Digital Literacy in Secondary Education Design Projects

Promoting Playful Reflection, Collaborative Creation and Self-Regulated Learning

Megan van Mook
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Executive Summary

Digital literacy has become an essential skill in the 21st-century workforce, prompting educational institutions to revise their curricula to incorporate digital literacy into their teaching methods. This research focuses on the challenge of integrating digital literacy into the secondary educational course Design&Technology, which follows a project-based, competence-driven approach that presents difficulties in establishing overarching guidelines and methods. Design&Technology teachers often adopt a coaching role and must adapt to various classroom situations on the spot.

The objective of this project was to explore the structural inclusion of digital literacy in the Design&Technology course without disrupting the current teaching methods. The research began with theoretical groundwork and quickly engaged Design&Technology teachers and students through context-mapping sessions. An analysis of the intended teaching methods and underlying educational principles, compared to student experiences, revealed a problem: the relatedness component, crucial for fostering self-regulated learning, was lacking, particularly in coaching students in the use of digital tools. Due to the fast-paced nature of the course, teachers rarely had the opportunity to step back and reflect, thus remaining unaware of this missing element.

The design goal of the project was formulated as follows: to help Design&Technology faculty collectively reflect on their daily experiences and enhance their ability to manage situations and guide students effectively. The aim was to ensure that teachers can communicate their expectations without hindering the student's self-regulated learning process.

The generation and iteration of proposed concepts involved educational experts, designers, and internal stakeholders, including Design&Technology faculties from two schools. The outcome of the project was the development of a "Reflectiespel" (Reflection Game). This game is intended to be played during pivotal moments within the faculty, such as the start of a school year, to facilitate the exchange of views and perspectives, promoting a unified outlook on the Design&Technology course at the school. The game prompts teachers to reflect on their interventions with student design teams and their effectiveness in supporting the self-regulated learning journey emphasized in the Design&Technology vision. Additionally, the game provides a safe space for participants to express personal opinions and viewpoints.

Finally, the designed game was evaluated within a relevant context, involving a Design&Technology faculty that had not been previously involved in the research process. The evaluation demonstrated that the game successfully facilitated meaningful conversations among colleagues, enabling reflection on daily teaching practices without judgment. Future research could involve gathering the student perspective during gameplay or testing the game across multiple faculties or schools to compare approaches and exchange advice.

Personal Note

Thank you for reading this master thesis and showing interest in the development of secondary school design education. I am writing this personal note with a mixture of excitement and gratitude as I approach the end of my master's journey in design education. This thesis represents hours of research, exploration and iteration, and it is with great pride that I present it in this report.

The field of secondary design education has gradually captured my interest all throughout my bachelor and master journeys. The opportunity to delve into the intersection of these disciplines in this thesis project has provided me with new perspectives on the power of design in educational contexts. Not only has this research allowed me to reflect on my skills and experiences as a designer, it has also prompted me to question and explore myself as a student and a secondary teacher. The process has deepened my understanding of the challenges and opportunities that lie ahead in secondary education and the influence of design skills on the next generation students.

In my opinion the combination of design and education as a cohesive, purposeful unit is a wonderful field to explore and I certainly plan to continue doing so. In short-term, this means I plan on attaining my teaching degree to be able to teach Design&Technology, starting next September.

It is my sincere hope this thesis can contribute to the ongoing conversation surrounding pedagogical practises in design education, inspiring educators and designers alike to embrace innovative approaches that empower the students.

In closing, I extend my heartfelt gratitude to members of my committee for their time, expertise and commitment. It was extremely inspiring to me to share my research with you and I eagerly look forward to any insightful discussions or cooperations that might follow. I would also like to thank the four schools that were involved in the duration of this research, especially School 3, where I was allowed to perform all three contextmapping sessions. Thank you so much for opportunity to experience the design education up close and explore current practises in context. Lastly, thank you to my friends and family for supporting me throughout this process, in particular Anna, Adhi and Britt, who contributed not only in emotional support but also directly to the quality and clarity of this research and report.

Glossary

Definitions

Design&Technology	Secondary education course in the Netherlands. In Dutch: Onderzoeken&Ontwerpen
Design&Technology faculty	The encompassing term for the Technator, the Design&Technology teachers and the Technical Assistant(s)
Design&Technology student	A secondary education student (aged 12 – 18) taking the Design&Technology course
Design&Technology teacher	Teacher that teaches the Design&Technology course
Technasium	General term for all things included in the Design&Technology course. It usually encompasses the area of the 'Technasiumlokaal' in the school or the faculty of Design&Technology teachers.
Technasiumlokaal	Classroom designed for the Design&Technology course, usually including area's for brainstorming, prototyping, collaborating and presenting
Technasiumschool	A school that offers the Design&Technology course and is connected to the Stichting Technasium network
Technasium network	Large network of Technasiumschools, clients, experts and Stichting Technasium
Technator	Facultyhead of the Design&Technology teachers, responsible for projects, clients and meetings
Technical assistant	Manager of the 'Technasiumlokaal', responsible for machinery and materials
HAVO	Senior general secondary education
VWO	Pre-university education

Abbreviations

DC	Design Criteria
D&T	Design&Technology
EEF	Education Endowment Foundation
ICT	Information and Communications Technology
ISTE	International Society for Technology and Education
KNAW	Koninklijke Nederlandse Akademie van Wetenschappen
Ministry of ECS	Ministry of Education, Culture and Science
Minister of ECS	Minister of Education, Culture and Science
SEC	Science Education and Communication
SLO	Stichting Leerplan Ontwikkeling
STEM	Science, Technology, Engineering and Mathmatics
TA	Technical Assistant

Table of Contents

01

The first chapter consists of the problem definition as well as an overview of the parties involved, the motivation for the project and the scope. Research questions are developed that will be answered through the course of this research.

Introduction

1.1 The Problem Definition

The Issue
Digital literacy has recently been recognised and defined as an important skill to have when entering the 21st century workforce. It is the responsibility of educational institutes to properly nurture this skill in their students in preparation for their future lives.

Since 2003, secondary education schools in the Netherlands have started to offer the new course Design&Technology (D&T). In this course, students are often divided into teams of around four to five people who work on beta technological problem statements in a project adressed over 10 weeks. The project briefs are given by actual clients and most are written by the D&T teachers themselves. Due to this, there is a large variation in projects given to students, making it difficult yet important for D&T guidelines and methods to apply to all projects. The subject is in large part a direct preparation for the bachelor course of Industrial Design Engineering or related bachelors (Technasium, 2020).

The Opportunity
Design&Technology teachers see an opportunity to integrate this digital literacy in the project based design results they ask of their students (Lukken & van Mook, personal communication, 8th of November 2022). The course offers opportunities to make use of basic digital skills such as searching, assessing and presenting information through digital tools, or more intricate skills such as making use of a laser cutter or 3D printer when creating a prototype.

Currently, the course set-up does not offer enough support for teachers to integrate these skills and this research aims to investigate why exactly this is so challenging, and what elements can help build a proper framework to include digital literacy in the secondary education course of D&T.

See Appendix A. for the original project brief.

1.2 The Stakeholders

Science Education and Communication (SEC)
The client for this thesis is the faculty Science Education and Communication at Delft University (Science Education and Communication, n.d-a.). Besides offering colleges for multiple secondary education teaching degrees, the faculty performs research that integrates numerous disciplines to work on social and technical sciences, discussing topics such as climate change, ageing healthily or the development of primary and secondary education with teams of students, scientists and professionals in practice.

In order to stimulate this cooperation, SEC is part of the 4TU platform (4TU.Federation, n.d.) which uses the core values of connection, representation and innovation to combine the expertise of the four technical universities in the Netherlands (Delft, Enschede, Eindhoven and Wageningen).

SEC also organises Het Wetenschapsknooppunt (Science Education and Communication, n.d.-b), to connect with secondary and primary schools in the South Holland-area. This collaboration of TU Delft employees, students and researchers, as well as secondary education teachers, deans and pupils, allows for the development of projects in which creative thinking, researching and designing helps develop the educational system.

Stichting Technasium
See the glossary on page 5 for definitions on specific terms used throughout the report.

Although Stichting Technaisum is not the client in this project, they are an important stakeholder. Stichting Technasium provides Technasiumschools with structure, possibilities and developments in the Design&Technology course. Through Stichting Technasium, this report covers all Technasiumschools as stakeholders.

Stichting Technasium is a foundation that supports secondary schools in offering and organising the subject D&T. Since their founding in 2003 the main goal has been to develop and improve STEM Education in secondary schools at the tracks HAVO and VWO* (Technasium, 2023a).

Stichting Technasium is responsible for cohesion between schools regarding the subject D&T, safeguarding the quality of the subject, and are the only officially assigning authority for the predicate of Technasiumschool.

Being a Technasiumschool allows the school to become part of the foundation's community and gives the school a platform to share experiences or developments. The community also connects the Technsiumscholen to potential, suitable clients and organisers further training and courses for the teachers and Technical Assistants at schools.

Lastly, Stichting Technasium is responsible for the continuous development of the course curriculum and they have close connections to the educational faculties at for instance the Universities of Delft, Eindhoven and Enschede, where teachers can obtain a D&T teaching degree (Technasium, 2023b).

*Dutch secondary education is divided into three tracks, VMBO, HAVO and VWO(+ Gymnasium). VMBO is pre-vocational secondary education. HAVO is senior general secondary education. VWO(+ Gymnasium) is Pre-university education. (Primary and secondary education, n.d.)

1.3 The Scope

There is currently a national trend of researching digital literacy and the incorporation thereof in primary and secondary education (KNAW, 2012; SLO, 2018; Curriculum.nu, 2019a). This research can account for significant knowledge on skill levels and education application across all courses and curricula. As stated in the problem definition the course of Design&Technology practises unique methods and contexts. The combination of this course and the application of digital literacy has not yet been extensively evaluated, something this thesis aims to initiate.

See the scope of the project in Figure 1. A numerous amount of researches established the level of skill students should attain after finishing primary school, the latest and most concrete example being *Inhoudslijnen primair onderwijs, digitale geletterdheid* (SLO, 2022b). In the exploration and development phase, the assumption that all students have reached that level will be applied in this project, leaving digital literacy in primary schools outside the scope.

In the exploration phase the literature presented are mainly on the topic of why and how to include digital literacy in education and Design&Technology. As Stichting Technasium has the intention to include digital literacy in their education this project starts with the same perspective. No counter-arguments or other opinions on the inclusion of digital literacy in the Technasium are communicated in this report.

1.4 The Research Questions

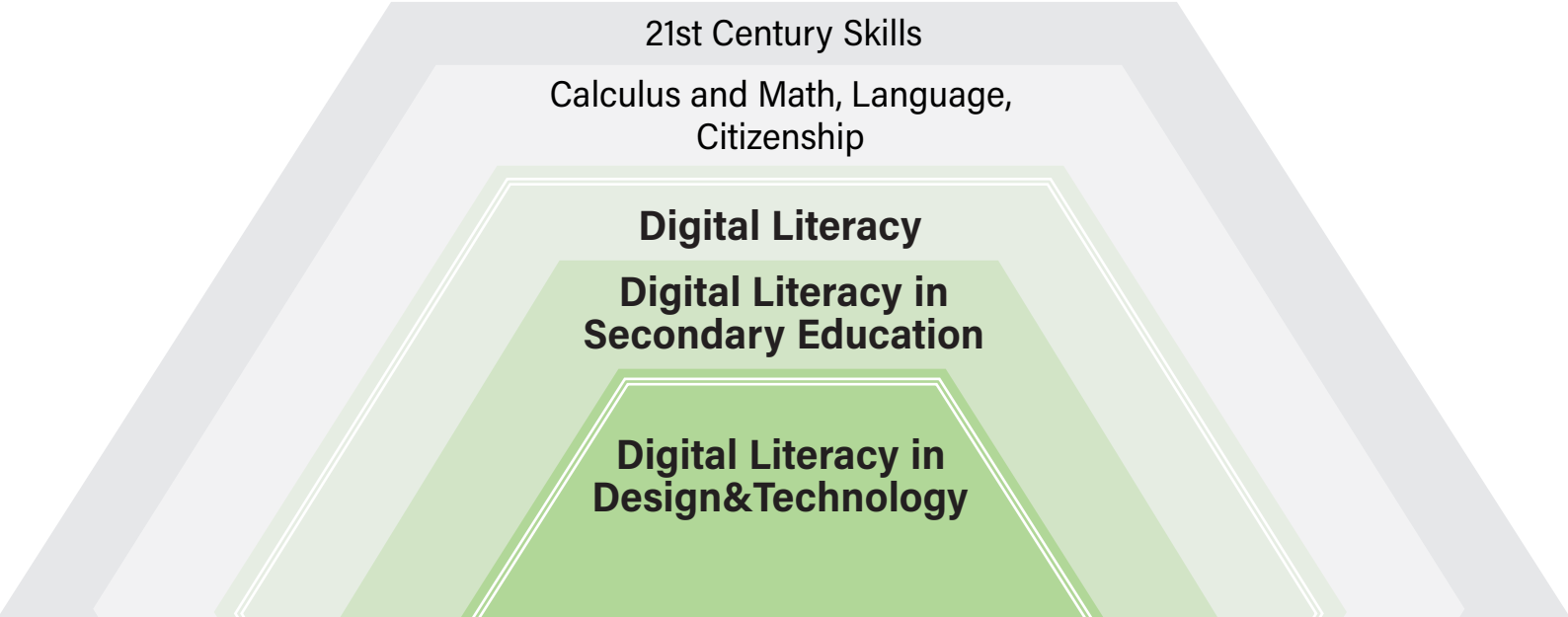
The goal of this research is to provide a framework to include digital literacy in the secondary education course Design&Technology. The research must first determine what currently challenges this inclusion. The main question of the thesis therefore is:

What elements currently challenge the inclusion of digital literacy in the Design&Technology course and what enabling characteristics can these elements have for a solution?

