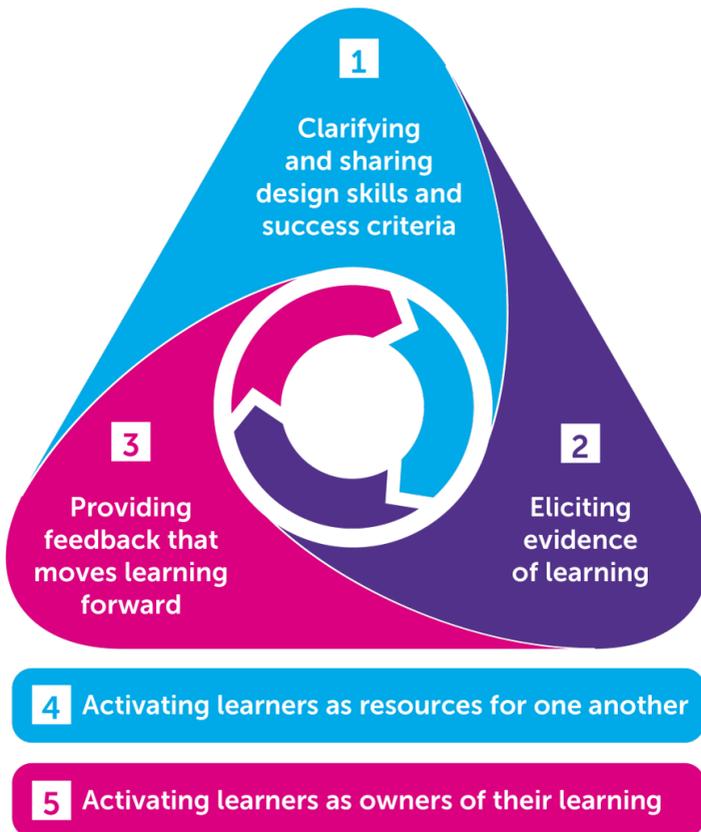


MAKE DESIGN LEARNING VISIBLE

- GUIDEBOOK -

Formative assessment tools for design thinking



An approach for formative evaluation of design skills in Design and Technology education designed for use with 8 – 14 year olds. The approach can be modified to use with younger or older pupils.

Contents of the set 'Make Design Learning Visible'

- ◆ **Skill cards:** 7 design skill practice cards for students
- ◆ **Toolbook:** 19 tools for formative assessment
- ◆ **Guidebook:** manual for the approach, including information on the 5 strategies for formative assessment

Colofon

Remke Klapwijk (Delft University of Technology) in association with Kay Stables (Goldsmiths University), 2019.

This publication is based on the Dutch approach 'Ontwerpen in Beeld - ontwerp en leren, formatief evalueren', developed by Wetenschapsknooppunt TU Delft and ontwerpbureau Meeple (Klapwijk, Visschedijk, Kok, Holla, 2017) in cooperation with Lucas Onderwijs, Rotterdam University of Applied Sciences, Marnix Academy University for Teacher education, Inholland University of Applied Sciences, HAN University of Applied Sciences, University of Applied Sciences Leiden and Brandt Onderwijs. Financed by The National Platform Science & Technology and above mentioned organisations.

If you have any questions or suggestions, please feel free to contact us at R.M.Klapwijk@tudelft.nl.

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Overview

This guidebook describes the five strategies of formative assessment in the context of design thinking. It helps you to use the practical tools for formative assessment described in the toolbox. After the introduction, section 2 describes the higher order design skills that are central to “Make Design Learning Visible”. Section 3 provides advice on the five strategies of formative assessment. You can also first check the practical tools related to each strategy in the toolbox and then return to the guidebook. Section 4 describes how to integrate the strategies and tools in your design lessons. Examples of how teachers use the formative assessment tools in their classes are included to provide you with a complete picture.

SECTION 1: INTRODUCTION

Goal

Many schools want to stimulate creative thinking. Design and technology (D&T) lessons are an excellent vehicle to develop creativity, especially when students are challenged to generate authentic solutions that match the user needs. Besides creative thinking, students will develop higher order skills such as cooperation and problem solving.

For many students involved in design and technology activities, it is however often not clear what is learned. Learning goals and success criteria may not have been shared with them so they embark on the journey of design and technology without knowing where they are going. It is often difficult for them to understand when they are successful in acquiring higher order skills and what to do to become skilled in creative thinking.

“Make Design Learning Visible” makes a difference in your classroom as it provides learners with easy to understand descriptions of higher order design skills. Teachers are also provided with lots of tools for formative assessment of design skills to make the learning visible and to raise the level of (peer) feedback.



When teachers apply the tools, students start to steer their own learning process and achieve higher order design skills more quickly. This is due to the clear, shared direction of the learning and many small manageable actions taken to progress the learning.

The approach was developed by the Delft University of Technology in cooperation with a great many of partners and is solidly based on the work of formative assessment experts including John Hattie and Dylan Wiliam and on rich insights from (student) teachers applying the tools. Also insights from research on formative assessment of design and technology lessons have been included, amongst others from Goldsmiths, University of London and Delft University of Technology.

