00 00";
// child 1 = "A4C4E152";
// child 2 = "04C5E152";
// child 3 = "14C6E152";
// child 4 = "74C6E152";
// child 5 = "54C7E152";
char c1 = readSerialNumber.charAt(1);
char c2 = readSerialNumber.charAt(2);
char c3 = readSerialNumber.charAt(4);
char  c4 = readSerialNumber.charAt(5);
char  c5 = readSerialNumber.charAt(7);
char  c6 = readSerialNumber.charAt(8);
char  c7 = readSerialNumber.charAt(10);
char  c8 = readSerialNumber.charAt(11);

void setup() {
  bg = loadImage("background.png");
  size(1900, 980);

  webcamFeed = new Capture(this, 640, 480);
  String[] devices = Capture.list();
  println(devices);
  webcamFeed.start();
  background(bg);

  myPort = new Serial(this, "COM11", 9600);
}

void draw() {
  //  boolean takePicture = false;
  if (webcamFeed.available() == true) {
    background(bg);
    redraw();
    webcamFeed.read();
  }


  c1 = readSerialNumber.charAt(1);
  c2 = readSerialNumber.charAt(2);
  c3 = readSerialNumber.charAt(4);
  c4 = readSerialNumber.charAt(5);
  c5 = readSerialNumber.charAt(7);
  c6 = readSerialNumber.charAt(8);
```

```
  c7 = readSerialNumber.charAt(10);
  c8 = readSerialNumber.charAt(11);

  while (myPort.available () > 12) {
    String val = myPort.readString();
    // (val.length(12)); 12 digits form the serial
number.
    readSerialNumber = val;
  }


  //check which RFID tag is scanned and print the
right name
  if ((c1+""+c2+""+c3+""+c4+""+c5+""+c6+""+c
7+""+c8).equals("A4C4E152")) {
      println("child 1");
    textSize(82);
    text("Sophie de Jong", 175, 800);
    fill(0, 102, 153);
  } else if ((c1+""+c2+""+c3+""+c4+""+c5+""+c6
+""+c7+""+c8).equals("04C5E152")) {
      println("child 2");
    textSize(82);
    text("Liam Smit", 190, 800);
    fill(0, 102, 153);
  } else if ((c1+""+c2+""+c3+""+c4+""+c5+""+c6
+""+c7+""+c8).equals("14C6E152")) {
    println("child 3");
    textSize(82);
    text("Noah Meijer", 190, 800);
    fill(0, 102, 153);
  } else if ((c1+""+c2+""+c3+""+c4+""+c5+""+c6
+""+c7+""+c8).equals("74C6E152")) {
    println("child 4");
    textSize(82);
    text("Zoë Vos", 195, 800);
    fill(0, 102, 153);
  } else if ((c1+""+c2+""+c3+""+c4+""+c5+""+c6
+""+c7+""+c8).equals("54C7E152")) {
    println("child 5");
    textSize(82);
    text("Emma Jansen", 185, 800);
    fill(0, 102, 153);
  }

  if (takePicture == true) {
    image(webcamFeed, 165, 135);
    takePicture = false;
    if (x < 100) {
      line(x, 0, x, 100);
      x = x + 1;
    } else {
      noLoop();
    }
    // Saves each frame as line-000001.png, line-
000002.png, etc.
    saveFrame("line-######.png");
  }
}


void keyPressed() {
  if ( keyPressed == true) {
    takePicture = true;
  }
}
```

```
//* Arduino code
// * -----------------------------------------------
-------------------------
// * This code uses parts of MFRC522 library ex-
amples; see https://github.com/miguelbalboa/rfid
// * The code is modified by Michelle van
Lieshout, Student at eindhoven University of
Technology.
// *
// * This sketch reads out the UIC code (other-
wise known as serial number) of a RFID tag and
sends it to the serial port.
// * -----------------------------------------------
-------------------------
// *
// * Typical pin layout used:
// * -----------------------------------------------
---------------------------------------
// *          MFRC522     Arduino      Arduino
Arduino    Arduino      Arduino
// *          Reader/PCD  Uno          Mega
Nano v3   Leonardo/Micro  Pro Micro
// * Signal    Pin          Pin          Pin        Pin
Pin          Pin
// * -----------------------------------------------
---------------------------------------
// * RST/Reset  RST        9            5          D9
RESET/ICSP-5   RST
// * SPI SS     SDA(SS)    10           53         D10
10            10
// * SPI MOSI   MOSI       11 / ICSP-4  51
D11     ICSP-4       16
// * SPI MISO   MISO       12 / ICSP-1  50
D12     ICSP-1       14
// * SPI SCK    SCK        13 / ICSP-3  52
D13     ICSP-3       15
// *
//
//
// #include <SPI.h>
// #include <MFRC522.h>
//
// #define RST_PIN       9         // Configurable,
see typical pin layout above
// #define SS_PIN        10        // Configurable,
see typical pin layout above
//
// MFRC522 mfrc522(SS_PIN, RST_PIN);   //
Create MFRC522 instance.
//
//
//
// * Initialize.
//
// void setup() {
// Serial.begin(9600);        // Initialize serial com-
munications with the PC
// SPI.begin();               // Init SPI bus
// mfrc522.PCD_Init();        // Init MFRC522
card
// }
//
//
// * Helper routine to dump a byte array as hex
values to Serial.
//
// void dump_byte_array(byte *buffer, byte buff-
erSize) {
// for (byte i = 0; i < bufferSize; i++) {
// Serial.print(buffer[i] < 0x10 ? " 0" : " ");
```

```
// Serial.print(buffer[i], HEX);
// }
// }
//
//
//
// * Main loop.
//
// void loop() {
// // Look for new cards
// if ( ! mfrc522.PICC_IsNewCardPresent())
// return;
//
// // Select one of the cards
// if ( ! mfrc522.PICC_ReadCardSerial())
// return;
//
// // Read "serial number"
// //  Serial.print(F("Card UID:"));
// dump_byte_array(mfrc522.uid.uidByte,
mfrc522.uid.size);
// Serial.println();
// }
```

Demoday code connecting tags taking pictures

Cost analysis

One kit is made for 20 children and consists of

- 20 boards
- 20 RFID tokens
- 20*10*10 fully described tokens
- 20*30 fill in tokens
- 20*6 open tokens
- Booklet proposal of projects and goals
- Guidelines
- Guideline movies children
- Site subscription (each year)

Each school will get what they ask for (based on their used methods) and the laser cutter will answer these personal needs. The station is more mass produced. The costs of the materials are based on a Google search and are not the cheapest nor the most expensive prices.