The formative and qualitative nature of this research is expected to cause a shift in the direction of the final result, allowing the influence of stakeholders to give it shape. With the intentionally open direction of the final deliverable the following question also arises during the process of this report:

How can Design&Technology teachers and/ or students be aided in surmounting these challenging elements?

Figure 1, The scope of the project excludes the 21st century skills and the four basic skills



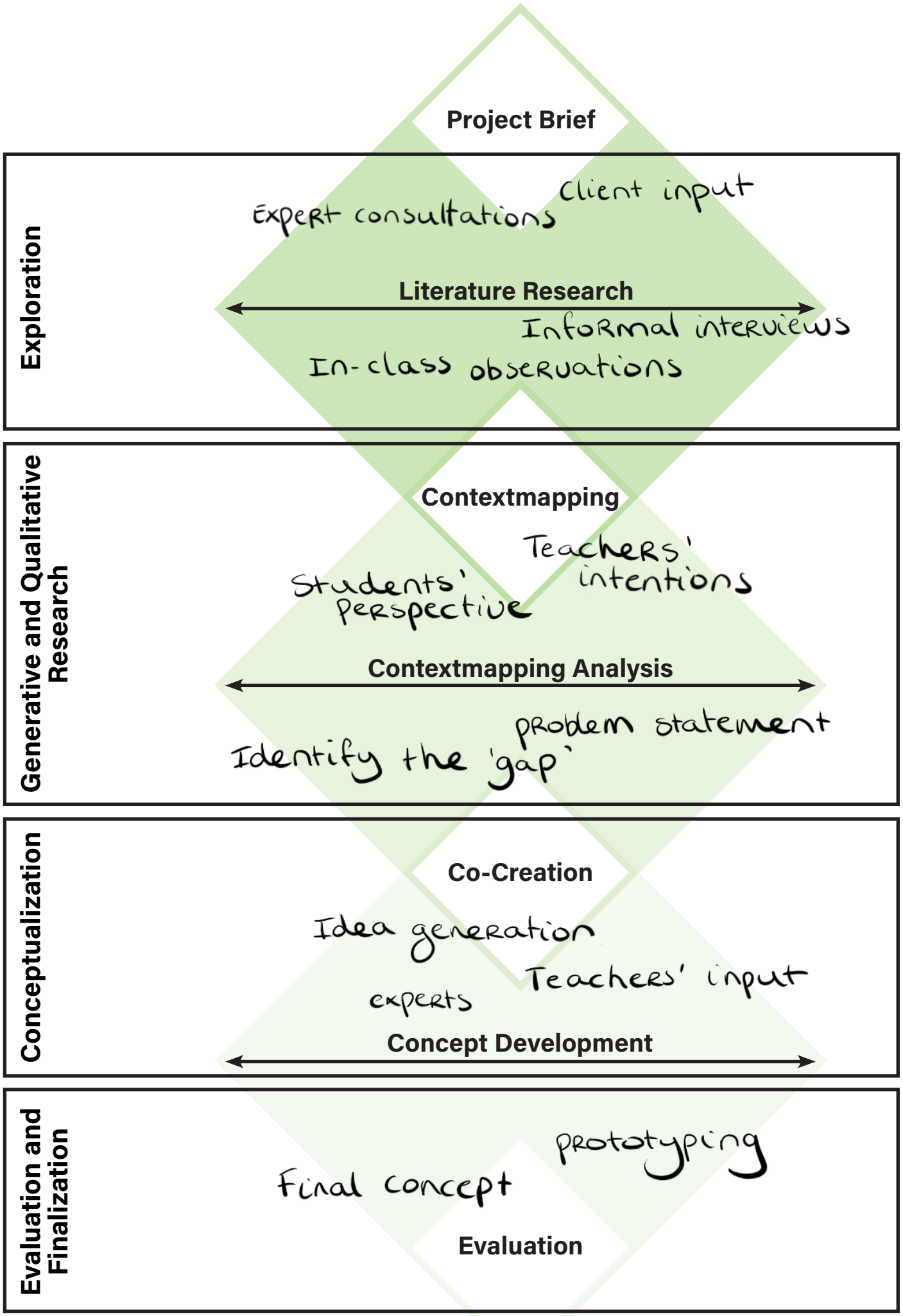


Figure 2, The project approach consists of four phases

1.5 The Approach

The project is planned in four phases; Exploration, Generative and qualitative research, Conceptualization, Evaluation and finalization, see Figure 2.

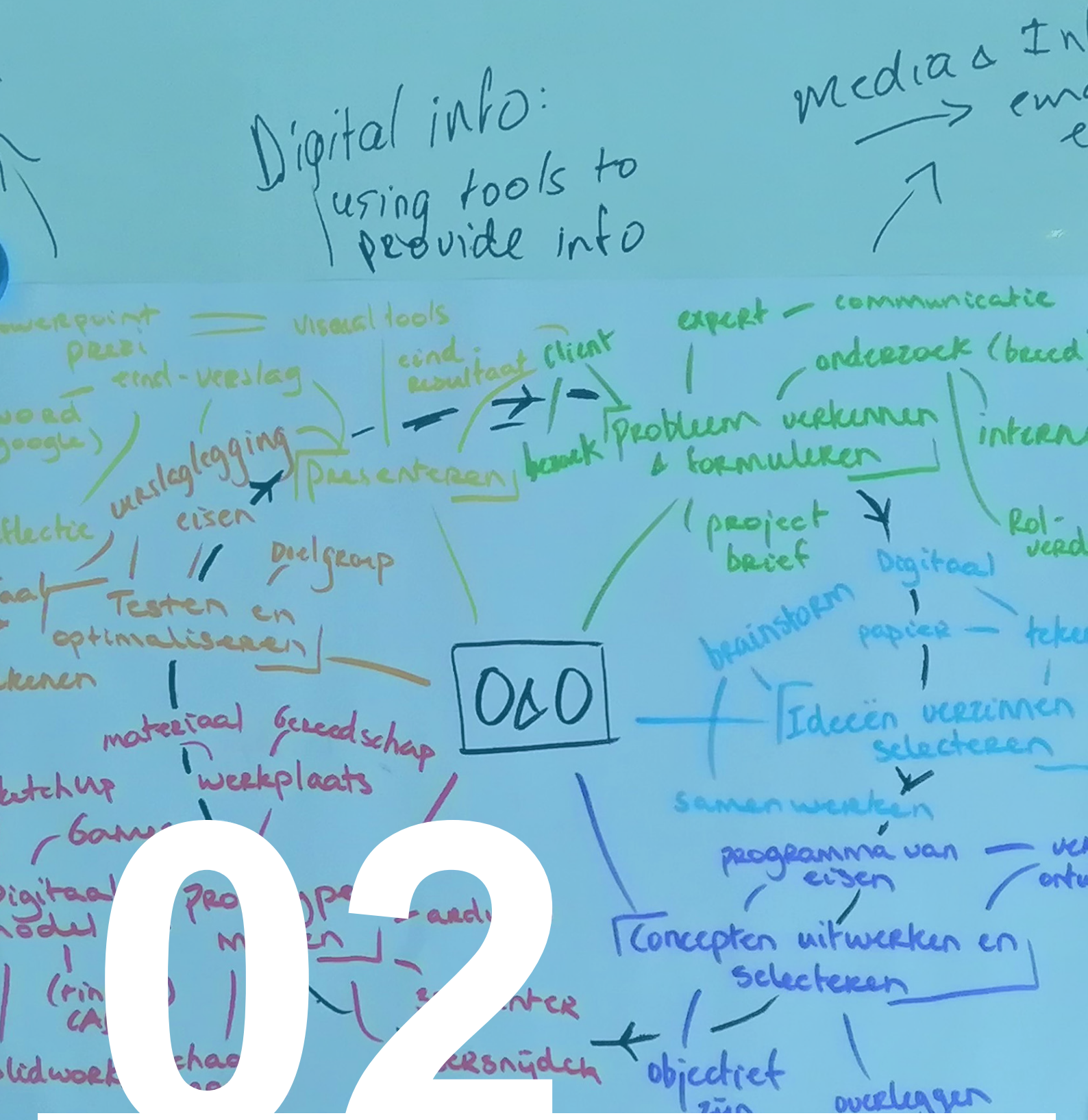
The exploration of this report starts with a broad analysis on digital literacy and continually narrows it down to digital literacy in the secondary education D&T course.

In addition to this the generative research gives rise to themes such as self-regulated learning, coaching and didactic reflection. These themes all stem from the contextmapping sessions conducted with teachers and students of the D&T course. Combining these revealed elements with the needed flexibility in design education creates a unique field of research and yield the design goal of this report.

The conceptualisation again takes into account the expertise and experience of teachers, Technators and educational experts through co-creative sessions. Together with established Design Criteria, the arguments and perspectives of these participants shape the final design.

This design is then evaluated in the final phase of the project. The evaluation places a prototype in a realistic situation and tests the understandability and envisioned use of the concept.

The report is concluded with a discussion and recommendations.



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To better understand the components digital literacy and the subject Design&Technology, there are several explorative questions that can be answered. These questions are:

What does digital literacy entail? When are you digitally literate? What exactly do students learn in the course D&T?

These relatively objective questions can be answered by exploring the project brief and the solution space. This chapter will contain research into literature about digital literacy, digital literacy in education, the course D&T and the combination of both components.

Exploration

2.1 Understanding Digital Literacy

Digital literacy refers to the capability of skilfully using ICT, digital media and other technologies to access digital information and platforms. The term consists of the word 'literacy', referring to the skill of reading and writing, and the word 'digital', adding an entirely new context in which this reading and writing might materialize. The combination of those two words creates a complex problem space in which people nowadays will need to learn to navigate in order to progress (Loewus, 2020).

A person is considered digitally literate when they are able to consciously and responsibly use digital technologies in a creative way, accessing information and actively engaging in the current and future society while keeping a critical attitude towards both the technologies and the information accessed or provided (Fraillon, Schulz & Ainley, 2013; SLO, 2018; van Rooyen, 2021; SLO, 2022c).

To better define digital literacy in its full meaning and complexity SLO researched the most used domains and connections between them in their *21e eeuwse vaardigheden in het curriculum van funderend onderwijs* (Thijs, Fisser & van der Hoeven, 2014). Concluding this research, they defined four domains that cover the main skills of digital literacy, see Figure 3.

Why is digital literacy important?
The aforementioned digital literacy is a required skill when it comes to navigating a digital society. Humans, technology and communication have never been this entangled. The importance of digital literacy has not only recently been researched in the Netherlands, but also by others in France, Germany, England, Sweden, Norway and Singapore according to the KNAW in *Digitale geletterdheid in het voortgezet onderwijs* (KNAW, 2012).

ICT basic skills Using the possibilities of technology and having some insight in the inner workings of electronical and digital appliances.	**Digital Information-skills** Systematically, effectively and efficiently using digital sources when collecting, evaluating, processing and sharing digital information.
Media wisdom Critically and consciously using digital media in a medialised-society.	**Computational thinking** (re)Formulate a complex problem using strategies so computer-technologies can assist in solving it.