Target group

Students from eight years old and upwards. The design skill practice cards and about half of the tools can be used with younger students and are listed on page 41.

The approach focuses on formative assessment of design skills and all examples given are related to design and technology lessons. Many teachers find the tools and skill cards relevant for other lessons, and apply them often, especially during activities that require creative thinking and problem solving.

Approach

The school's regular design and technology lessons are the starting point. The teacher will then add a number of formative assessment activities by selecting one or two of the tools from the complete set.

These formative assessment activities are meant to put a specific design skill in the limelight and to make students aware of what they have learnt so far and where they are going. Inspiring and constructive dialogues arise between learners and between learners and the teacher and together they develop small, manageable actions to take a next learning step.



Eliciting evidence of learning, using the tool 'Photo storyline'

Formative Assessment strategies

The following five Formative Assessment strategies are part of the approach:

1 Clarifying and sharing design skills and learning goals

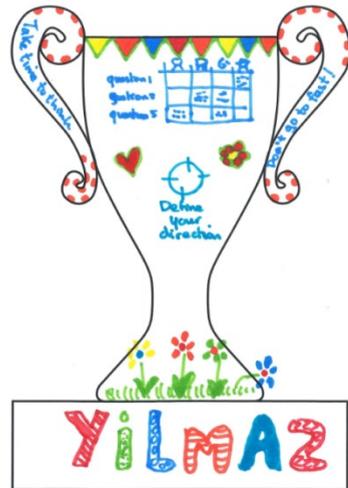
These tools help to clarify and share the design skills in an interactive way. Often, success criteria are specified and students understand what they are supposed to learn.

2 Eliciting evidence of learning

These tools help to collect information during the design lessons that can be used as evidence of learning. The design process and the (intermediate) outcomes are captured, for example by students taking pictures. The collected information contains information about the way the students applied the design skills. This will reveal their ability to apply a certain skill and forms the basis for diagnosis and feedback.

3 Providing feedback that moves learning forward

“Make Design Learning Visible” also contains tools that stimulate effective feedback and motivate learning. The feedback is given by teachers, classmates or developed through self-monitoring. Often, new challenges are set and tasks to achieve are developed by both students and teacher. Success is made visible and celebrated.



4 Activating learners as resources for one another

A central idea in the approach is that classmates are able to support others in the formative assessment process and are a resource for one another. This is possible as they all understand where they are going in their learning. They collect evidence of learning, provide feedback and help others to take a next step.

5 Activating learners as owners of their learning

Formative assessment enables students to become owners of their own learning and set their own goals with respect to skill development. A number of tools have ownership as a specific focus. Students set their own goals and look for ways and tasks to master these goals.

The tools are ordered per strategy in the Toolbook so you can find the ones you need easily. Some of the tools combine strategies, these are organised under the central strategy. The tools were specifically developed to clarify and assess the higher order design skills shown here:



Source: based on Klapwijk, e.a. (2017)

Many of these skills are also relevant in other areas of learning that ask for creative thinking, e.g. Art, Science, History, Geography or Literacy. Teachers experience the tools as a great addition to other approaches to assessment as it enables them to determine and guide progress in creative thinking.

Effect on learning

Formative assessment is one of the few approaches that has been shown to impact positively on learning. Research shows again and again that formative assessment has a huge impact on learning. According to assessment expert Dylan William (2018) substantial increases in student achievement – of the order of 50 to 70 percent increase in the speed of learning – are possible when teachers integrate formative assessment practices into minute-by-minute and day-to-day activities.

Our own research in the area of design and technology education (Klapwijk and Van den Burg 2019) indicates that the tools enable students to improve their design skills at a higher rate. We also noticed during various pilots with the tools that (future)teachers at the Universities of Applied Sciences in Rotterdam who used the approach were better able to prepare, develop and give design lessons. Their lessons contained more opportunities for pupils to practice higher order skills, their pupils received more feedback and enjoyed the learning more because they felt responsible. The (future) teachers got more feedback on their teaching approach and quickly developed into professional design and technology teachers.

A story we would like to share...

One of the student-teachers in our pilot, Badia, did her placement at an inner city school in Rotterdam, one of our biggest harbour cities with over 600,000 inhabitants and more than 170 nationalities. Badia wanted to apply the tool 'Suggestions wall' with 8 year olds. Her mentor said that she did not believe that this tool would work at this school but allowed her to try it. Although the start was difficult because her students were not used to being responsible for their own learning, they were all able, after some time, to provide suggestions that were useful for classmates. Her students were more engaged and felt responsibility for their learning. Within three weeks, their self-esteem had grown because they knew they were experts in certain areas of helping their peers.



This story of one 21 year old woman and her class and many other stories are behind our wish to develop an English version and to make these tools available to teachers all over the world. Applied with love, the teachers will be a change-agent for their students and make learning enjoyable. As progress is made visible and small steps are noticed and celebrated, learning will be more geared towards a growth-mindset.

EXAMPLE: ON THE RIGHT TRACK?

Teacher Ms. Ehlers applies formative assessment in a design project about "gymnastics in the future". Her class has already examined the design problem and the users in a previous lesson and decided that they wanted more non-competitive games that they can play in the gym. Brainstorming is on the agenda for today.