Costs materials:
- 20 RFID stickers tokens €26,- for 100   €5,20
- 1 RFID reader   €10,-
- 1 Arduino (nano)   €6,-
- 1 camera   €40,-
- 1 station (wood and plastic)   €30,-
- 2740 tokens (acrylic) 33 acrylic plates (720*560 mm) €2,80 each   €92,-
- Colour foil for 2740 tokens on 46 * (700*400 mm) = (500 mm*1250 mm)*21*€6,-   €126,-
- Whiteboard foil for 300 tokens (20*30/2 + 20*6) 5*(700*400 mm) = 3 rolls of (450*2000) = 3*7,50   €22,50
- 20 boards (wood) = 7 wood plates (700*400 mm) = Mahony 250*250*60mm needed 2 €22,50,-   €45,-
- Cost booklet (printing)   €40,-

Total €416,70
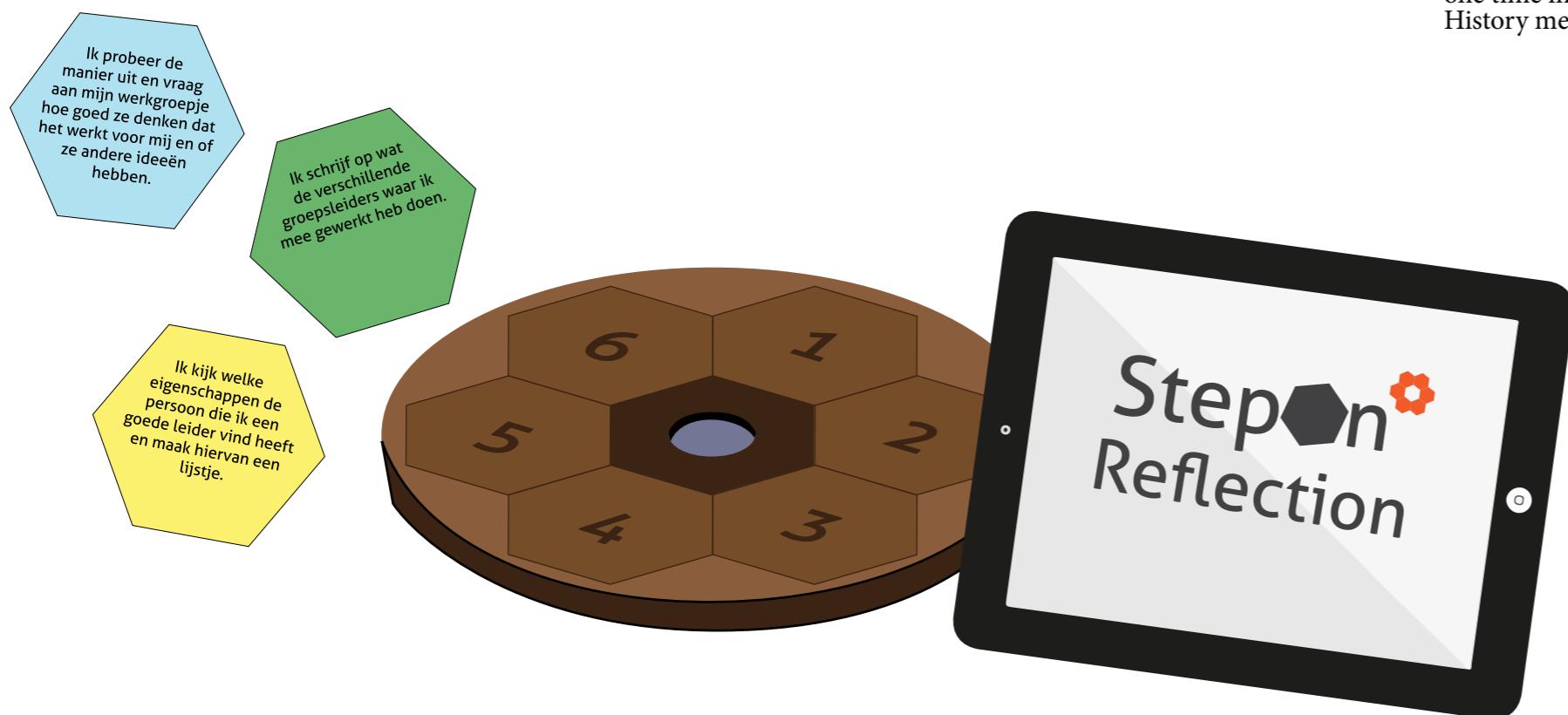
To develop the tool a company with 5 employees should work for one year. This means that each person works 1600 hours. I will pay the employees €90,- / hour

Employees: concept, programming (site), promotion, production, sourcing.
The employees are paid: 5*1600*€90,- = €720.000,- salary

A risk avoidance should be calculated, I take 25% of the salary as this risk avoidance.
€180.000,-

Total: €900.000,-

After one year the company will continue with only 3 employees, keeping the site up-to date.
Employees: promotion, programming, production
Here a risk avoidance of 25% is also taken into account.

Total: €540.000,-

Using a rule of thumb I found [1] with material cost *3 being the manufacturing costs (€1250,1) and material cost *9 being the selling price (€3750,3). That would mean a profit of €2083,5 for each product set.

This comes down to **€187,52 cost per child as a one-time investment** where the tool can be used multiple years. To be able to keep supporting the site a subscription to the site costing €250,- each year for 20 children should be part of the plan. This comes down to **€12,50 per child each year.**

There are 6804 primary schools in the Netherlands. If 40% of these schools buys 1 kit this would pay:
680*€2083,5 = €141.678.0,-

Each year the subscription would pay €680,400,-

In 2015 a Dutch primary school could spend €6.100,- per student for educational purposes [2]. This one time investment and the yearly subscription being not too high. Compared with the Wijzer! History method [3] this is a little more expensive but the physical tool can be used longer.