Figure 3, The four domains of digital literacy, Thijs, Fisser & van der Hoeven (2014)

Extensive skills are required to navigate the digital world of accumulating data, especially with a specific goal in mind. Digitally literates can come up with relevant search terms, scan for applicable texts or documents, discard unnecessary terms and summarise the information compiled, or even add contributions (Sijberts & Woldhuis, 2021; De Vries & Van Rooyen, 2021).

As in any society, this digital plane of existence requires morals and ethics, which are still very much in development and are hindered somewhat by the borderlessness of the digital world. With infants having their own phones or iPads, digital etiquette needs to be taught structurally and from a young age (van Rooyen, 2021).

Furthermore, the current generation's upbringing in relation to the early availability of digital tools sets the stage for a very common misconception; that they are experienced with digital devices (SLO, 2018). Meelissen, Punter and Drent (2014) explain that the opposite is observed. Their skill is based on the recognition of similar icons or set-ups in commonly used digital devices and applications (Kirschner, 2016) which according to Paul Gilster's (Gilster 1997) definition cannot be qualified as digital literacy.

Gilster defines digital literacy not as the skill of using a keyboard correctly, but the understanding of technical concepts and the ability to command the skill and knowledge needed to control and use those concepts. The SLO *Startnotitie digitale geletterdheid* (2018) explains that the students lack the actual understanding on the inner workings. Once this younger generation begins to understand technical concepts, digital tools will allow them to be much more innovative and creative, continuing their expansive digital reach and developing the next generation of digital tools and research (Curriculum.nu, 2019a).

In conclusion, digital literacy is important because it can shape a person from a young age in regards to how they develop their personality, their perspective on society, and even how they relate to others.

2.2 Digital Literacy in Secondary Education

Companies and businesses increasingly request digital skills from their employees. Some require a basic overall understanding, but most have specific tools or strategies that require creativity or in- depth knowledge from their users.

This is visible in higher education as well, which has started to include these devices or tools in their programmes and often require their students to have already gathered adequate knowledge and skill (KNAW, 2012; Faillon, Schulz & Ainley, 2013; Meelissen, Punter & Drent, 2014). This leaves the initial cultivation of digital literacy among students to occur in primary or secondary education (KNAW, 2012; Agirdag et al., 2021).

Furthermore, the process of learning and acquiring digital literacy is a lengthy one, often connected to different topics or innovations and therefore perfectly suitable for application in schools as early as primary school.

The following pages contain a brief timeline with research on digital literacy and its inclusion in secondary education.

1997

Many consider Paul Gilster the first to shape the definition in his book with the self-evident title *Digital Literacy* (1997). Gilster focused mostly on the digital reading and writing, dealing with various techniques and formats of providing information.

2007

In 2007, the non-profit organisation International Society for Technology and Education (ISTE) came with a report that explained various skills needed to navigate our digital society, among which digital literacy (ISTE, 2007).

2012

The Royal Society publishes "*Shutdown or restart*" (2012) giving a clear overview of the current digital literacy in the United Kingdom and ways to implement this in education. Similarly, and in the same year, the Koningklijke Nederlandse Akademie van Wetenschappen (KNAW) produced an analysis pleading for fixed spots in the Dutch secondary education curricula for all the 21st century skills. They advise the Minister of Education, Culture and Science (ECS) to promote digital literacy to be included in every subject as seen suitable by the schools and encourage collaboration between courses.

2013

The report of the KNAW is closely followed by other organisations providing their analysis on digital literacy and its various aspects and touchpoints in education such as the *Internation computer and information analysis* by Faillon, Schulz & Ainley (2013) and *Digitale geletterdheid van leerlingen in het tweede jaar van het voortgezet onderwijs* by Meelissen, Punter & Drent (2014).

2015

OnsOnderwijs2032 was kickstarted in 2015 by Secretary of State Sander Decker. This research was an open invitation for anyone to give their opinion and insight into the improvement of education (De Wereld draait door, 2014). The report with recommendations was published in 2016 (Platform Onderwijs2032, 2016), with the platform and education committee ending immediately after due to the lacking inclusion of teachers and the top-down advice (Visser, 2016).

2017

Curriculum.nu was founded; a committee consisting of teachers, deans and experts, publishing their recommendation on improvements to the current curriculum, advocating 9 different learning areas, one of which is digital literacy (Dekkers, 2017; Curriculum.nu, n.d.). They state that first the central goals and in terms will need to be fixed in the national rules and regulations, and therefore responsibility falls on ministries and governments to make the next concrete move (Curriculum.nu, 2019a). The committee was ended in 2019 with the government expressing doubts behind the broad analysis of the problem definition and the missing movement towards an actual solution (NOS, 2019).

To continue working towards the intended improvement of the national curriculum, the Ministry of ECS has given the assignment to Stichting Leerplan Ontwikkeling (SLO).

"Ze [einddoelen] moeten concreter en eigentijdser worden. Niet via grote vernieuwingsprocessen zonder wetenschappelijke basis, maar op basis van een heldere probleemanalyse. Kleinschalig, met meer focus op de basisvaardigheden."
Wiersma, 2022b, p.9

The SLO report *Startnotitie Digitale Geletterdheid* (2018) gives a very similar story to that of the KNAW (2012) and Curriculum.nu (2019a, 2019b). They reiterate that although the students might be considered digital natives, the actual measured skill most students have is lower than expected and even insufficient against demands from employers.

2022

The latest post on the SLO website provides the information that they started the revision of the central goals and exam requirements in spring 2022, as was assigned by the Ministry of ECS (Teunis, 2023).

2.3 The National Curriculum Change

While assessing past research and developments on digital literacy and digital literacy in education, it is impossible to miss the general struggle surrounding the curriculum revision. There has not been a structured and periodic revision of the given Dutch education since 2006 (Het Lerarencollectief, 2023).

"Het geven van deze heldere opdracht aan scholen gaan we echter niet voor elkaar krijgen op de manier waarop de curriculumherziening tot nu toe is aangepakt. Dit proces heeft nu al veel te lang geduurd, en is te groots en meeslepend opgezet."
Dennis Wiersma in his kamerbrief *Masterplan Basisvaardigheden* (2022b, p.9)

Because the revision of the central goals and end terms have been in wait for so long the workload accumulated over time and a starting point is indiscernible.

It is unclear whether the inclusion of digital literacy is in perfect timing for this change, or if it only creates a larger load of development and cannot be included without an steady educational basis. This report the latter claim. Agirdag et al state that "*Veel scholen zullen de nieuwe leergebieden willen integreren in bestaand onderwijs, deels om overladenheid van het curriculum tegen te gaan, en deels vanuit inhoudelijke overwegingen. Hoe scholen dat vormgeven, is te beoordelen door henzelf*" (2021, p.26)

The government is certainly responsible for creating attainable revisions but the inclusion of teacher and expert advice is also imperative. Education must be based on practical experiences and classroom-scenario's. Building overarching plans and assigning responsibility to schools to implement these goals is not realistic. The plan SLO is currently working on needs to give an adequate platform for teachers and practical solutions and support to schools that can be implemented flexibly.

2.4 Understanding Design&Technology

The Design&Technology Mission

In 2003, in cooperation with parents and educational professionals, the idea for a new type of school arose (Vijlder, Bakker & van den Blink, 2014). The course Design&Technology was created, intending to bridge the gap between secondary and higher education in STEM (Stichting Technasium, 2021).

The mission of the course is to offer project-wise education, rich with context and aimed at developing competences. It operates on the aspects of self-regulatory learning and project-based education. In these projects, the course aims to provide students with as much context on STEM studies and workforces as possible.

The projects generally last 10 weeks, with double the time for the last two projects in which students are expected to perform their research or design project almost completely without teacher interference or support.

The course generally accommodates the use of the widely-known research or design steps, see Figure 4, but determining the specific tasks is up to the students. It the intention that projects are not disrupted by lessons or classes about specific skills or tools. In practise these lessons do happen in the lower classes, mainly in support of using certain programmes or tools such as a lasercutter.

Figure 4, De Ontwerpcyclus makes use of six main steps in the design process, Wetenschapsknooppunt TU Delft (2020)

As the students then grow and develop over the years, they start shaping their own projects, letting their interests and previously developed skills point them in the right direction. Since the projects can be recruited or written by schools themselves, it is up to the school to determine their own D&T curriculum, ensuring the skills required for any well-executed research or design project get picked up by students along the way.

"Als technasiumcommunity dragen wij bij aan een betere wereld door onze leerlingen op te leiden tot waardebewuste, competente wereldburgers en zelfbewuste, betatechnische studenten."

Laarveld et al. (2021), p.8

Due to the curriculum revision Stichting Technasium is responsible and eager to keep D&T relevant in the context of the added skills. Refer to Stichting Technasium's *Het technasiumonderwijs: De onderwijsfilosofie van het technasium op hoofdlijnen* (2021) for more information on the Design&Technology course.

Competence based education

The course Design&Technology operates on 'competence-based learning' and formative assessment. This means the course does not have predetermined levels of knowledge or wisdom that students must be able to wield before they can graduate. Stichting Technasium mainly operates on six overarching competences or skills they encourage in the students. These are: Creativity, Innovation, Project-wise, Cooperation, Self-regulated and Communication.

Assessment and reflection of the student is based on 20 smaller competences determined to help them in their future studies and careers, as well as their own personal development. Competences contain topics such as: planning, creativity, cooperation, taking initiative and self-regulated learning. Since 2019, the 'Competentiemonitor' is an online tool that allows students to access their earlier versions and visualise their developments in the D&T course (Competentiemonitor, n.d.).

Self-regulated Learning

'Self-regulated learning: Hij [Knowles, 1975] omschrijft zelfsturend leren als 'het proces waarbij het individu initiatief neemt, met of zonder hulp van anderen, om zijn leervraag en leerdoelen te formuleren, menselijke of materiele bronnen te raadplegen, om geschikte leerstrategieën te kiezen en toe te passen en om de uitkomsten te evalueren.'
Stichting Technasium, (2021), p.12

Due to the formative character of the course, there is an emphasis on the self-regulation of students during their learning process. Within the projects given to the students, they are expected to plan their own timeline and design activities. Stichting Technaisum (2021) divides this self-regulated process in three elements: the self-image of the students, the feedback on their performance and the coaching of the teacher. Ryan & Desi (2000) in their Self-Determination Theory call these elements competence, autonomy and relatedness.

"The theory posits that goal directed behaviours are driven by three innate psychological needs: autonomy (the need to feel ownership of one's behavior), competence (the need to produce desired outcomes and to experience mastery), and relatedness (the need to feel connected to others) in every human being."
Wang et al., 2019, p.1

Should a situation or scenario foster all three elements, the student is more inclined to operate on intrinsic motivation, leadin to a better performance and a positive impact on their wellbeing. As a teacher, coaching with these elements in mind is quite difficult. The Education Endowment Foundation (EEF) provides seven recommendations for teachers on developing meta cognition and self-regulated learning with their students. In their report they mention self-regulated learning can not be taught in a self-regulated way; the teacher must stay close to the students, show examples, explain what they are thinking and slowly give them more independence and autonomy. Eventually, metacognition and self-regulated learning will become habitual in both the teachers and the students (Quigley, Muijs & Stringer, 2018).

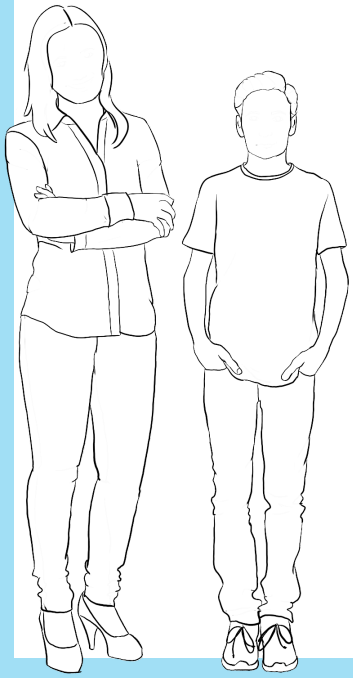
There are many tactics available to guide students through a self-regulated process. EEF mainly gives structure on proper activities to perform with the class while for instance De Docenten Academie has a Begeleidingsladder (steps to coaching) on direct, verbal coaching (Joosten, 2021)

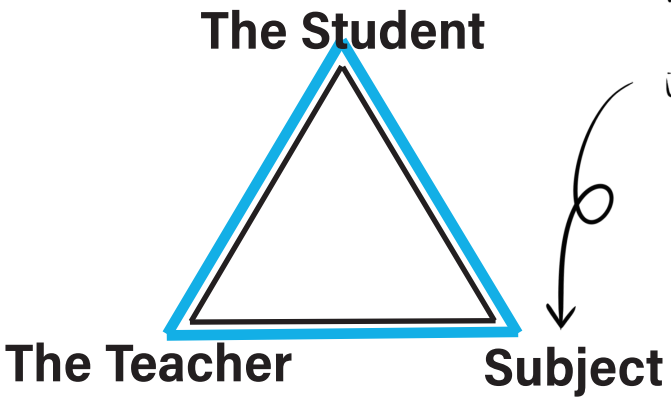
The Design&Technology Teachers

With all these goals and requirements on self-regulated learning, and no specific knowledge to pass on the role of the teacher changes almost completely compared to regular courses. As Stichting Technasium (2021) posits; The teacher now must assume a coaching role, often requiring them to wait and see what the students do. It is imperative for the teacher to apply active methods in the classes and support the students in their own personal development. In the ideal world, Design&Technology students and teachers collectively decide on the learning goals of a project so that afterwards, the assessment can be based on whether the student achieve these goals or not.