Clarifying and sharing the design skill (strategy 1)

Because the students are not familiar with the design skill ✨ "Think in different directions" Mrs. Ehlers starts with an interactive dialogue to share and clarify the design skill and learning goals. She uses the tool "Visualize a design skill". She asks her class "What does it look like if you think in all directions? What do you do?". Soon the first student comes up with an idea and Mrs. Ehlers summarises it as "mix ideas to develop new ones". The class is then challenged by her to think of a picture and they suggest a big pan in which ideas of different students are mixed. They also develop eight other suggestions - e.g. think of the opposite. All students are actively involved, especially in developing small drawings.



Collecting evidence of learning (strategy 2)

Next, the students start brainstorming. They draw random pictures from an envelope for inspiration. After ten minutes, Mrs. Ehlers announces a pause. She asks the students to check

whether they have succeeded in thinking in all directions as suggested in the tool “On the right track?”. The students look back at their process to see if they succeeded in thinking in different directions. Mika tells Lisa that she was stuck with one idea: "Look, I have five ideas with hockey." Lisa says that mixing ideas went pretty well. "I drew a picture with a clock and then I thought you could do the gym activity as quickly as possible ...".

Providing feedback (strategy 3)

Mrs. Ehlers asks all students to identify one point that went well and one point that does not work yet. She also asks the students to give themselves a manageable suggestion. What thing are you going to do differently? Mika wants to make sure that she no longer gets fixated on the same idea. By talking to Lisa she understands how she can use the pictures from the envelope to come up with a new idea. The students continue with the brainstorm. Mika thinks that her second brainstorm is better than the first part, “in the first brainstorm I had only ideas related to hockey, now I have varied ideas and also some really new ideas for our gym”.



Activating learners

(strategy 4 and 5)

As you can see, Mrs. Ehlers stimulates the students as resources for one another as well as taking responsibility for their own learning.

SECTION 2: HIGHER ORDER SKILLS IN DESIGN & TECHNOLOGY EDUCATION

What is design and technology education about?

The following quotation, often attributed to Albert Einstein, emphasises the creative and generative nature of design:

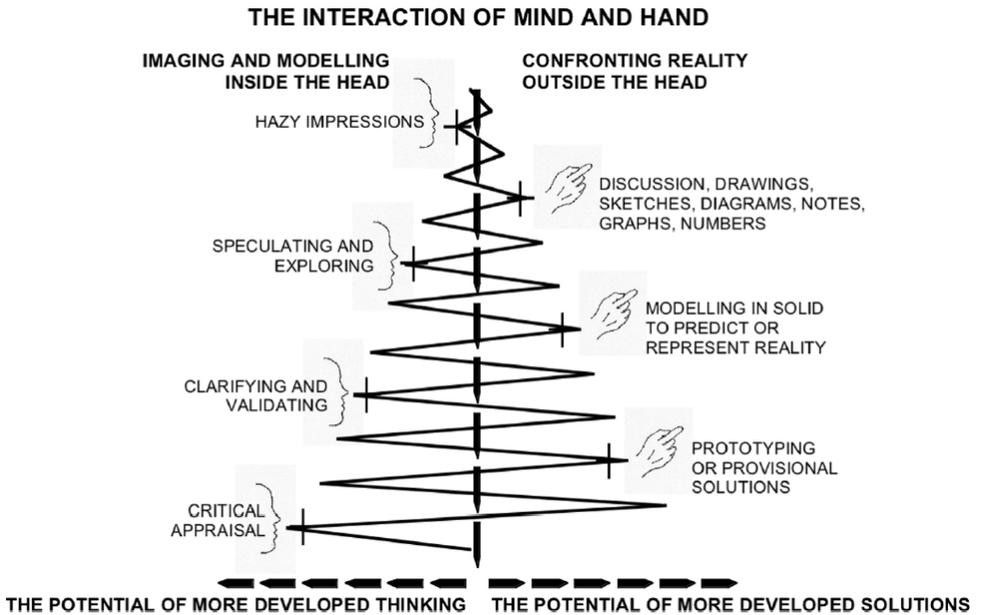
“Scientists investigate what already is, engineers create that which has never been”

Creativity is always about something that is not yet there; it is about the future. Designery thinking is an excellent vehicle to develop creative thinking in classrooms and can be applied to any topic – from designing a digital game to learning mathematics, from developing an environment for polar bears to organising an Easter party for parents.

Through creative design and technology students learn to develop new or original solutions. The design outcomes do not have to be new in the sense that they have never been thought of before. Most important is that students create outcomes and solutions that are new for them. The result is not copied, but a result of the student’s imagination and therefore authentic.

In these projects hands and minds interact continuously. Through iterations learners will develop their solutions. Investigation of the problem, idea generation and selection as well as developing, making and testing are important at all stages in a project.

As a teacher you guide your students in this creative process and give them the chance to use mistakes to improve their designs.