Profit left after paying employees

First year
€141.678.0,- + €680.400,- - €900.000,- = €200.718.,-

Years after
€680.400,- - €540.000,- = €140.400,-

[1] https://www.ohio.edu/mechanical/design/Resources/Costestimation.pdf **(30 May 2016)**
[2] https://www.rijksoverheid.nl/onderwerpen/financiering-onderwijs/inhoud/overheidsfinancier-ing-onderwijs **(30 May 2016)**
[3] http://goo.gl/HAfRUJ **(30 May 2016)**

Ik probeer de manier uit en vraag aan mijn werkgroepje hoe goed ze denken dat het werkt voor mij en of ze andere ideeën hebben.

Ik schrijf op wat de verschillende groepsleiders waar ik mee gewerkt heb doen.

Ik kijk welke eigenschappen de persoon die ik een goede leider vind heeft en maak hiervan een lijstje.

StepOn Reflection

Explore
station
shapes

Scenario

Choose a goal from a learning line and divide it in steps; choose from the pre-proposed specific goal steps and pre-proposed universal steps.

Take picture of chosen goal-process with the station standing at the teacher's desk.

Work in class; keeping the goal in mind or work on the goal step you are at.

Discuss and reflect in a group on your goal step.

Rethink the steps you made and choose a different step when necessary

Take a picture of the new goal-process when you changed it.

Work in class; keeping the goal in mind or work on the goal step you are at.

Discuss and reflect on your goal step with the teacher / using tips of the teachers; or discuss a reflection with the whole class.

Rethink the steps you made and choose a different step when necessary. Ask yourself 'what do I need to do to still achieve the goal in time?'

Take a picture of the new goal-process when you changed it.

Work in class; keeping the goal in mind or work on the goal step you are at.

Reflect in depth using the StepOn website, answering hand-picked questions that are related to your work and level of reflection. Decide if you reflected and worked well 'apply for puzzle piece'.

Other situations you might come across
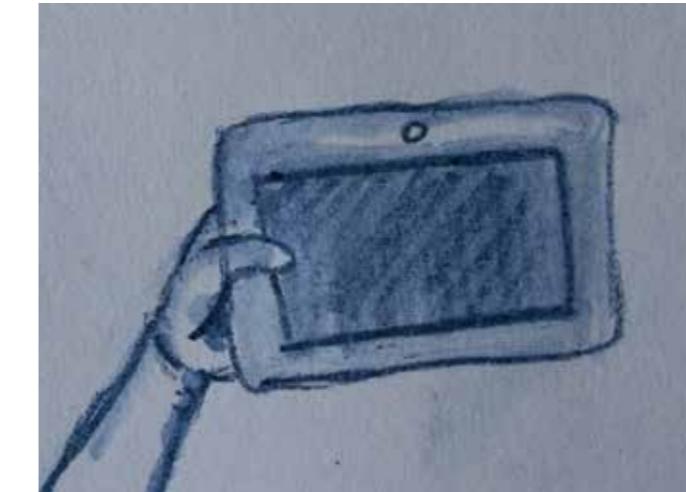
Together you earn puzzle pieces, you earn one if you reflected well and if you worked well. The puzzle pieces of your whole class together form a puzzle. You can look at it together. (e.g. when you start class in the morning)

Work on a group goal, using a design approach.

Watching back a previous reflection and looking at the feedback the teacher gave you or looking at an overview of how you separated your goal in steps and how this changed over time.

Choose a self thought up goal and divide it in steps; choose from the half proposed goal steps or fill in the steps yourself. This use case is recommended for more advanced users.

As a teacher you...
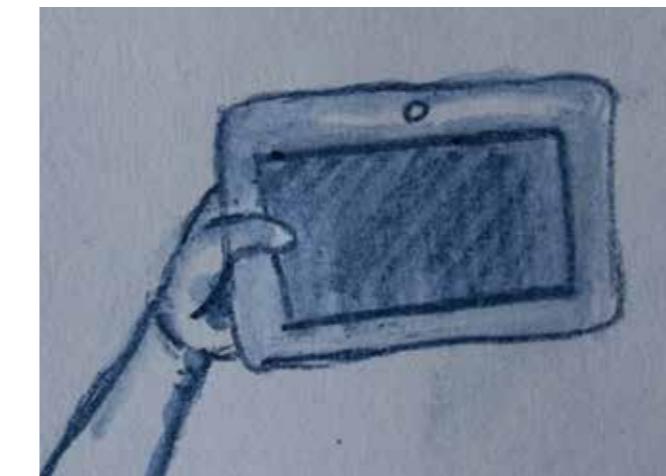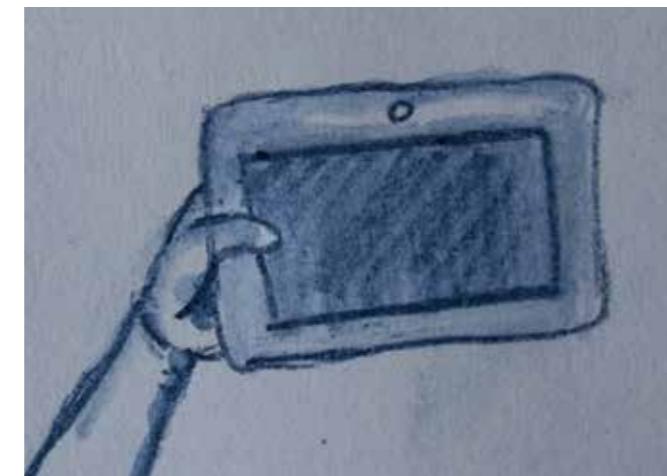
Discuss reflections with the class or give children tips on how to reflect better when reflecting short on the steps.

Give feedback on reflections of the children and decide if they deserve a puzzle piece.

Pick questions based on the level of reflection a child can achieve or the project a child is working on (and save these presets so they can be used more often).

• Handouts and study •

Appel

Wat is gezond? En varieert dit per doelgroep?
- http://www.schooltv.nl/video/gezond-eten-gevarieerd-eten-is-belangrijk/#q=eten
- http://www.schooltv.nl/video/smaken-verschillen-waarom-eten-we-liever-geen-insecten-of-meelwormen/#q=eten

Waarom eten we niet gezond?
- http://www.schooltv.nl/video/waarom-is-vet-eten-zo-lekker-juist-omdat-het-zo-vet-is/#q=eten
- Wordt het niet goed gepresenteerd?