Since the course is relatively new, the D&T sector has a large amount lateral entries. Teachers mostly transferred from courses such as Physics, Chemics, Math and Biology, but also Art or Workshop. Although Stichting Technasium (2021) states that it is of great importance to have one coherent vision on self-regulated learning if the D&T course is to be successful, all these teachers unwittingly bring their own perspectives and methods to the course.

This thesis makes use of De Didactische Driehoek, see Figure 5, formulated by Tielemans in his *Psychodidactiek* (1999). Its shows a simple representation of the relations between the teacher, the student and the topic/subject with the message that all relations must be balanced in order for productive education to occur.





In the case of this research the subject is Digital Literacy in Design&Technology specifically

Figure 5, De Didactische Driehoek must be in balance, Tielemans (1999)

2.5 Digital Literacy in Design&Technology

Based on the literature presented on digital literacy in the paragraphs before it can be concluded that adding digital literacy to the entirety of the schools, both elementary and secondary curricula is quite necessary. Furthermore, the goals and importance of digital literacy (preparedness for higher education, future workforces and participation in society) are similar to the main motivations of the Design&Technology course.

The D&T course is unique in its approach towards teaching with competence-based aspects. There are ample opportunities and arguments to stimulate the learning of digital literacy within the D&T course, mainly because of the multiple tools that are used within the course, as well as the context-rich environment in which the students perform their work.

"O&O kan sterker worden gepositioneerd als bètavak. Bèta-technologische kennis dient een plek te hebben in het examenprogramma. Er liggen kansen om thema's als burgerschap en digitale geletterdheid in de examenprogramma's een plek te geven"
Sijbers & Woldhuis, 2021, p. 17

The process of a D&T research project also creates a larger difficulty in the inclusion of digital literacy as every project varies and every year the students' competences grow. The growth of a student is never linear within the D&T course.

This thesis argues for the inclusion of digital literacy in a situation in which it is surrounded by context as well as immediately applied instead of taught. The unique didacts of the course, as well as the difficulty of applying this new skillset makes the realm of design such an interesting place to research the inclusion of digital literacy.

2.6 Informal Observations and Interviews

In order to create a first-hand sense of the approach of the Design&Technology course, I conducted informal and in-context observations and interviews. These observations entail shadowing the teacher during one of their D&T classes on two different secondary educational schools. In total, I attended three classes, and interviewed three teachers and Technical Assistants informally during the observations.

School 1 gives the D&T course to years 1-6. The Technasiumlokaal can accommodate to two classes simultaneously.

School 2 gives the D&T course to years 1-6. The Technasiumlokaal can accommodate to six classes simultaneously.

Both schools take the approach to a fixed curriculum very differently. School 1 allows teachers to mostly determine for themselves what will be required of the students in a particular project, School 2 has created a fixed timeline on certain skills they require of their students, providing more stability and guidance to the teachers. Based on this, it can be concluded that every school and even every D&T teacher has their own perspective on the didactics of the course as well as the approach to self-regulated learning and the application of digital tools within that learning.

School 1
Teachers attempt to keep up with the everchanging technology by following trends and learn skills based on what students require of them. An interview example of this is the Arduino: A teacher at School 1 learned the skill in his own time after many students requested help on the use. This cultivation of skill outside of working hours does not lead mastering it, it merely allows the teacher to understand and assist students in developing their concept.

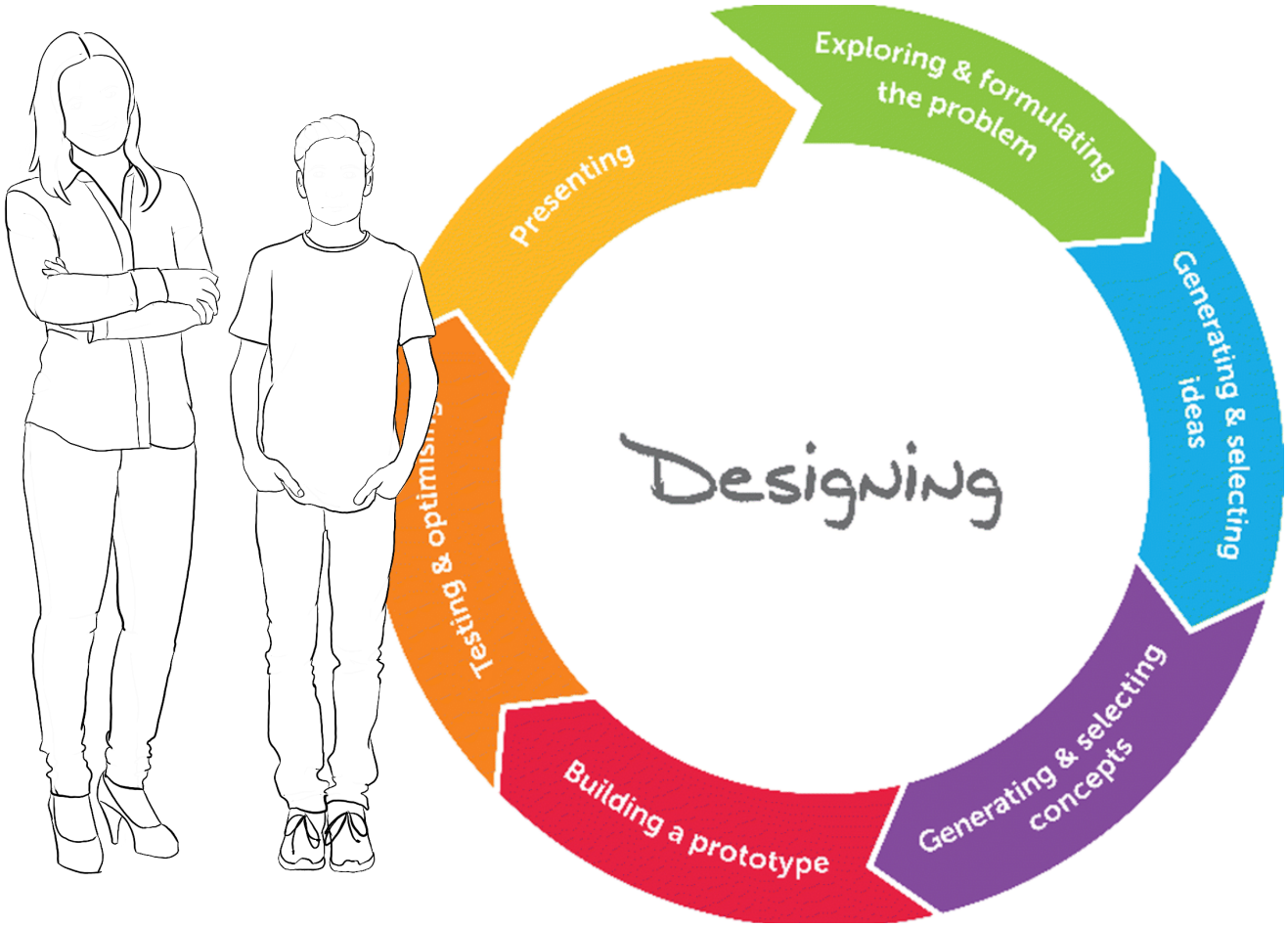
"Veel leerlingen zijn verder dan ik [wat betreft sommige programma's]."
Teacher, 40+ years of experience, upper classes

The Technical Assistant at School 1 explains he and many teachers have been asking for space and time in the curriculum to offer workshops to students on specific skills. This has not been granted yet due to shortages of time and manpower.

At school 1 the project brief rarely require the use of a particular skill or digital programme. Students have to find a cultivate the suitable skills and ideas themselves and often rely on experiences they have (had) outside the Design&Technology classroom such as using games.

School 2
School 2 does make use of a continuous growth of skills in their curriculum. They carefully planned when students will come into contact with which (digital) skills and can therefore also determine which teachers will need to be knowledgeable on these. These planned activites mostly take place in the lower classes so that once the students reach the upper class they will have a large repertoire to choose from.

The skills School 2 has included in their curriculum are among others: 3D-printer, Arduino, lasercutting (using programmes for creating the designs) and presenting using a multitude of various visual programmes.



1.

Digital Information Skills:
Students make use of websites and digital sources to gather information.
Media Wisdom:
Students make use of email and linkedin to contact client, coach or expert.
Students must make critical use of digital media such as websites.
Computational Thinking:
Students reformulate the problem space given by the client. When a tool is required, the problem solution must be computed to enable the use of that tool.

2.

ICT Basic Skills:
Students must record, save and share brainstorm results and ideas.

3.

Digital Information Skills:
Students must record, save and share brainstorm results and ideas.
Computational Thinking:
(re)Formulate the concept to enable the use of (digital) tools for solving.

4.

ICT Basic Skills:
Differentiate between programms to determine which to use for what purpose.
Insight and experience with appliances.
Digital Information Skills:
Using (digital) tools to provide information (a model is also a communication of information)
Computational Thinking:
(re)Formulate the concept to enable the use of (digital) tools for modelling.

5.

Digital Information Skills:
Find, record , order and communicate data about the model.

6.

ICT Basic Skills:
Differentiate between programms to determine which to use for what purpose.
Digital Information Skills:
Use (digital) tools the correct way to best present the gathered information and final solution.

Digital literacy in the design process

Based on the observations and interviews a schematic was made on visible digital literacies performed within the design process, see the previous page. The visual shows which of the four digital domains from paragraph 2.1 are present during the six steps of the Ontwerpcyclus introduced in paragraph 2.4.

The domains with the largest presence are Digital Information Skills during step 1. *Probleem verkennen en formuleren* where students research and establish their problem brief and Digital Information Skills and Computational Thinking in step 4. *Prototype* where students need to be able to compute their ideated concepts to a visual representation making use of digital programmes.

Although ICT Basic Skills and Media Wisdom do surface in the Design&Technology course, **the main focus is on Digital Information Skills and Computational Thinking which are linked to the use of digital programmes.** This will consequently be the focus of this report when talking about digital literacy in the D&T course.