Source: Kimbell, R., e.a. (1991)

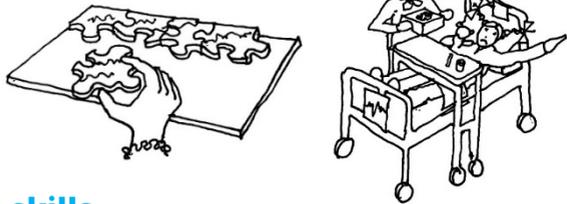
Design and technology projects usually contain the following elements:

- ◆ There are people who have a problem or wish
- ◆ The design brief /question/scenario has an open nature: different solutions are possible
- ◆ Different solutions are developed, made and tested
- ◆ Iterations between hand and mind, thinking and doing, are important

An iterative process

This short video introduces an iterative design process using an example of helping a girl who has a back injury to do her favourite jigsaws from her hospital bed. How do ideas originate and develop through thinking, drawing, reflection and prototyping towards a well thought out developed outcome?

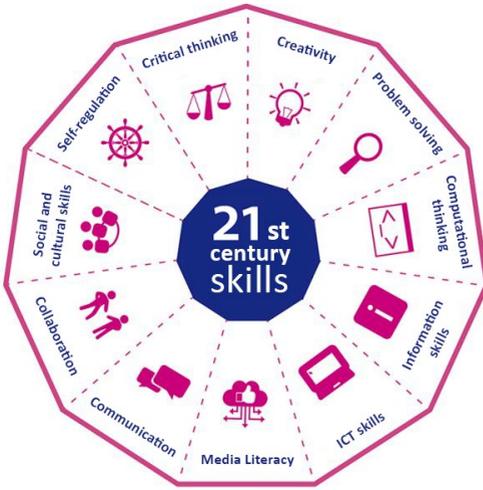
<http://tv.data.org.uk/Home/Iterative-Design-in-Action-Iterative-Processes-of-Designing/139131>



Higher order design skills

Skills such as creativity, cooperation and problem solving have been important as long as humans have existed, and are more and more required in today's workplaces. In addition, creativity makes life enjoyable and valuable. Educators, business leaders, governments and parents are placing increasing emphasis on early development of these so-called 21st century skills. 21st century skills are often associated with higher order skills and behaviour such as creativity and problem solving, see figure on the next page, and are important in design and technology lessons. They differ from other goals in that they are not primarily content knowledge-based.

Current descriptions of 21st century or higher order skills are not directly useful as learning goals in the design and technology lessons because they are very broad. "Make Design Learning Visible" therefore uses the seven design skills (Klapwijk e.a. 2017).



slo educational expertencentrum
leerplanontwikkeling

Kennisnet



Source: Stichting Leerplan Ontwikkeling (SLO) and Kennisnet

21st century skill

Design skill

Creativity		Think in all directions
Problem solving		Bring ideas to life
Communication		Make productive mistakes
Collaboration		Share ideas
Social and cultural skills		Develop empathy
Self-regulation		Make use of the process
Critical thinking		Decide on your direction
Information skills		
Computational thinking		Depending on the theme
ICT skills		
Media Literacy		

Three skills of the skills in the hexagon model are related to creativity and problem solving:

- ◆ Think in different directions (divergent thinking)
- ◆ Bring ideas to life
- ◆ Make productive mistakes

Social and cultural skills are also important 21st century skills. In the hexagon model these skills are made specific for design processes and named “empathy” for the user and “sharing ideas”.

The skills are described in a very concrete way on the next pages. Each skill is divided into three concrete subskills You will find a description for educators but also one that you can use directly in the classroom for students. Also a set of design skill practice cards that can be used by students are included in the set.

The specific descriptions and sub-goals will make formative assessment a lot easier because it is clear what kind of behavior needs to be observed to check if the skill is properly understood and applied.

THINK IN ALL DIRECTIONS

Pupils generate many, diverse and original ideas. They combine, associate and imagine. They seek inspiration in unusual places and look at problems from different perspectives. And most important, they postpone their judgement.



- › **Many** – come up with a lot of relevant possibilities, solutions and ideas.
- › **Diverse** – think from different viewpoints and try out various directions
- › **New connections** - associate, combine and make new connections.



DEVELOP EMPATHY

Pupils empathise with and understand other users. They experience the problem themselves, investigate the users and context and actively seek input and feedback. They focus on the user's wishes.

- › **Experience** - Experience the problem yourself, identify yourself with the problem, users and stakeholders.
- › **Target group** - Research the user and context through field research and use the findings in their design process.
- › **Active** - Involve users and stakeholders in their design process and actively seek input and feedback (context mapping, co-creation, testing).

BRING IDEAS TO LIFE

Pupils express and elaborate their thoughts and ideas in appropriate, meaningful ways and use tools such as stories, drawings, models and prototypes. Making ideas tangible is not only essential for sharing them, it is how you think and learn.



- › **Express** - Depict ideas and insights for yourself and others.
- › **Develop** - Make ideas as concrete as necessary in order to share them and make decisions .
- › **Model** - Use media related skills, including drawing, visualisation, drama, storytelling, simulation, modelling, (prototypes) making and computer programming.



SHARE IDEAS

Pupils share their ideas and collaborate within their team. They involve users and other stakeholders in their design process and they look for collaboration with people outside the process to improve, spread and implement their ideas. They design together.