- http://jeugdjournaal.nl/artikel/2095361-vloggers-moeten-stoppen-met-reclame-maken-voor-ongezond-eten.html
- http://jeugdjournaal.nl/artikel/2089162-eten-en-drinken-met-veel-suiker-minder-populair.html

Moeten we ons beeld veranderen op eten omdat bijvoorbeeld vlees nog steeds gezien wordt als belangrijkste onderdeel maar dit niet het gezondste onderdeel is?
- http://www.schooltv.nl/video/smaken-verschillen-waarom-eten-we-liever-geen-insecten-of-meelwormen/#q=eten

### Misschien is het gezonde eten niet toegankelijk of te duur?
- http://www.schooltv.nl/video/vroeger-zo-de-hongerwinter-1944/#q=eten
- http://www.schooltv.nl/video/smaken-verschillen-waarom-eten-we-liever-geen-insecten-of-meelwormen/#q=eten

Wat kan er nog meer invloed hebben op het wel of niet kiezen voor gezond eten?
- http://www.schooltv.nl/video/het-klokhuis-restaurant-van-de-toekomst/#q=eten
- Hebben we wel de tijd om gezond te koken?

Wat gebeurt er als je ongezond eet?
- http://www.schooltv.nl/video/vetlekker-strak-in-je-vel/#q=eten
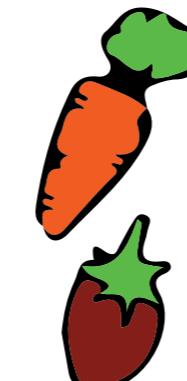
Bosbes

Wat is gezond? En varieert dit per land? Wat kan er nog meer invloed hebben op het wel of niet kiezen voor gezond eten?
- http://www.schooltv.nl/video/het-klokhuis-restaurant-van-de-toekomst/#q=eten
- https://www.salusi.nl/5-redenen-waarom-we-niet-gezond-eten/
- https://gezondetips.nl/wat-eten-we-in-de-verschillende-landen-van-de-wereld

Moeten we ons beeld veranderen op eten omdat bijvoorbeeld vlees nog steeds gezien wordt als belangrijkste onderdeel maar dit niet het gezondste onderdeel is?
- http://www.schooltv.nl/video/smaken-verschillen-waarom-eten-we-liever-geen-insecten-of-meelwormen/#q=eten
- http://www.schooltv.nl/video/het-klokhuis-vegavlees/#q=eten

Het nieuws
- http://jeugdjournaal.nl/artikel/2095361-vloggers-moeten-stoppen-met-reclame-maken-voor-ongezond-eten.html
- http://jeugdjournaal.nl/artikel/506573-we-moeten-meer-insecten-eten.html
- http://jeugdjournaal.nl/artikel/2089162-eten-en-drinken-met-veel-suiker-minder-populair.html

Citroen
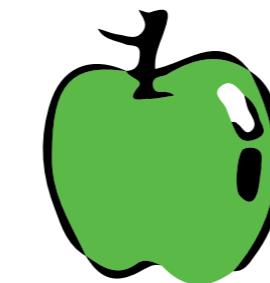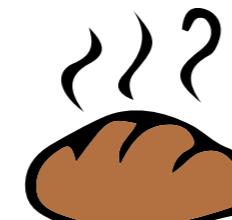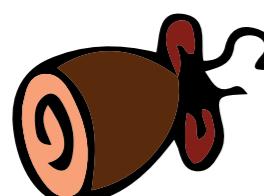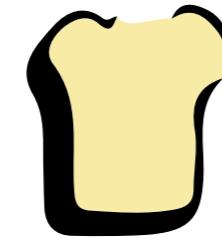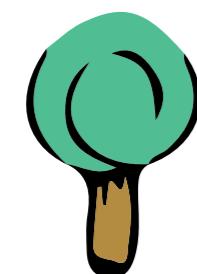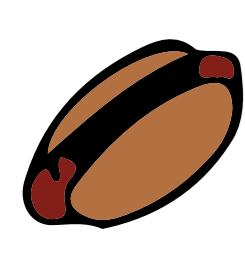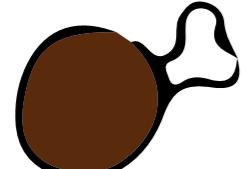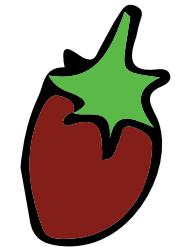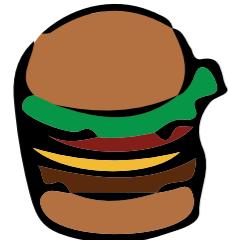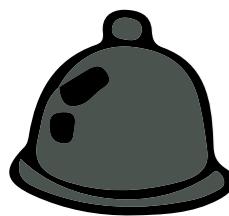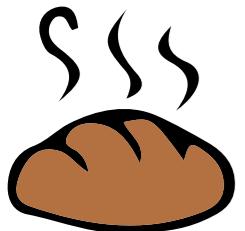
Inspiratie
- https://www.youtube.com/watch?v=t68bqIpcf_M
- https://www.salusi.nl/5-redenen-waarom-we-niet-gezond-eten/
- http://www.schooltv.nl/video/het-klokhuis-restaurant-van-de-toekomst/#q=eten
- https://gezondetips.nl/wat-eten-we-in-de-verschillende-landen-van-de-wereld
- http://www.eetgoedvoeljegoed.nl/waarom-indiaas-eten-zo-goed-is-voor-je/

Het nieuws
- http://jeugdjournaal.nl/artikel/506573-we-moeten-meer-insecten-eten.html
- http://jeugdjournaal.nl/artikel/2098854-eten-uit-een-3d-printer.html

Reflectie vragen

Welke vragen moet ik beantwoorden in mijn reflectie?

- Wat wilde ik bereiken?
- Wat gebeurde er, en wat voelde en dacht ik daarbij? (Vertel in het kort wat goed ging en wat niet zo goed ging.)
- Wat heb ik geleerd?
- Hoe hangt dit samen met de dingen die ik al gedaan heb?
- Wat kan ik hiermee in de toekomst?
- Waarom dacht ik dat de plannen waar ik het doel in opsplitste zouden werken, hoe zou ik het nu anders doen?
- Wat waren de aannames die zorgden dat ik een bepaalde manier van denken gebruikte?*
- Wat voor soort denken gebruikte ik en was dit een handige manier van denken toen ik het gebruikte?** (Welke manier zou ik beter kunnen gebruiken en waarom?)