Take-aways

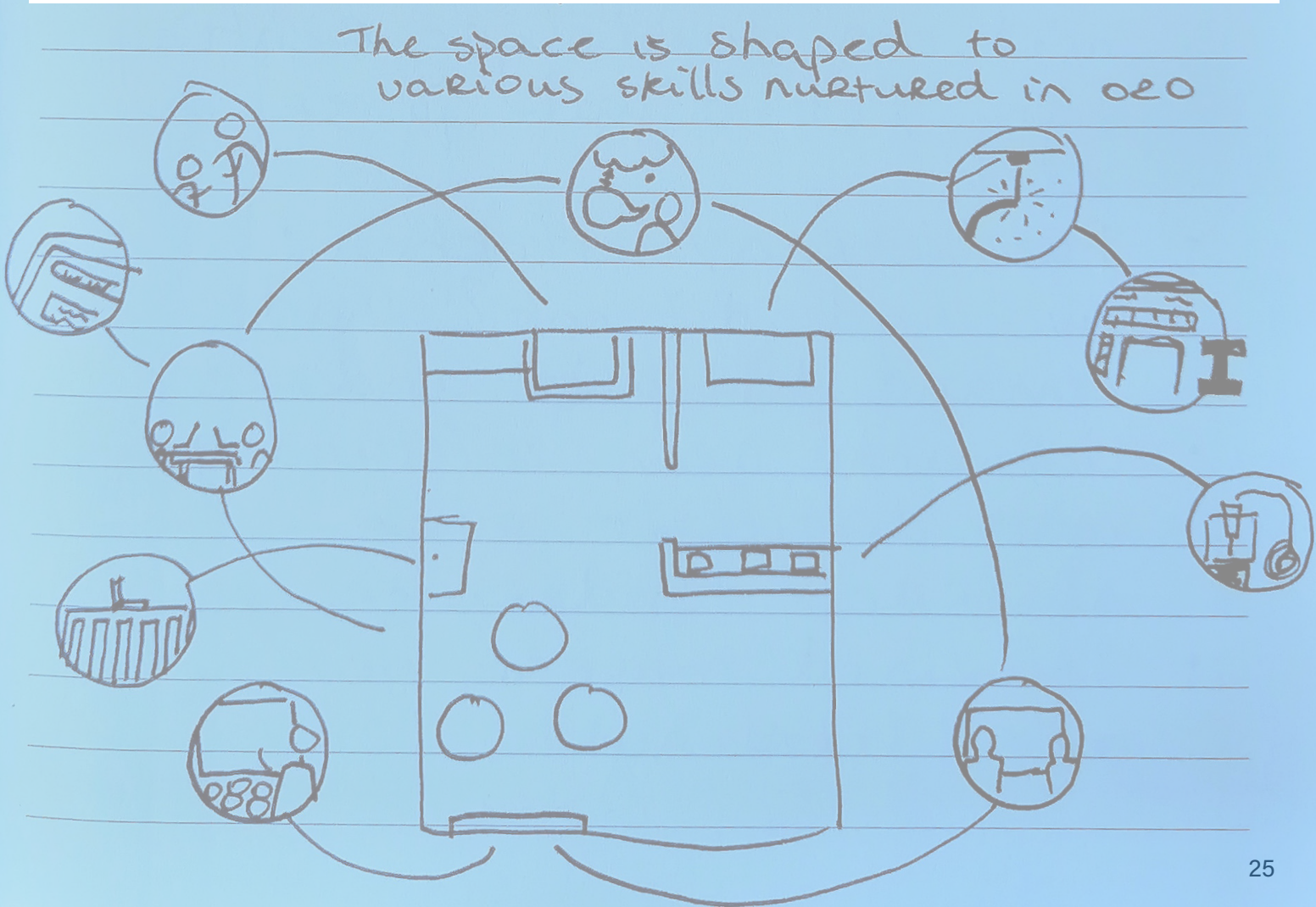
Digital literacy is a very important skill to have in the society we have developed into, as well as the developments ahead.
Digital literacy can be defined as finding, using and communicating information using digital appliances.
Due to the long process and overlapping other skills it is up to educational institutions to teach this digital literacy to youngsters, starting as early as elementary school.
The secondary education course Design&Technology is a project based course that build competences within its students.
D&T teachers are mostly lateral entrants and bring many different perspectives to the course.
Due to the project based nature of the course with project briefs that change regularly, providing a fixed regulation to integrating digital literacy would be unsuitable.
Therefore; a flexible framework to include or improve digital literacy in the D&T course is needed.

Conclusions of the Exploration

In the exploration phase it is established that Design&Technology education is very diverse and can rarely be described by overarching principles. The current approach in the curricula revision is not expected to be immediately applicable to the teaching of the D&T course.

From the observations it can be concluded the specific curriculum of a D&T course is mainly arranged by a schools D&T faculty. This can lead to large differences in structure, demands and expectations between schools or even between teachers. The interviewed teachers have mentioned their struggles in finding the time to continuously update their curriculum or didactics. This is visible, for instance, in how progressive School 2 is in the inclusion of digital literacy compared to School 1. The result of this research will need to be applicable to this variation in schools and provide overarching support no matter what approach the faculties prefer or curently use.

All three elements of De Didactische Driehoek (Tielemans, 1999) play an important role in this scenario. Currently the teacher, student and content seem to be developing at different paces or in different directions. There needs to be a coherence between them, not starting at ideals or principles, but with past experiences and current situations they bring to the table. Once these are identified, the research can aim to bring all three pillars of the triangle back to the same position, fostering a unified development.



03

After the exploration phase, it is clear two important components of the research are yet missing. Even though teachers and students have been slightly included already, there is a delicate balance between a teacher, the students and the educational content.

This leads to the topic of this chapter, where contextmapping and collaborative design allow the research to balance out across the tree pillars of this research. The contextmapping with teachers will give a better insight into their current knowledge and experience on digital literacy without asking direct, yet hard to answer questions. The creative session with students that follow the D&T course, to confer whether the aimed intentions of teachers actually surface in the students, will allow the research to identify the gap between then teacher and the student when it comes to the content.

Co-Creation

3.1 Contextmapping

Contextmapping is a method frequently used at the start of a project before determining the problem statement. It allows the designer to approach a new situation and places them outside the role of expert. Instead, the method places users and stakeholders in a central role, stating they are the experts of their own experience (Sleeswijk Visser et al., 2005; Sanders & Stappers, 2012).

By facilitating these stakeholders with creative exercises in a collaborative setting, they are able to reach tacit knowledge, allowing for interesting discussions and insights to arise. Although the preparation and analysis are difficult and taxing on the facilitator, the contextmapping method is believed to generate more valuable information in qualitative, curiosity-driven research.

A contextmapping study is generally approached in three phases, see Figure 6. The first is the preparatory phase; The researcher creates the session set-up and invites participants. A couple of days before the session, the participants are usually asked to undergo a 'sensitising' activity. This activity can last up to a week, taking no more than 10 minutes a day, and ensures the participants have started 'waking up' any tacit knowledge they possess on the topic.

That leads to the second phase of the method: the session itself. Contextmapping sessions usually allow for 2-10 people and consist of creative activities to support effective discussions and sharing experiences. A format used this thesis is the Make/Say activity where first the participants are asked to make an artefact on a certain topic, taking about 10 minutes, and then present their artefacts and the reasoning behind creating it to the group.

During this session, there is ample recording going on. The designer/facilitator tends to be busy ensuring the session runs smoothly and is unable to write down any observations or interesting quotes. Audio recordings are generally used, as well as video recordings and taking pictures. All three sessions in this thesis make use of those three recording methods, and even use a second researcher to support the facilitator.

The last phase is the analysis; With all the recordings and artefacts, the designer/facilitator can create a clear overview of the context of the problem statement. This research uses Statement Cards and Clusters to create this overview. The Statement Cards allow a free interpretation of quotes spoken during the session and enable the designer to abstract the results. By then clustering these Cards, the main topics of the context become clearly visible.

Regard the topic, the facilitator is recommended to set up a scope and a focus. The Sensitising activity incorporates the entire scope of the research and during the session the topic can continuously be narrowed down to the focus of the research.

Figure 6, The structure of a contextmapping study, Sleeswijk Visser et al (2005)

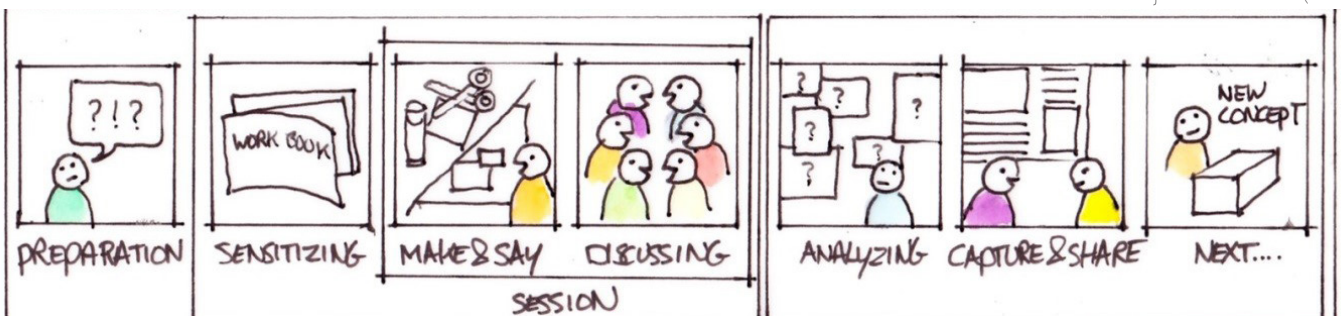


Figure 7, A Session 1 participant showing their result

Approach Session 1
Session-Data
Date: 19/01/2023
Duration: 1 hour
School: School 3
Participants: D&T faculty (9 teachers and 1 TA)
Group: 10 participants
Data Gathering: Audio recording, Video recording, Pictures
Informed Consent Form: yes
Analysis: Statement Cards and Clustering

Scope: The D&T course
Focus: Digital literacy in the D&T course

Aim
The aim of the first session is to better visualise the context of being a D&T teacher and how digital literacy currently plays a role in their classes.

Pilot
In preparation of the session, a pilot was conducted with one creative teacher. The pilot was especially aimed at keeping the timing correctly.

The informed consent form, session setup, sensitizing, session materials and clustermap can all be found in Appendix B.-F.

3.2 Session 1

Sensitizing
Before the session, the participants were sensitised by giving them a booklet. The booklet was to be filled in over 5 days, each day a page. The exercises started with factual aspects about the participants as D&T teachers and slowly developed into small exercises on experiences with, and opinions on the course.

Ice-Breaker
To ease the participants into the topic and the method of presenting/speaking in turn, they were asked to introduce their neighbour by an interesting page of their sensitising booklet. This also gives attention to the booklets, showing the participants that what they make is valuable.

Make/Say 1
In Make 1 the participants were asked to visualise digital literacy in their D&T classes, including the contrast between the current situation and the ideal situation they imagine. The participants were then asked to present their poster to the group and explain their choices and opinions.

Make/Say 2
In Make 2 the participants were asked to make an object that would help them bring their D&T classes to the ideal version they just made, taking digital literacy into consideration again. They were given 5 minutes to create this object and then each 2 minutes to present.

Conclusion
The session was closed by ensuring the participants their contribution had been valuable and explaining the next concrete steps that would be taken in the project.

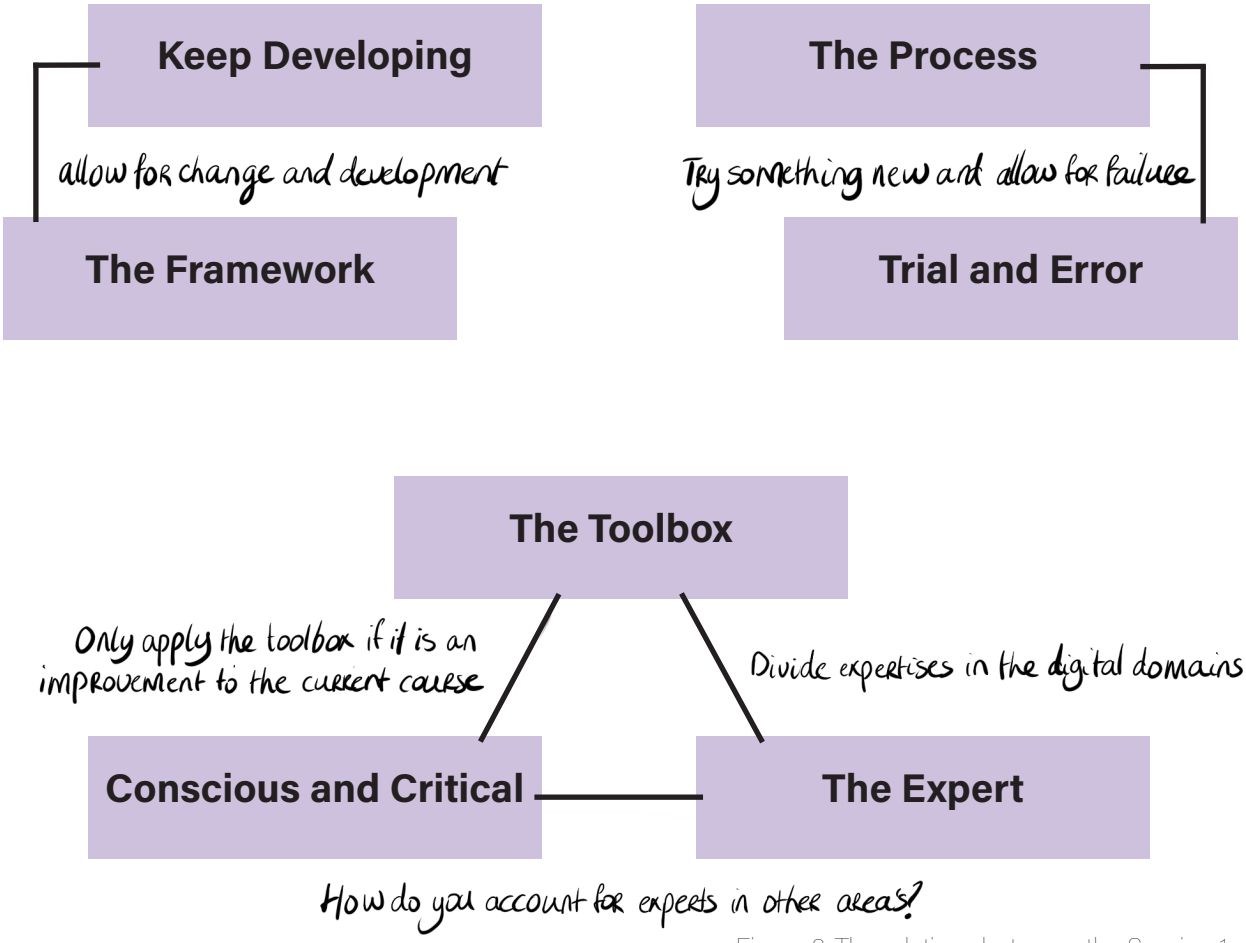


Figure 8, The relations between the Session 1 clusters

Analysis Session 1

After conducting the first session, the results were analysed. As previously explained, this research uses Statement Cards and Clustering as an analysis method, interpreting and abstracting spoken quotes by participants. A Statement Card contains a quote by the participant, an interpretation by the researcher, and a title. Statement Cards with similar interpretations are then mapped, preferably physically on a large wall, creating a cluster map. By naming the clusters of cards and describing how they relate, a clear overview of the interpreted context arises. In Figure 8 above, the relations between the most important clusters of the first session are shown.