- › **Letting go** - Share your own ideas: find the balance between letting go and staying true to an own idea
- › **Complement each other** - Be open to each other's ideas, complement and help each other.
- › **Outward** - Involve people with various backgrounds (inside and outside the process) for feedback, support and guidance. Inspire others.

DECIDE ON YOUR DIRECTION

Pupils organise their ideas and develop an overview of their project. They form an opinion about the essence of the problem and the desired quality of the solutions. They decide on their design direction.



- › **Validate** - Form your own opinions, dare to make value judgments, aim for your ideals and take balanced decisions.
- › **Overview** - Order all the generated ideas and information collected to provide an overview and use this to make decisions on the design direction.
- › **Focus** - Determine your vision, focus on the core and draw conclusions



MAKE PRODUCTIVE MISTAKES

Pupils try out- at the earliest possible stage - their beliefs, ideas and solutions. They deliberately apply different approaches, techniques and resources. They iterate and use mistakes to learn from.

- › **Try out** - Try out as many things as fast as possible. Search deliberately search for mistakes and deficiencies.
- › **Learn from mistakes** - Recognize and acknowledge failures. Investigate, comprehend failures and use them to improve and learn.
- › **Deal with frustration** - Learn to deal with uncertainty, ambiguity and frustration.

MAKE USE OF THE PROCESS

Pupils switch between different ways of thinking within the design process. They steer the process and switch between divergent and convergent thinking, nonconformity and cooperation, abstract and concrete thinking.

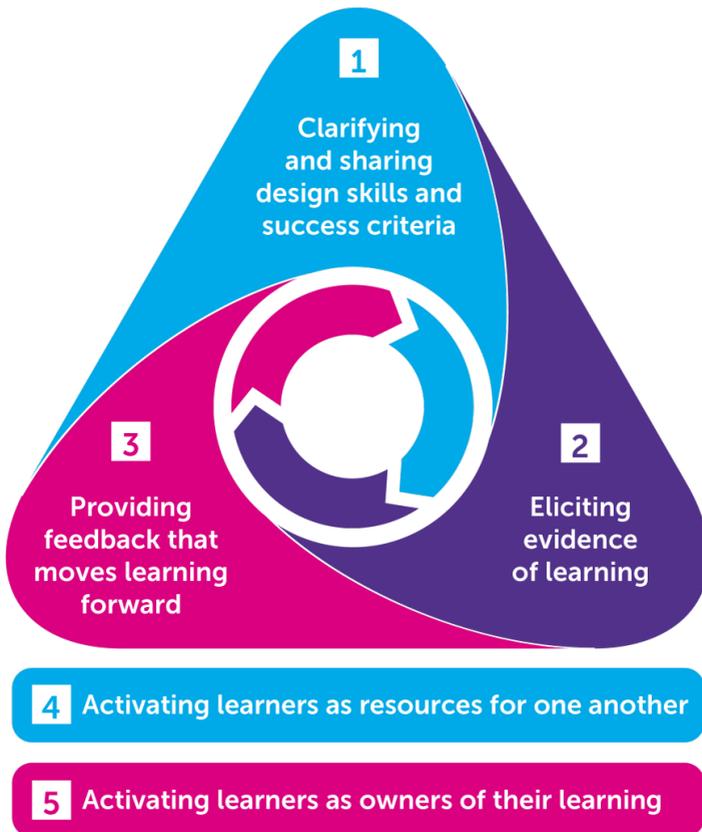


- › **Process knowledge** - Understand the processes of designing and different techniques. Use these in appropriate ways.
- › **Reflection** - Reflect on design processes and use feedback for improvement.
- › **Self-knowledge** - Discover and develop own skills, design approach, preferences and most suitable methods for you and your project.

SECTION 3: FORMATIVE ASSESSMENT IN DESIGN & TECHNOLOGY EDUCATION

What is formative assessment?

“Make Design Learning Visible” is based on five strategies for formative assessment of the British educator and researcher Dylan William (2018).



Source: based on William (2018)

Many teachers are used to evaluating and grading students work. This is often done at the end of a course to monitor the educational achievement of students and to check if the students arrived at a set standard. This is known as summative assessment.

Quite in contrast is the use of formative assessment to provide feedback to both the students and the teacher at each stage of the teaching- learning process. Formative assessment is a continuous process, interwoven with design activities, as you can see in the example of the class of Ms. Ehlers. It is meant to collect evidence about the development of students in order to determine what they are already able to do, to discuss what they want to learn next and to show how they can get there through practise.

During the formative assessment process, teachers will clarify and share the learning intentions related to the design skills with the class so all students are aware of what they are learning. All students will know which design skills they are going to practise and understand what they need to do to be successful!

In formative assessment, students are also stimulated to monitor themselves and their peers. Everybody – not just the teacher – is involved in collecting evidence of learning and providing feedback on the design skills. Lisa and Mika in Ms. Ehlers class give each other feedback. Feedback is given by:

- ◆ Teacher
- ◆ Peers
- ◆ Learner

As a teacher you integrate at specific points during the design lessons activities the three main strategies: clarifying learning goals, eliciting evidence and providing feedback. Not only the teacher but also each learner and his/her peers are actively involved in formative assessment (strategy 4 &5).