*Bijvoorbeeld

Als je reclame maakt voor een boekenwinkel dan doe je bepaalde aannames; je zegt bijvoorbeeld 'iemand koopt boeken voor zichzelf' maar dit hoeft natuurlijk niet zo te zijn het kan ook zijn 'iemand koopt boeken voor iemand anders' en dat zou een ander resultaat opleveren dan wanneer je de eerste aanname gebruikt. Je neemt ook aan 'iemand koopt boeken om te lezen' maar het zou ook kunnen 'iemand koopt boeken om plaatjes te kijken' en bij deze aanname zou je ook op een andere manier reclame maken.

** Bijvoorbeeld

- Samenvatten – een duidelijk kort overzicht maken van wat we aan het bespreken waren met de belangrijkste punten.
- Vergelijken – kijken naar iets dat al gedaan is of naar wat een ander groepje doet.
- Positieve-negatieve- en interessante punten gebruiken voor beslissingen
- Mindmapping – vanuit één begin punt (idee) kijken naar wat er allemaal bij komt kijken en kijken wat er bij elkaar past en bij elkaar hoort
- Tekenen
- Kijken naar vorige resultaten
- Een ander perspectief aannemen – bijvoorbeeld proberen om in de juf haar schoenen te staan en vanuit haar te denken
- Vragen stellen
- Veel ideeën bedenken en nieuwe combinaties maken met de verschillende ideeën
- Structureren
- Intuïtief – gewoon doen wat goed voelt

Escape thinking

Wat zijn de dingen die je aanneemt rondom de ontwerp challenge / het probleem?
Probeer vanuit een andere hoek naar deze aannames te kijken.

Bijvoorbeeld:
Je denkt misschien 'mensen kopen boeken voor henzelf', draai deze aanname om naar
'mensen komen boeken NIET voor zichzelf'.

Nu kun je in de richting van kadotjes denken.
Een andere aanname / een ander vooroordeel
kan zijn 'mensen kopen boeken om te lezen' als je
dit omdraait kom je er misschien op uit dat mensen
boeken kopen om naar de plaatjes te kijken etc.

Teleportatie

Wat als je het probleem zou moeten oplossen op een andere locatie? In een ander
land? In een ander sterrenstelsel? Hoe zou je het dan aanpakken?
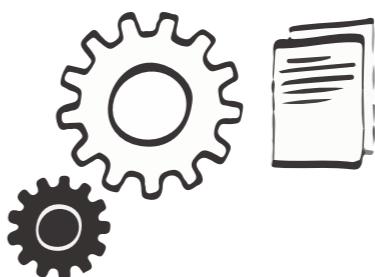
Reverse thinking

Hoe kun je het tegenovergestelde van wat je wilt bereiken, bereiken?

Bijvoorbeeld:
Je wilt dat mensen naar een feestje komen dat heel erg leuk is.
Hoe kun je zorgen dat ze zeker niet komen?

Superpowers

Wat als je ineens superpowers zou hebben? Hoe zou je het probleem dan oplossen?

Of als je een van die coole spionnen gadgeds had, wat zou je dan nodig hebben om het
probleem op te lossen?

Reverse thinking

Hoe kun je het tegenovergestelde van wat je wilt bereiken, bereiken?

Bijvoorbeeld:
Je wilt dat mensen naar een feestje komen dat heel erg leuk is.
Hoe kun je zorgen dat ze zeker niet komen?

2050

Hoe ziet de toekomst er uit in 2050?
Bedenk 12 verschillende versies van de toekomst.

Hoe passen de ideeën die je hebt in deze toekomst? Past je idee in de toekomst of is het
nu handig? Waarom zoude mensen jou idee willen 'gebruiken' in de toekomst?
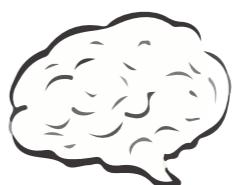
Improviseren

Schrijf één woord op en geef het blaadje met het woord aan de persoon naast je. De persoon naast je moet het eerste woord waar hij aan denkt bij het lezen van jou woord opschrijven. Daarna geef je het blaadje weer door.

Bijvoorbeeld:
Verjaardag, kado spelling, nederlands, citotoets

Futuristisch schetsen

Schets 10 ideeën waarvan je denkt dat ze nu nog niet bereikt kunnen worden (omdat we de technologie bijvoorbeeld nog niet hebben).

De schetsen hoeven niet heel goed te zijn, probeer alleen te zorgen dat je groepsgenootjes ze snappen. Het is vaak zo dat ideeën duidelijker worden wanneer je ze schetst, ook omdat je meer details moet weten.

Als je een rode rugzak beschrijft aan iemand met woorden stelt die persoon zich waarschijnlijk een hele andere rode rugzak voor dan dat jij bedoelt.

Pictionary

Bedenk allemaal één idee en schets dat idee. Laat daarna de anderen raden wat het is. Doordat ze iets anders raden kom je misschien op nieuwe ideeën.

Slice and dice

Splits het 'probleem' of de context van het probleem op alsof het kamers heeft binnen een huis. Elke kamer is een ander deel van het probleem. (deel het probleem op in stukjes).

Nu kun je je huis her-inrichten, je kunt op elke kamer iets aan het probleem proberen te verbeteren in plaats van het hele probleem in één keer op proberen te lossen.

Bijvoorbeeld:
schroevendraaier --> rond, stalen buis, houten handvat, kruis-vorm uiteinde, met de hand te bedienen, draaien om te laten werken, gebruikt om schroeven los en vast te draaien

Cherry picking

Wat wil je bereiken in twee woorden. En schrijf bij deze woorden weer twee nieuwe woorden die in je opkomen bij het horen van de eerste woorden op. Dit doe je twee keer, hierdoor heb je acht woorden. Probeer bij deze acht woorden ideeën te bedenken.

Bijvoorbeeld:
Hoe kunnen we de methode om kersen te plukken verbeteren?
--> kersen plukken
plukken: weghalen, vervoeren
weghalen: aanraken, uitzoeken -- vervoeren: grond, dozen
kersen: kwetsbaar, los
kwetsbaar: kapot, voorzichtig -- los: selecteren, afstand van elkaar

Individual assessment form

Appel / Bosbes / Citroen

Reflecteert de leerling op het onderwerp dat ik verwacht had (zo nee, wat had ik verwacht)? JA/NEE
Wat valt er op? OF Wat doet de leerling anders dan normaal bij reflecteren (wat wijkt er af)? Waar zou dit aan kunnen liggen anders dan het werken met de nieuwe methode?