The first session showed very clear signs of uncertainty and unspoken opinions within the Design&Technology faculty. The teachers kept themselves within two distinct groups: the beta technological experts and the more artistic teachers. Some participants mentioned the worth of the method as a researching tool, immediately seeing the bountiful results that could be extracted.

The Toolbox.

The first cluster, The Toolbox, is based on the regularly repeated sentiment that a toolbox, be it physical or an organisational collection of programmes and tools, could be useful during the Design&Technology classes. A toolbox such as this would allow for teachers and students alike to get inspiration and ideas on what programmes to use.

"Dat we als het ware die hulpmiddelen, die technische dingen als een gereedschapsrek zien zodat ze kunnen weten wat ze waarvoor gaan inzetten, ten behoeve van wat."

Figure 9, An artefact on a toolbox to use when picking a digital tool or skill to teach.

The Expert.

The second cluster is a large collection of quotes on the topic of allotting expertise among the D&T faculty, making the teachers responsible for instance on one or two tools that are used during the D&T classes. This could very easily be linked to the aforementioned idea of a toolbox. Students would get a basic overview of the tool from their own teacher and would then be able to ask for more detailed advice to these teachers that are experts on the topic.

"We hebben een behoefte aan bepaalde vaardigheden binnen een groep. Ja, die [expert] zoekt dat uit en die verzamelt know-how. Daardoor komen we in een systeem terecht waar niet iedereen alles voor zichzelf hoeft uit te zoeken, maar dat we verschillende experts van verschillende sets know-how binnen de groep bevinden."

Conscious and critical.

The demand arose that if the digital aspect of D&T is to be developed and improved it would have to be with a conscious and critical outlook to the main structure of the course. This means the development of digital literacy among students would have to be an improvement to the course, as opposed to an extra workload.

"Ik wil graag dat ze efficiëntere lessen hebben doordat ze digitaal een aantal dingen automatiseren."

"Waar het mij eigenlijk allemaal om gaat, is dat bewust omgaan met digitale middelen en dat we niet zomaar wat doen."

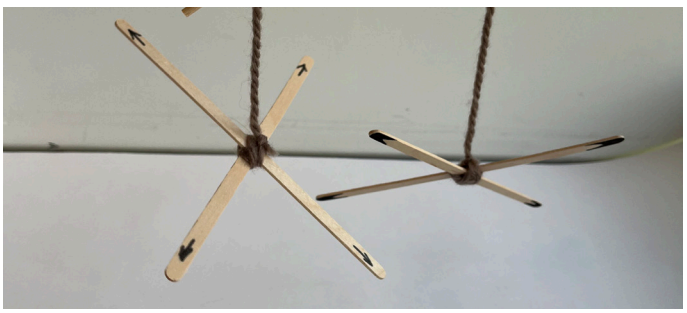
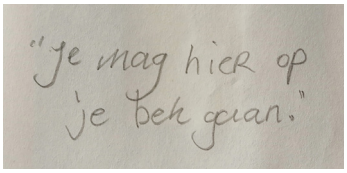


Figure 10, An artefact expressing the need for a balanced direction when developing the course of D&T

The Process & Trial and error.

These two clusters mainly attuned to the process of developing something such as this digital literacy in an existing course. It recognises the need for trying something new and accepting failure within that process.

"Dat je doelgericht gaat risico's nemen en soms ook valt en dat dat niet erg is om dat dan te laten gebeuren."



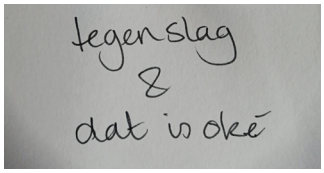


Figure 11 and 12, Artefacts expressing the acceptance that mistakes will be made while teaching D&T

Keep developing & The Framework.

Both clusters consider that any materials developed from this context map has to be flexible to allow for a transition period of change and developments. This means the toolbox mentioned in the first cluster, for instance, would have to allow for changes that might occur in the future. What might be offered as a solution also has to be a framework that will fit many occasions and situations.

"Ik heb een flexiebel framework gemaakt dat je dat ook kan aanpassen naar de veranderingen die komen, zodat je die verschillende wegen kan vinden en zoeken naar jouw eigen doel en inzet."

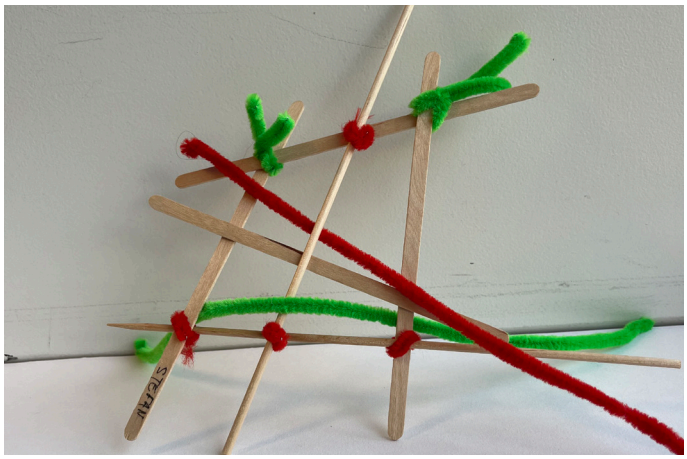


Figure 13, An artefact illustrating the need for a flexible framework that can be applied to all D&T schools.

Conclusions Session 1

In session 1 some conflicting perspectives surfaced. The participants grounded themselves in their respective backgrounds and the artefects varied massively on each opinion. The scattering of perspectives within this team can lead to an unclear collective ideal, making it difficult to establish a clear vision on the Design&Technology course. It will be interesting to map if this fractured vision in the faculty has any influence on the students perspective.

The participants noticed the large amount of information that can be discussed and explained in such a short session. The discussion and results immediately created a sort of vision overview for the team. Collaborating on creative activities and discussion expressed opinions can allow a team to appreciate their collagues anew.

The first session is concluded with the supposition that creating a coherent vision within the D&T faculty on the aim of the course will improve efficiency, structure and communication within the course. With this in mind, the D&T students are included in the research by having them participate in the next two sessions.

Figure 14, An impression of Session 1

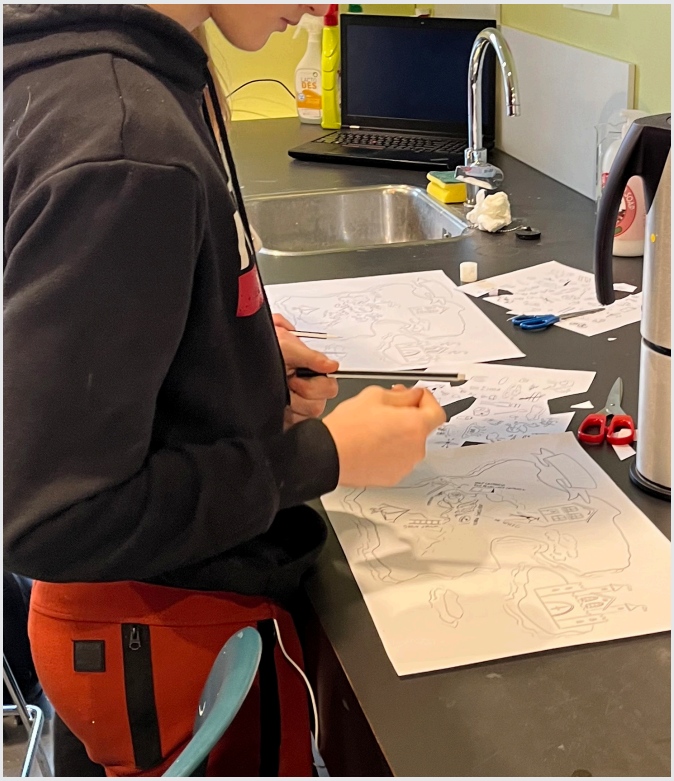


Figure 15, A participant of Session 2 working on their artefact

Approach Session 2
Session-Data
Date: 24/02/2023
Duration: 45 minutes
School: School 3
Participants: D&T students, third year
Group: 7 participants
Data Gathering: Audio recording, Video recording, Pictures
Informed Consent Form: yes, from the parent(s)
Analysis: Statement Cards and Clustering

Scope: Digital tools in the D&T course
Focus: Learning a digital tool in the D&T course

Aim
The aim of the second session is to examine if the intentions of the teachers are properly adressed according to the students.

The informed consent form, session setup, session materials and clustermap can all be found in Appendix H.-J.

3.3 Session 2

Sensitizing
To not resemble the feeling of homework with a booklet they had to fill in at home, the sensitizing activity was something they could perform together in a D&T class beforehand. The participants were asked to sticker all digital appliances in the Technasiumlokaal.

Introduction
The participants were asked to lead the facilitator through the Technasium classroom and show all the stickers they stickered. This immediately shows the participants they are meant to lead the facilitator around, both through 'their' space and their experiences.

Make/Say 1
In Make 1 the participants were asked to visualise a learning journey they had experienced when learning a new digital appliance in the D&T course. During this journey they had surely encountered obstacles or things that helped them, and they could visualise or draw those using metaphoric figures. In the last ten minutes of the session the participants were asked to present their journey.

Make/Say 2
Due to the short available period of time for this session the second make/say activity was scratched to allow optimal realisation in the first activity.

Conclusion
The session was closed by ensuring the participants their contribution had been valuable and explaining the next concrete steps that would be taken in the project.