The purpose of formative assessment is to give students insight into their own learning process and to provide customized education. As a teacher you ensure that:

- › Students know where they are going and know what they want to learn and what to do to be successful;
- › Students know where they are because they monitor themselves and their peers during the design process;
- › Students receive timely and specific feedback that helps them to take the next learning step

Students know what to do to present a design idea by making a puzzle in advance



Effect on development of design skills

The timing of the feedback can be more useful than in summative evaluation. Teachers and students will take short, reflective, pauses as soon as possible to provide feedback. In this way, there is ample time for students to try again and do better.

Teachers and peers are also very specific in their feedback so the learner knows what to do next. This is due to the use of concrete success criteria. Think of learning to interview users about their experiences with play gardens. Once students understand the success criteria – e.g. I have to pause and ask further questions to get useful answers from the user – they are able to look back and to diagnosis what went well and what needs improvement.

This way you evaluate very effectively during the learning process and provide the chance to practise again and properly explain the positive effect on the learning outcomes. This kind of assessment is very different from summative assessment that takes place at the end of a learning process, for example by having a test. For design learning, formative assessment during authentic design projects is more appropriate for developing skills than assessing afterwards with a test.

An informative five minute video called Austin's butterfly showing a class using formative assessment and peer feedback during a science lesson is available on YouTube (search term: Austin's butterfly)

In this video you see that specific succes criteria support the process of monitoring and peer-feedback. With the tangible

design criteria and the tools of “Make design learning visible”, the same kind of formative assessment can be applied in design and technology lessons. Students learn approximately 50-70% as much in the same time. (William, 2018) This is also for higher order skills such as creative brainstorming.

On the next pages, each of the five formative assessment strategies will be described. You can also check the tool cards related to each strategy to develop a mental image of how you could apply the strategy in your own classroom.

Note: The set of tools do **not** describe the design activities and lessons itself. They are meant to **help** you include **formative assessment** in your classroom once you have selected a design activity.

Strategy 1 Clarifying learning goals and design skills

Importance of clarifying design skills

Students are more motivated and learn better if it is clear to them what they are working towards in a lesson. Clarifying learning objectives and skills is always important but in design and technology lessons even more. Quite often goals related to the content of the lessons are easily visible. For example in a design lesson about making a garden more livable for insects, students quickly understand that they are learning about insects. However, they are less likely to realize that they are developing their higher order design skills as well, e.g. think creatively and develop empathy for insects and other users the garden.

Develop a sense of quality

Students can only develop and improve themselves if they understand when design skills are used successfully. According to assessment expert Sadler (1989) students need to develop a concept of quality that is roughly similar to that held by the teacher. Without this concept, they are not able to monitor the quality of their design process and the applied skills.

Using the design skills cards can also be useful for less experienced teachers to develop their own understanding. When teachers use the tools of “Make Design Learning Visible” they quickly develop a concept of quality for design skills because they constantly evaluate student work from the perspective of design skills and by making learning goals specific, teachers are also more aware of where they are heading. During classroom pilots of the resource, understanding of the design skills grew amongst both the development team and the teachers involved.

Dialogue on design skills

Dialogue is an effective way to develop a shared, collective idea of design skills in your classroom. Discuss design skills before, during and after the design lesson. Why do you think that a design skill is used well or less well? You can use tools like “Visualise a design skill” or “Evaluating examples in advance” to activate and guide a constructive dialogue on success criteria. You will notice that there are often various ways that can be good.

Great profit in learning

Researchers have shown through qualitative research that formative assessment amplifies learning in design processes (Stables and Bain, 2009, Stables and Kimbell, 2007 & Klapwijk and Van Den Burg, 2019). In addition, quantitative studies in related areas such as creative brainstorming and on research skills show positive effects. In one study all students had to learn to become good researchers through a series of physics experiments. Both groups did the experiments, but only one group had a dialogue on the research skills, monitored themselves using smiley faces and made use of peer-feedback.

Consequence? The research skills of these students grew twice as fast as those of the students in the classes that did not hold a dialogue on the research skills nor applied (peer) feedback on the skills (White and Frederiksen 1998; Wiliam, 2011). Their content knowledge also improved more quickly.

Practical advice

- ◆ **Couple dialogue to exercises.** Organise a dialogue on one of the design skills and couple it with a small design exercise in which the students directly apply the design skill.
- ◆ **Work in interdisciplinary ways.** Decide (with your colleagues) to focus on one of the skills in all lessons during a week , e.g. “think in different directions’, “ share ideas” or “make productive mistakes”.
- ◆ **Focus on a specific success criteria.** Focus on two or three specific success criteria during a design activity and celebrate success before you introduce additional, more difficult learning goals.



Clarifying design skills, using the tool ‘Evaluate examples in advance’

Strategy 2 Eliciting evidence of learning

Making learning visible

Making learning visible is an important feature of formative assessment. Students are not tested afterwards to see if they have mastered the subject matter. Instead, the teacher and student actively seek evidence of learning during the lessons. In this way, it is possible to assess (and discuss) the extent to which students are mastering the learning objectives and skills.