Zijn er dingen die de leerling vertelt (conclusies die hij/zij trekt) waar ik het niet mee eens ben (omdat ik dit anders heb geobserveerd)? (Hoeveel dingen en wat zijn die dingen) Gebeurt dit normaal ook bij het reflecteren? JA / NEE

De reflectie

De reflectie is voor mij in zijn geheel

Niet duidelijk — *Heel duidelijk*

De leerling vindt een balans in negatieve en positieve punten in zijn/haar werk

Helemaal niet — *Erg goed*

Over zijn geheel is de reflectie

Erg slecht — *Erg goed*

De herkenning jegens de eigen vooroordelen en assumpties van de leerling is

Niet aanwezig — *Succesvol*

De leerling kan aanwijzen hoe hij iets geleerd heeft en hoe succesvol deze methode voor hem is

Erg slecht — Heel duidelijk

Het doel

Komt met suggesties voor aanpassingen op inhoudelijke (wat moet ik leren om dit doel te bereiken) en procesmatige aspecten van het onderwijsleerproces (Doet aanpassingen in 'de planning' (hoe te bereiken) op het fysieke doel wanneer nodig)

Erg slecht — *Erg goed*

Beoordeelt of hij een uitgevoerde taak goed had voorbereid en uitgevoerd en verbindt hier consequenties aan voor de volgende keer..(kijkt naar toekomst bij reflecteren)

Erg slecht — *Erg goed*

Houding en voortgang

Komt met vragen naar expert wanneer nodig (autonomie) zodat zelf ingrijpen niet nodig is

Helemaal niet — *Erg goed*

Beoordeelt zijn eigen voortgang (plantje)

Erg slecht — *Erg goed*

Opmerkingen (was dit verwacht / is er voortgang etc.) / Deze vraag zou ik de leerling stellen.


Group assessment form

Appel / Bosbes / Citroen

Reflecteren de leerlingen op het onderwerp dat ik verwacht had (zo nee, wat had ik verwacht)? JA/NEE
Wat valt er op? OF Wat doen de leerlingen anders dan normaal bij reflecteren (wat wijkt er af)? Zijn er dingen die de leerlingen vertellen (conclusies die ze trekken) waar ik het niet mee eens ben (omdat ik dit anders heb geobserveerd)? (Hoeveel dingen en wat zijn die dingen) Gebeurt dit normaal ook bij het reflecteren? JA / NEE

De 3 reflecties van de groep

De reflecties zijn voor mij in zijn geheel

Niet duidelijk — *Heel duidelijk*

De leerlingen vinden een balans in negatieve en positieve punten hun werk

Helemaal niet — *Erg goed*

Over zijn geheel zijn de reflecties

Erg slecht — *Erg goed*

De herkenning jegens de eigen vooroordelen en assumpties van de leerlingen zijn

Niet aanwezig — *Succesvol*

De leerlingen kunnen aanwijzen hoe ze ets geleerd hebben en hoe succesvol deze methode voor hen was

Erg slecht — *Heel duidelijk*

Het doel

De leerlingen komen met suggesties voor aanpassingen op inhoudelijke (wat moet ik leren om dit doel te bereiken) en procesmatige aspecten van het onderwijsleerproces (Doet aanpassingen in 'de planning' (hoe te bereiken) op het fysieke doel wanneer nodig)

Erg slecht — *Erg goed*

Beoordelen of ze een uitgevoerde taak goed hadden voorbereid en uitgevoerd en verbinden hier consequenties aan voor de volgende keer.(kijkt naar toekomst bij reflecteren)

Erg slecht — *Erg goed*

De groep

Eén student werkt aan de reflectie — *De groep werkt gelijkmatig aan de reflectie*

De reflectie slaat op één student — *De reflectie slaat op heel de groep*

De leerlingen bespreken met anderen hoe ze hun project hebben aangepakt gericht op de voorbereiding, het proces en het resultaat.

Helemaal niet — *Erg goed*

Opmerkingen (was dit verwacht / is er voortgang etc.) / Deze vraag zou ik de student stellen.

Evaluation questions

Evaluation questions children

- Hoe was het om je project in stappen op te delen en zo te werken?
- Waren er dingen onduidelijk / moeilijk? (wat dan?)
- Verbeterden deze dingen door de week heen? Wat was er beter aan?
- Heb je het gevoel dat je veel geleerd hebt?
- Heb je dat gevoel normaal ook? (Bij andere lessen)
- Op welk gebied heb je dingen geleerd (eten / reflecteren / een project doorlopen etc.)?
- Wat vond je het leukste of fijnste aan werken met het doel in stappen opgesplitst en het reflecteren?
- Werkte je anders dan normaal? Zo ja; wat deed je anders en hoe was dat?
- Als je iets mocht veranderen aan het doel in stappen opsplitsen en het reflecteren, wat zou dat dan zijn?
- Zou je vaker op deze manier willen werken? En waarom zou je dat wel / niet willen?
- Wil je verder nog iets kwijt?

Evaluation questions teacher (accompanying an interview)

- Hoe was het om met de reflectie tool te werken?
- Waren er dingen onduidelijk / moeilijk? (wat dan? Heb je ideeën van hoe je dat zou kunnen veranderen?)
- Wat vond je het leukste of fijnste aan werken met de tool?
- Als je iets mocht veranderen aan de tool, wat zou dat dan zijn?
- Kun je de manieren van reflectie op volgorde zetten van kort naar lang in de tijd die je besteedde aan het nakijken (asessen)?
  1.   2.   3.
- Zou je deze manier ook aanraden om te gebruiken (levert het ook goede resultaten op?)? Waarom?
- Welke manier van reflecteren wil je het liefst altijd gebruiken om na te kijken? (Wil je misschien mixen?) Waarom?
- Zou je vaker met een vergelijkbare tool willen werken? En waarom zou je dat wel / niet willen?
- Wat gebeurde er niet wat je wel verwachtte?