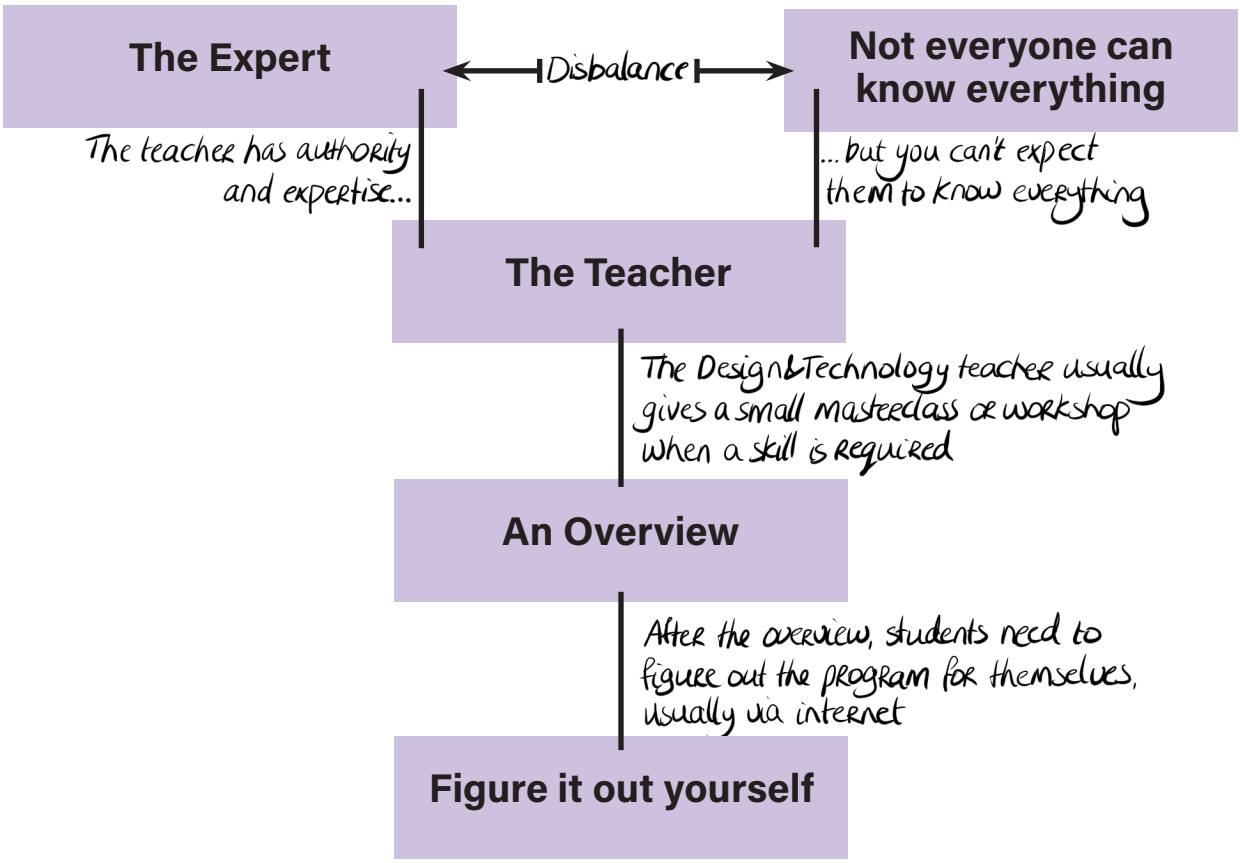


Figure 16, The relations between the Session 2 clusters

Analysis Session 2

Again, immediately after conducting the second session, the results were analysed in a similar way that the first session had already been analysed. Statement Cards were created based on quotes spoken by the participants of the session and by interpreting these quotes and gradually abstracting them, creating an oversight on the main topics of the session. The area of context around the topic was visualised, this time from the perspective of the Design&Technology students.

Figure 16 above visualizes the relations between the most important clusters of the second session.

The Expert.

A clear yet surprising cluster that arose again was the expert. Similar to the expert cluster from the first session with the D&T faculty, the students also recognised authority and expertise within their D&T teachers and Technical Assistants. However, there was an undertone of injustice to this cluster as the participants seemingly were unable to corroborate this expertise their teacher was supposed to have with some actions or behaviour that their teacher showed them.

"Nou Meestal denk ik van, ja, ze hebben vast wel gelijk en ze weten dat beter dan ik het weet."

The Teacher & Not everyone can know everything.

In these clusters the students can be found to feel as if the teacher is there to check up on them and to see if they are doing the right thing, without providing the right coaching or support. This creates a confusing stand-off, where students are obliged and willing to accept the authority of the teachers, yet must also understand that not everyone, not even teachers, can know everything.

"Zal ik ook de docent maken?
Dat hij dan even komt aankakken en kijken of het goed gaat
Nee ik ga zeggen dat hij dan gaat zeuren ..
Ja daar doet hij wel moeilijk over
We moeten zo'n emotie gebruiken, dat we boos zijn"

" .. dan kwam de docent het meestal controleren. En dan was het meestal niet goed en dan werd ik geirriteerd. Dan gingen we toch maar verder werken met een beetje tegenzin".

Figure 17, An artefact expressing the negative feeling a student get when a teacher checks their work

An Overview.

The context created in this cluster by the students is that whenever they are taught a new skill or new tool, the teacher starts with an overview of the possibilities of the tool and shows the students the initial steps in mastering it. However, when asking follow up questions on the skill the participants during the session were unable to answer the questions and admitted to only knowing the very basics of the programme.

"M: En dan lever je het bestandje aan.. aan wie?
Aan de docent en die ging het in de lasersnijder stoppen
M: Legt hij dan nog uit hoe dat werkt?
Nee."

"We beginnen hier, toen kregen we een initiële uitleg van hoe het ongeveer een beetje werkt."

Figure 18, An artefact communicating the confusion students feel after the teacher gave a quick explanation

Figure it out yourself.

In some cases the project brief does demands a certain skill or tool being used during the process of the design project. As mentioned in the previous cluster, the students receive a basic overview of this usually digital tool and are then left to autonomously learn more about it. However, from the cluster and the recorded quotes, it appears as though this autonomous process is not communicated clearly to the students. They tend to speak of looking up tutorials or trying things out and feeling like they have to understand an alien because their teacher wouldn't be of any support.

"Het voelde alsof je een alien moest begrijpen en dat was best lastig."

"Daarna gingen we uitleg-video's zoeken en daarom begon ik het een beetje te snappen."

Figure 19, Artefacts explaining figuring out a tool is difficult

Conclusions Session 2

The clustermap of the second session shows a general overview of miscommunications and unclear objectives. Seemingly the application of the self-regulated learning process is not communicated properly to the students. Looking back to the self-regulated learning paragraph in Chapter 2, it can be suggested that the students miss the feeling of relatedness during the Design&Technology course, creating a discrepancy between the teachers' intentions and the students experience.

This self-regulated learning process can be found across the entirety of the D&T course, yet it seems directly visible when looking at the learning experience of a digital application. This results from teachers being unable to give in depth knowledge on all topics and relying on the autonomously driven motivation of the students. The digital tools and skills are also, both for teachers and students, the most tangible skills that are taught in the D&T course. **Should the self-regulated process be improved on the visible, tangible skills both parties will develop the experience and intuition to apply this process to less explicable skills as well.**

To dive deeper into self-regulated learning experience and check the supposition that relatedness is the missing element, the third session will be conducted with the narrowed scope: Autonomously learning a digital tool in the D&T course.

Figure 20, An impression of Session 2

Figure 21, A Session 3 participant holding their artefact

Approach Session 3
Session-Data
Date: 27/03/2023
Duration: 1 hour and 15 minutes
School: School 3
Participants: D&T students, third year
Group: 6 participants
Data Gathering: Audio recording, Video recording, Pictures
Informed Consent Form: yes, from the parent(s)
Analysis: Statement Cards and Clustering

Scope: Digital tools in the D&T course
Focus: (autonomously) Learning a digital tool in the D&T course

Aim
The aim of the third session is to examine if the intentions of the teachers are properly adressed according to the students. How do these students experience the learning process of autonomously mastering a digital skill?

The informed consent form, session setup, session materials and clustermap can all be found in Appendix H.-I., & K.

3.4 Session 3

Sensitizing
To not resemble the feeling of homework with a booklet they had to fill in at home, the sensitizing activity was something they could perform together in a D&T class beforehand. The participants were asked to sticker all digital appliances in the Technasium classroom.

Introduction
The participants were asked to lead the facilitator through the Technasium classroom and show all the stickers they stickered. This immediately shows the participants they are meant to lead the facilitator around, both through 'their' space and their experiences.

Make/Say 1
In Make 1 the participants were asked to visualise a learning journey they had experienced when learning a new digital appliance in the D&T course. During this journey they had surely encountered obstacles or things that helped them, and they could visualise or draw those using metaphoric figures. In the last ten minutes of the session the participants were asked to present their journey.

Make/Say 2
In the second Make-exercise the participants were asked to make an object that could support them in their self-regulated learning at a moment they had labelled as hard or tough in their first make/say.

Conclusion
The session was closed by ensuring the participants their contribution had been valuable and explaining the next concrete steps that would be taken in the project.

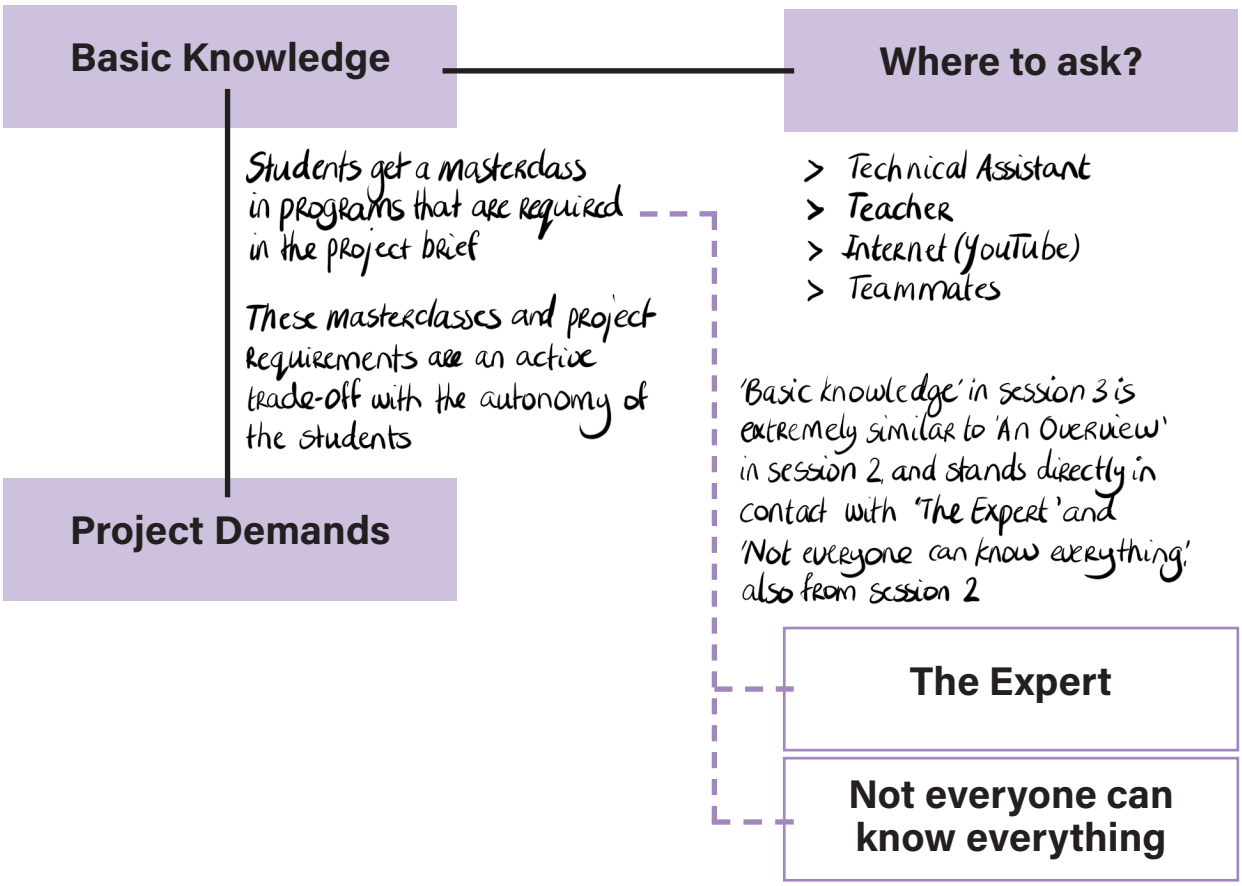


Figure 22, The relations between the Session 3 clusters

Analysis Session 3

For the third time the recording of the session was analysed based on quotes and statements and clustered according to prominent interpretation and themes. Opposed to Session 2 the participants of Session 3 were able to perform both Make/Say activities, resulting in more artefacts to support as evidence. Despite the intention of clustering the statements of the two sessions separately, the supposition stemming from the analysis of Session 2 seemed to influence the objectivity of the analysis of Session 3, creating links and patterns already throughout the clustering of the cards.

Figure 22 above indicates the relations between the most important clusters of the third session and includes to connecting link to two clusters from Session 2.

Basic knowledge.

The first cluster of this session is again the notion that the students are given an initial overview of a digital tool or method they could use within their design projects. The teacher generally gives this short and limited overview, and students are then required to further develop their skills in this tool in an autonomous way.

"Maar ik krijg dus een beetje uitleg van hoe het ongeveer in elkaar zit en wat je ongeveer moet doen."

"Wat het is eigenlijk is bij alle projecten bij O&O,.. ja, je begint een project en dan ga je eerst onderzoek doen en een beetje kijken wat het inhoudt."

"M: En hoe stuur je dat [model] dan naar de 3D-printer?
Je moet het op een USB zetten en dat kan de docent dan in de..
M: En heeft hij toen ook uitgelegd hoe zo'n printer werkt?
Nee niet echt."

Project demands.

Students encounter certain skills or tools of importance during the design process through demands stated in the project brief. For example: *the design resulting from this problem statement must be presented with a laser cut model to scale.* This is not unusual, especially during the first couple of years of secondary education. However, it does place itself into stark contrast with the students admitting they usually receive only a basic explanation on the tool and then have to determine the amount of assistance they require themselves.

"Nou dat was zeg maar een tussenproject. Maar we hadden het wel nodig voor het project."