Comparing various ways of designing

Searching for evidence of learning means listening, observing, asking and collecting information. Encourage students to visualise and to articulate what they do. Which thinking steps are they using? Revert to the dialogue on design skills and help students to understand how they relate to a certain way of designing. Let them experience the effect of different ways of designing and compare them through discussion. How did interviewing users help you to develop “empathy” in comparison to a simulation? What kind of interview approach revealed a lot about the user?

Eliciting evidence of learning, using the tool ‘Golden Frame’



Actively engage students

Involve students in collecting evidence about their own learning and that of their peers. This will save you time as a teacher, but the main reason is to ensure that students find it normal to evaluate their own work. Dewey (1938) says: "You are only an active learner if you not only shape the learning task yourself, but also act as an evaluator".

Errors are material for learning

All the evidence collected is interesting. Take a good look at materials that indicate that the way of working did not lead to a good result. The subsequent analysis is crucial for learning. Can you explain why the intended result was not achieved? What characteristics of your way of working are responsible for the result? Is this always a wrong way of working or only in this specific situation? When "errors" receive attention, learning starts.

Practical Advice

- ◆ **Plan sharing learning intentions.** Determining learning objectives prior to a lesson is a common approach. In addition, consider in advance how evidence will be collected during the lesson to visualise a design skill.
- ◆ **Postpone your judgment.** Usually there is some logical thinking behind a mistake. Discover what thoughts were behind a mistake or an approach. Ask further questions and take the time to look at the underlying reasoning.

Strategy 3 Providing feedback that moves learning forward

Give specific and concrete feedback

Feedback should give hope and help learners to develop themselves. Ask questions and find out what is going well, where there are opportunities for improvement and what would be a suitable next step. State as specifically as possible what students are already doing well when designing and give one or two specific instructions for improving their approach. Help students take the next step.

Forget about grades

In a study by Butler (1987), students were given exercises in the design skill divergent thinking ('Think in all directions'). Butler compared three ways of giving feedback: a grade, a clue for improvement, and a grade in combination with a clue. Indications were, for example: "You have come up with many ideas. Can you come up with more ideas? Have you thought in other directions? Can you come up with very special, perhaps crazy ideas? "Consequence? The performance of students who received a clue increased by around 30%. The performance of students who received a grade did not increase. What is special is that the performance of students who received a grade in combination with a clue did not increase either. These students ignored the directions. Factual compliments and directions for improvement stimulate what Carol Dweck calls a growth mindset (2014). Students realise that they can learn by practising and believe that their abilities can be developed if they work on it and accept failures and challenges as opportunities to grow.

Visualise feedback

Giving feedback in the moment or as soon as possible is valuable. In this way, it can be picked up and processed directly by the students. Visualising feedback speeds up both giving and receiving feedback. Use the symbols of the design skills for this. Paste or draw them on the students' work, give the students (individual) feedback in comments. Or ask the class to focus attention on a design skill as Ms Ehlers did half way through an activity. The class can then immediately respond to the feedback in the remaining lesson time.

Practical advice

- ◆ **Encourage a growth mindset.** Look back at performances over a longer period and make clear that much has been learned. This encourages hope and confidence in taking the next step.
- ◆ **Think of a manageable step.** Match feedback to a student's self-esteem or confidence. Challenge students with high self-esteem with an ambitious, big goal. Formulate a small next step for a student with low self-esteem. With many small steps you will get a long way.



Providing feedback that moves learning forward, using the tool
'What isn't working yet?'

Strategy 4 Activating learners as resources for one another

Develop awareness of own expertise

Learning together is one of the most successful approaches in education, as noted by education researchers Slavin, Hurley and Chamberlain (2003). The use of students as a resource for each other has many advantages. The motivation to learn increases, students get more pleasure in learning and they develop awareness of their own expertise. The social cohesion of the class also increases. Students feel more part of the group and the well-being of the group is very important to them.

Learning deepens

Giving help and receiving help is instructive and connecting. Students who receive help learn to articulate their request for help and learn to seek the right classmate to support their learning. Students who are the ones providing help need to reflect on their design approach and to think about what is important for someone else. Learning deepens. The provider (helper) thinks more deeply and consciously about the design skills and the recipient receives customised advice.

Encourage explanation in detail

Explaining is crucial when giving help. Taking over work or responding superficially does little for the development of design skills. It is better to provide detailed explanations, demonstrate design skills and clarify why it is good to use skills in a certain way. Then the provider of help and the receiver both learn.

Almost as effective as instruction from teachers

The profit is big; explanation by another student is almost as effective as one-on-one instruction by the teacher (Schacter, 2000). Students speak each other's language more and listen to each other as equal peers. They don't just "send a message" but interact. They dare to show each other much better than to their teacher that they do not understand something. "If I don't understand the teacher after a second explanation, I pretend I get it," says a student. Students do not want to appear stupid or they don't want to further burden their busy teachers (William 2011).

Practical Advice

- ◆ **Vary the way of working.** Alternate in the ways in which students can help each other. Oral explanation works nicely for one student, while others prefer writing down tips.
- ◆ **Make your students experts.** Give instruction to a small group of students and make them responsible for transferring this instruction to the rest of the class.