Reflectie vragen

1. Wat was ons doel voor vandaag? (kijk naar je planning van donderdag & het plan op het doel blokje)
2. Is dit gegaan zoals we van tevoren dachten? Waarom wel / niet?
3. Wat hebben we geleerd?
4. Hebben we al ooit iets gedaan wat lijkt op wat we vandaag deden? Wat?
5. Ging het nu beter of slechter dan toen? Waarom?
6. Waar kan ik wat ik heb geleerd vandaag in de toekomst gebruiken?
7. Klopt de planning nog? Hoe zou ik de planning veranderen zodat we het doel kunnen behalen?
8. Wat zijn de dingen waar ik vanuit ging van tevoren bijvoorbeeld 'de kleuters eten liever vormpjes die er leuk uit zien', 'een poster met felle kleuren vinden de mensen voor wie ik ontwerp erg mooi' en 'dieren vormpjes uit fruit gesneden zien er leuk uit'?
9. Hebben de dingen waar ik vanuit ging invloed gehad op keuzes die wij met het groepje maakten? Welke keuzes?
10. Welke manier van denken gebruikten we? _Kies uit:_ Samenvatten, vergelijken, tips & tops, mindmap, tekenen, kijken naar vorige resultaten, 'in de schoenen van een ander persoon staan', vragen stellen, veel ideeën bedenken, combinaties maken van verschillende ideeën, structuur aanbrengen, gewoon doen wat goed voelt.
11. Was deze manier van denken een goede keuze voor wat we aan het einde van vandaag wilden bereiken?
12. Welke manier was beter geweest? Waarom was die manier beter?
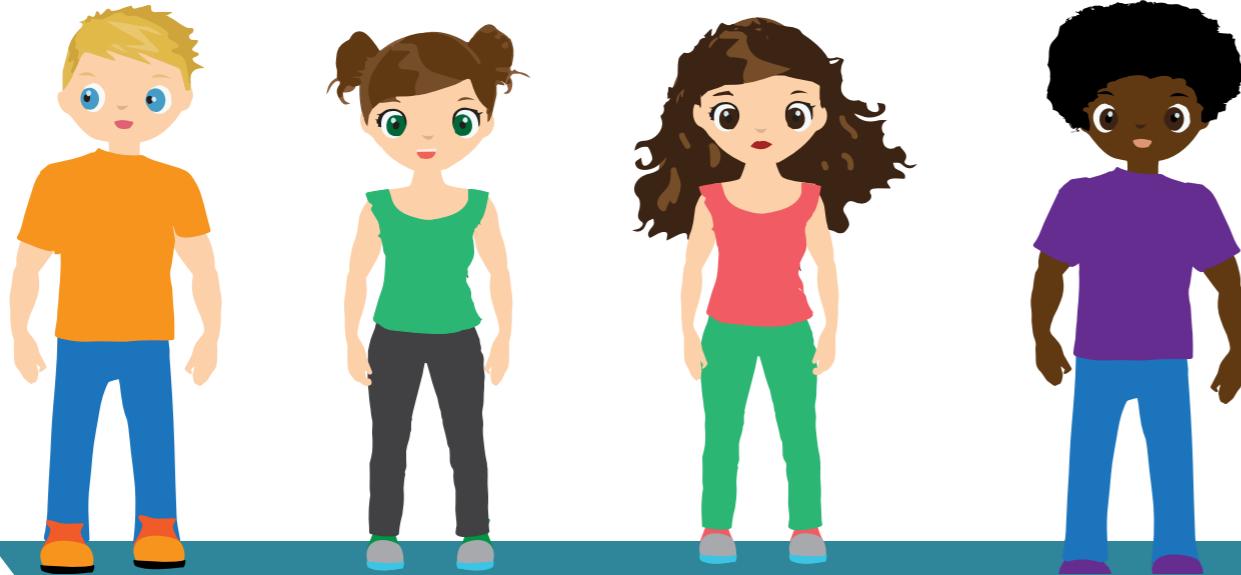
Dag 1

Onderwerp	groep 13	groep 12	groep 10	groep 8	groep 6	groep 3	groep 2	groep 15	groep1	groep14	groep 11	groep 22	groep4	groep 5
reflecties zijn voor mij geheel niet duidelijk	9	5	9	8	8	9	9	9	8	4		8,5	9,5	9
leerlingen vinden balans in neg. en pos punten hun werk	9	3	4	7	6	5	5	8	8	6		7	8	4,5
over zijn geheel zijn de reflecties	5	1	5	6	8	7	8	8	8	2		8	9	3,5
de herkenning jegens eigen voorooordelen en assumpties v leerlingen zijn	1	1	3	4	8	2	4	4,5	9			6,5	7	1,5
leerrlingen kunnen aanwijzen hoe ze iets geleerd hebben hoe succesvol methode v hen was	1	1	3	3	8	1	4	5,5	7,5	2		7,5	9	2
Het Doel														
komen met suggesties v aanpassingen op inh. En procesmatige aspecten v onderwijsleerproces	6	1	4	5	6	5	5	7,5	7	2		7	6,5	4
beoordelen of ze uitgevoerde taak goed hebben voorbereid, vebinden hieraan consequenties	5	1	4	6	6	5	8	14	5	2		7	7	3
De Groep														
Een student werkt aan reflectie/De groep werkt gelijkmatig aan reflectie	10	10	9	9	9	9	7	9	6	4		9	9	7,5
De reflectie slaat op een student/De reflectie slaat op heel de groep	10	10	9	9	9	9	8	9	9	8		9	9,5	8
leerling bespreken met anderen aanpak gericht op voorbereiding,het proces en het resultaat	4	1	8	6	8	8	7	9,5	9	2		8	8,5	6,5
	60	34	58	63	76	60	65	84	76,5	32		77,5	83	49,5

Dag 1	Waardem
gemiddeld foto	46
gemiddeld video	66,8
gemiddeld audio	75,125
reflectie kwaliteit foto	3,25
reflectie kwaliteit video	7,1
reflectie kwaliteit audio	7,5

Dag 2

Onderwerp	groep 13	groep 12	groep 10	groep 8	groep 6	groep 3	groep 2	groep 15	groep1	groep14	groep 11	groep 22	groep4	groep 5
reflecties zijn voor mij geheel niet duidelijk	8		9	9	9	8	7	5,5	8,5	8	5,5	8	9,5	8
leerlingen vinden balans in neg. en pos punten hun werk	7		8	1	7	5	5	4	2,5	7	2	6	9	3
over zijn geheel zijn de reflecties	7		6	4	7	7	5	4	2,5	7	2	8	9	3,5
de herkenning jegens eigen voorooordelen en assumpties v leerlingen zijn	5		7	1	9	1	1	1	1	5	5,5	8	9,5	1,5
leerrlingen kunnen aanwijzen hoe ze iets geleerd hebben hoe succesvol methode v hen was	4		7	1	9	1	1	1	1	7,5	1	7	9	1,5
Het Doel														
komen met suggesties v aanpassingen op inh. En procesmatige aspecten v onderwijsleerproces	7		4	4	7	5	5	3	7	4	5	4	7	7
beoordelen of ze uitgevoerde taak goed hebben voorbereid, vebinden hieraan consequenties	5		6	4	7	4	5	6	3,5	6	2	4	7	2,5
De Groep														
Een student werkt aan reflectie/De groep werkt gelijkmatig aan reflectie	9		9	9	9	9	9	5	8	9	5,5	10	8	4
De reflectie slaat op een student/De reflectie slaat op heel de groep	9		9	9	9	9	9	8	9,5	9	9,5	10	10	6,5
leerling bespreken met anderen aanpak gericht op voorbereiding,het proces en het resultaat	7		7	4	9	10	7	9	7,5	8	4,75	9	10	4
	68		72	46	82	59	54	46,5	51	70,5	42,75	74	88	41,5

Dag 2	waarden
gemiddeld foto	63,3125
gemiddeld video	58,7
gemiddeld audio	62,125
reflectie kwaliteit foto	5,5
reflectie kwaliteit video	5,4
reflectie kwaliteit audio	5,75

Dag 3

Onderwerp	groep 13	groep 12	groep 10	groep 8	groep 6	groep 3	groep 2	groep 15	groep1	groep14	groep 11	groep 22	groep 4	groep 5
reflecties zijn voor mij geheel niet duidelijk	7,5	7,5	6,5	7,5	8,5	8,5	7	8	9		8,5	9	9,5	5,5
leerlingen vinden balans in neg. en pos punten hun werk	6,5	6,5	6	4,5	7,5	8,5	5	6	8,5		7,5	9	9	7
over zijn geheel zijn de reflecties	6,5	6,5	5	6	7,5	8,5	6	7	8,5		8,5	8,5	9,5	6,5
de herkenning jegens eigen voorooordelen en assumpties v leerlingen zijn	5	8	6	6	5,5	7	5	6	3		8,5	8,5	9	6,5
leerrlingen kunnen aanwijzen hoe ze iets geleerd hebben hoe succesvol methode v hen was	7	6,5	6,5	6	7,5	5,5	5,5	4	7,5		7,5	7,5	9,5	6,5
Het Doel														
komen met suggesties v aanpassingen op inh. En procesmatige aspecten v onderwijsleerproces	6,5	5,5	4,5	2	8,5	8,5	8,5	3	8		7,5	6,5	8,5	6,5
beoordelen of ze uitgevoerde taak goed hebben voorbereid, vebinden hieraan consequenties	6,5	5,5	4,5	4,5	8	9	7,5	6	8,5		8	8,5	10	6
De Groep														
Een student werkt aan reflectie/De groep werkt gelijkmatig aan reflectie	8,5	9	5,5	9	7	9,5	8,5	3	9		10	9,5	10	9,5
De reflectie slaat op een student/De reflectie slaat op heel de groep	9	9	6,5	7	7	8,5	8,5	5	9,5		10	9,5	10	9,5
leerling bespreken met anderen aanpak gericht op voorbereiding,het proces en het resultaat	8,5	7	5	1,5	7	8,5	5,5	4	8		9	9	10	7,5
	71,5	71	56	54	74	82	67	52	79,5		85	85,5	95	71

Dag 3	Waarden
gemiddeld foto	70,875
gemiddeld video	78,9
gemiddeld audio	66,375
reflectie kwaliteit foto	5,5
reflectie kwaliteit video	7,8
reflectie kwaliteit audio	7,25

Dag 4

Onderwerp	groep 13	groep 12	groep 10	groep 8	groep 6	groep 3	groep 2	groep 15	groep1	groep14	groep 11	groep 22	groep4	groep 5
reflecties zijn voor mij geheel niet duidelijk	9	8,5	4	8	9,5	9	7	8,5	9	8	7,5	9	9,5	5,5
leerlingen vinden balans in neg. en pos punten hun werk	6,5	8	4	7	8	8	5	7	8,5	7	8	9,5	9	7
over zijn geheel zijn de reflecties	8,5	8	4	6	9	8,5	6	5,5	8,5	7	8	9,5	9,5	6,5
de herkenning jegens eigen voorooordelen en assumpties v leerlingen zijn	7,5	8		3,5	8,5	8,5	5	5	3	5	8,5	9	9	6,5
leerrlingen kunnen aanwijzen hoe ze iets geleerd hebben hoe succesvol methode v hen was	9	8		3	9	8	5,5	7	7,5	7,5	7,5	9	9,5	6,5
Het Doel														
komen met suggesties v aanpassingen op inh. En procesmatige aspecten v onderwijsleerproces	9	7	4	3	8,5	5,5	3,5	6	8	4	5	8,5	9	6,5
beoordelen of ze uitgevoerde taak goed hebben voorbereid, vebinden hieraan consequenties	9	7,5	1	4,5	9	7,5	5	6,5	8,5	6	5	8,5	9	6
De Groep														
Een student werkt aan reflectie/De groep werkt gelijkmatig aan reflectie	9,5	9,5	3	8,5	10	10	7	9,5	9	9	9	9,5	10	9,5
De reflectie slaat op een student/De reflectie slaat op heel de groep	9,5	9,5	3	8	10	9,5	7,5	9,5	9,5	9	9,5	9,5	10	9,5
leerling bespreken met anderen aanpak gericht op voorbereiding,het proces en het resultaat	9,5	8,5	6	8	9	10	8	6,5	8	8	7,5	9	10	7,5
	87	82,5	29	59,5	90,5	84,5	59,5	71	79,5	70,5	75,5	91	94,5	71

Dag 4	waarden
gemiddeld foto	68,9
gemiddeld video	77,8
gemiddeld audio	78
reflectie kwaliteit foto	7,1
reflectie kwaliteit video	7,8
reflectie kwaliteit audio	7,5