Activating learners as resources for one another, using the tool 'students as experts'

Strategy 5 Activating learners as owners of their learning

Stimulate personal learning goals

Students are more motivated if they can make their own choices. They become aware of their learning and thus direct their own learning process. Students think about the design skills they already have a good command of and about the skills that they still find difficult. They make their own plan to develop and seek appropriate help from the teacher or from other students.

Create motivation for meta-cognitive thinking

When meta-cognitive thinking processes are powerfully developed, students can think about how they can learn something new and what works for them. Research shows that students often use their meta-cognitive skills in their free time to regulate their own learning process, but do not apply this at school (Corno, 2001). In many cases, the problem is not a lack of meta-cognitive skills, but a lack of motivation.

Match difficulty and capacity and flow will follow

Intrinsic interest in the task is of great importance in motivation. Equally important is a good match between a person's capacity and the difficulty of the task (William 2011). If the level of difficulty is high and someone's capacity is low, fear will arise. If it is the other way around, boredom will arise. With the right match between difficulty and capacity, flow and the motivation to continue are created.

Take time

Students are often not used to being the owners of their learning process. Usually the teacher determines what students (should) learn. Give students time to become the owner of their learning process and help them with it. Firstly, have students practise designing, clarifying learning objectives and collecting evidence a few times. Give them as often as possible a choice between two tasks. Secondly, in interaction with the teacher, they come up with personal learning goals and associated design tasks. Thirdly, they will also do this independently.

Practical Advice

- ◆ **Formulate personal learning goals.** Let students formulate their own learning goals or team goals for a design skill. Provide opportunities to work on these goals in the next design lesson.
- ◆ **Own design style.** Designers each have their own design style. Let students develop their own style and set goals related to this style. Let them connect to (adult) designers with similar styles.



Activating learners as owners of their learning, using the tool 'Group design results'

EXAMPLE: BIOMEDICAL DESIGN

Develop empathy in a biomedical design activity

Teacher Mr. Puccino is conducting a series of design lessons where students will come up with ideas to help people with arthritis. In today's lesson, the students will simulate that they have arthritis by attaching lollipop sticks with masking tape to their hands to feel what it is like to have arthritis during daily activities (stiff fingers and unable to apply force).



Clarifying and sharing the design skill (strategy 1)

As his class knows little about the design skill "empathise" Mr. Puccino uses the tool "Evaluating Examples in Advance" to clarify the skill at the start of the design lesson. He has collected good and bad work from a class from another school who designed products for the elderly in their neighborhood. Some examples show that the students had really understood and empathised with elderly people, other work shows that these students completely forgot about their target group. Mr. Puccino's students now understand why designers have to empathise and that you need information about the users. They are eager to start the simulation.

Eliciting evidence of learning and providing feedback

(strategy 2 & 3)

Mr. Puccino takes a good look around the classroom during the simulation. He sees that all students find it easy to empathise with people with arthritis and he compliments his class. However, while designing and working out a design for people with arthritis, Mr. Puccino notices that one team has developed a design that is not suitable.

He asks the whole class to pause and to reflect on the design. When he asks them “Is your design idea suitable for someone with arthritis?” some of the teams discover that their product is very awkward to use for someone with stiff, painful fingers. “We have to change our idea to make it suitable for someone with stiff fingers!”.



Students working out their designs

SECTION 4: HOW TO USE THIS IN YOUR OWN DESIGN & TECHNOLOGY LESSONS?

Integrate formative assessment tools in your own D & T lessons

Prepare the design lesson as you normally would. An additional goal is to consciously practise one design skill by integrating a tool from “Make Design Learning Visible”

1. Select a design lesson and a design skill to focus on.
2. Provide sufficient opportunity to develop this design skill in class.
3. Select a tool from the “Make Design Learning Visible” toolbox and integrate it into the lesson plan.
4. Determine if additional formative assessment activities for the strategies that are not covered by the tool are needed and include them in the lesson or series of lessons.
5. Perform the design lesson and apply the tool.

Formative assessment with young children

Do you teach 3-7 year olds? The design skills and formative assessment are also relevant for them. The following seven tools have been found to work well with young children:

- Perseverance Cup
- Library of Inspiration
- Photo Storyline
- Suggestions Wall
- Golden Frame
- What isn't working yet?
- Group Design Results



Adjust the tools and ask the students to tell and draw. Sketch or write down their key words or make a drawing and hang these in the classroom.

Formative assessment with older pupils

Do you teach 15 year or older pupils? The design skills and tools are also relevant for your design and technology lessons. Most tools are directly useful, some will need adaptation to this specific age group.

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Tools

- Traffic Lights, Evaluating Examples in Advance and Student Reporter are based on Wiliam 2011.
- Photo storyline is based on Kimbell and Stables (2007).
- Obstacle Game is inspired by Challenge Cards, www.gamestorming.com
- All other tools are based on the Dutch version of "Make Design Learning Visible" (Klapwijk e.a. 2017).

MAKE DESIGN LEARNING VISIBLE