"Door eisen in de projecten kom je ook in contact met andere apparaten, waardoor je alles wel een keertje probeert."

Where to ask.

This cluster is a large collection of various perspectives and opinions. After the initial explanation on the new tool or skill set, the students autonomously look into the programme a bit more. With questions there is an overload of locations to look for answers, yet students stated an insecure feeling as to where they should address these questions. Material- and tool-wise, the Technical Assistant is usually available and the teacher also readily accepts questions. Students are hesitant to pick these options, presumably since the teacher also has an evaluating rule at the end of the course. The Internet is a logical place for most students, yet they feel as if it is something they have found for themselves to be a good place for questions. It is unclear to students if using the internet is against the teachers' intentions and expectations or not. Lastly, the students explain classmates or project mates or sometimes also a good place to get help.

"M: En heb je dit in een groepje geleerd?
Ja, met [klasgenoot].
M: Die heeft jou geholpen?
Ja."

"Nou dat was vooral een klasgenoot die daarbij geholpen heeft. Die snapte het wel.
M: En denk je dat je eerder naar YouTube gaat, of eerder naar de docent?
Ligt eraan of de docent in het lokaal is of niet, die is ook nog wel eens weg."

"M: En hoe helpt de docent bijvoorbeeld?
Nou in zo'n situatie.. onze deed bijna niets. Mijn groepje werkte op de gang en ik wou het altijd zelf doen.

"Dit is mijn vraag-machine pus kennisdoosje. .. Je kan vragen stellen en dan komen er kaartjes uit met het antwoord."

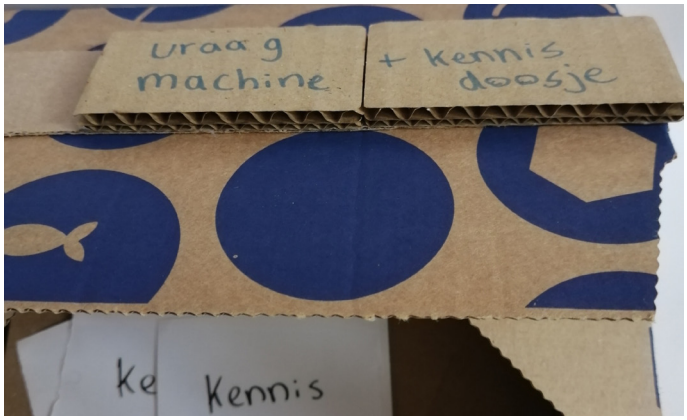


Figure 23, An artefact showcasing a students' undertainty of where to adress questions

"Ik heb gewoon YouTube gemaakt. Op het moment dat je een vraag hebt of het niet meer weet, dan kan je het opzoeken en dan krijgen we uitlegvideo's."

Figure 24, An artefact showcasing a students' usual adress of questions

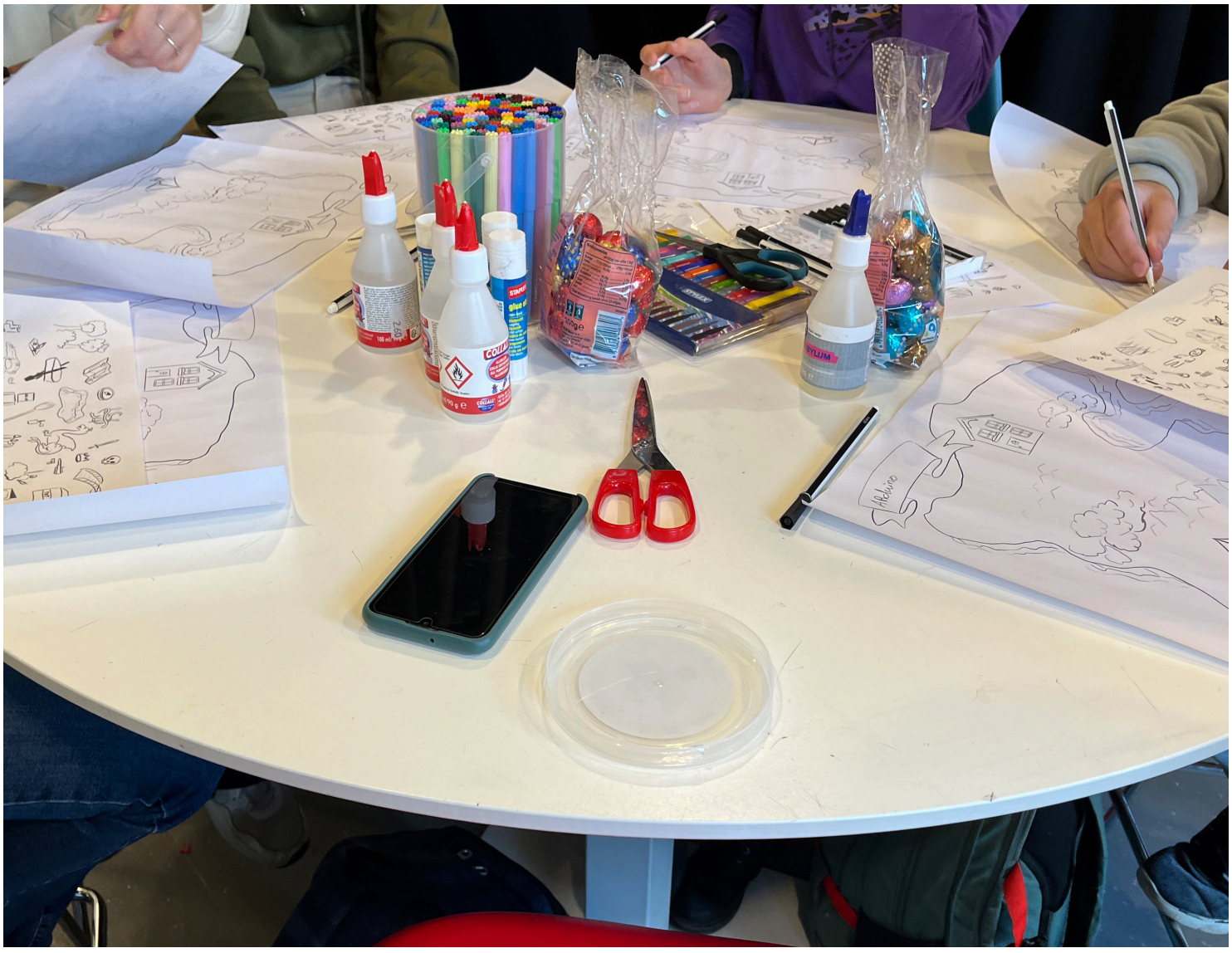
Conclusions Session 3

An eminent aspect of the Design&Technology course is that students are able to find ample information and have many experts available in, and around the Technasiumlokaal. However, the sessions show that students admit to feeling floundered when being stuck in their learning process and that they are uncertain as to were there to address their questions.

Based on the literature, this could also be because of the implicitness of either relatedness, autonomy, or competence within the course (paragraph 2.4 on self-regulated learning). The students are able to master the required skill, find information on the skill autonomously, yet still do not feeling a sense of accomplishment.

If a group tries to achieve a certain outcome, development can be hindered if members of the team do not share the same goal. A student and a teacher can also be considered a team trying to achieve a goal. It becomes clear in session 3 that their goals do not align. The students goal is 'I want to learn this', whereas the teacher might think 'I want the student to learn that autonomously'. Because the goals seems quite similar the disconnect can go unnoticed by the teacher but still leave a lingering negative feeling with the student. **Solving this disconnect can be done by voicing expectations and intentions and is traditionally the responsibility of the teacher.**

Figure 25, An impression of Session 3



3.5 The Design Goal

As in any educational course, a Design&Technology teacher tries to bring the students to a certain level of knowledge, experience or competence. They do this by relying on experiences, intuition and improvisation. Being in this situation daily can make it difficult for the teachers to take a step back and reflect on how they handled certain questions or situations. Miscommunications can sometimes go unresolved because the teacher is not aware of them in situ and is unable to find a moment of rest or realisation. Students are receptive to influences of teachers and can often feel the miscommunication without being able to identify or name it.

The resulting elements that make the inclusion of digital literacy challenging are the lack of relatedness between teacher and student, the low exchange of experiences and perspectives between teachers and the deficit reflection of teachers themselves. The key to prevent this disconnect between teachers and student is communicating goals and expectations clearly.

The design goal is established to intervene at the level of the Design&Technology teachers. The first level of intervention directed at the students is deemed unsuitable due to the identified gap in practise being addressed at the teacher communications.

The third level, an intervention in the training of the D&T teachers, either at the TU's or the Technasium Academy would be suitable, but is unattainable for development and evaluation in the timespan of this project.

Focussing now on the second research question, the Design Goal of this project is **to help a D&T faculty to collectively take this step back from their daily experiences and allow them to reflect on how they managed certain questions or situations. Furthermore, the design must also facilitate the faculty in determining how they would want to handle these scenario's in the future to better prepare them for similar occurrences.** The responses will then have theoretically grounded intentions and influence the teachers' didactics without much thought.

The teacher will know how to communicate their expectations without impeding on the self-regulated process of the students.

See Figure 26 on how various elements influence De Didactische Driehoek. Paragraph 3.6 Design Criteria counts eleven criteria to which the design must adhere. These result from the theoretical framework, the observations and the three contextmapping sessions.

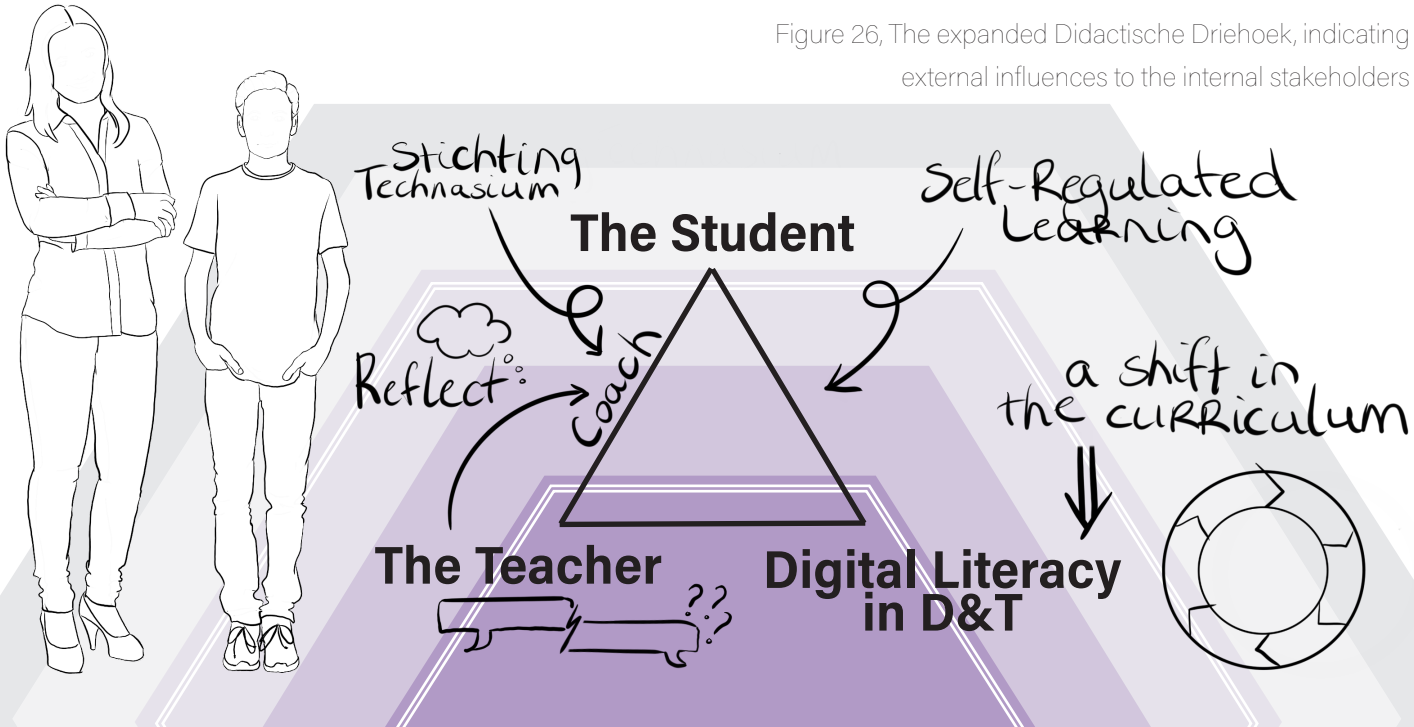
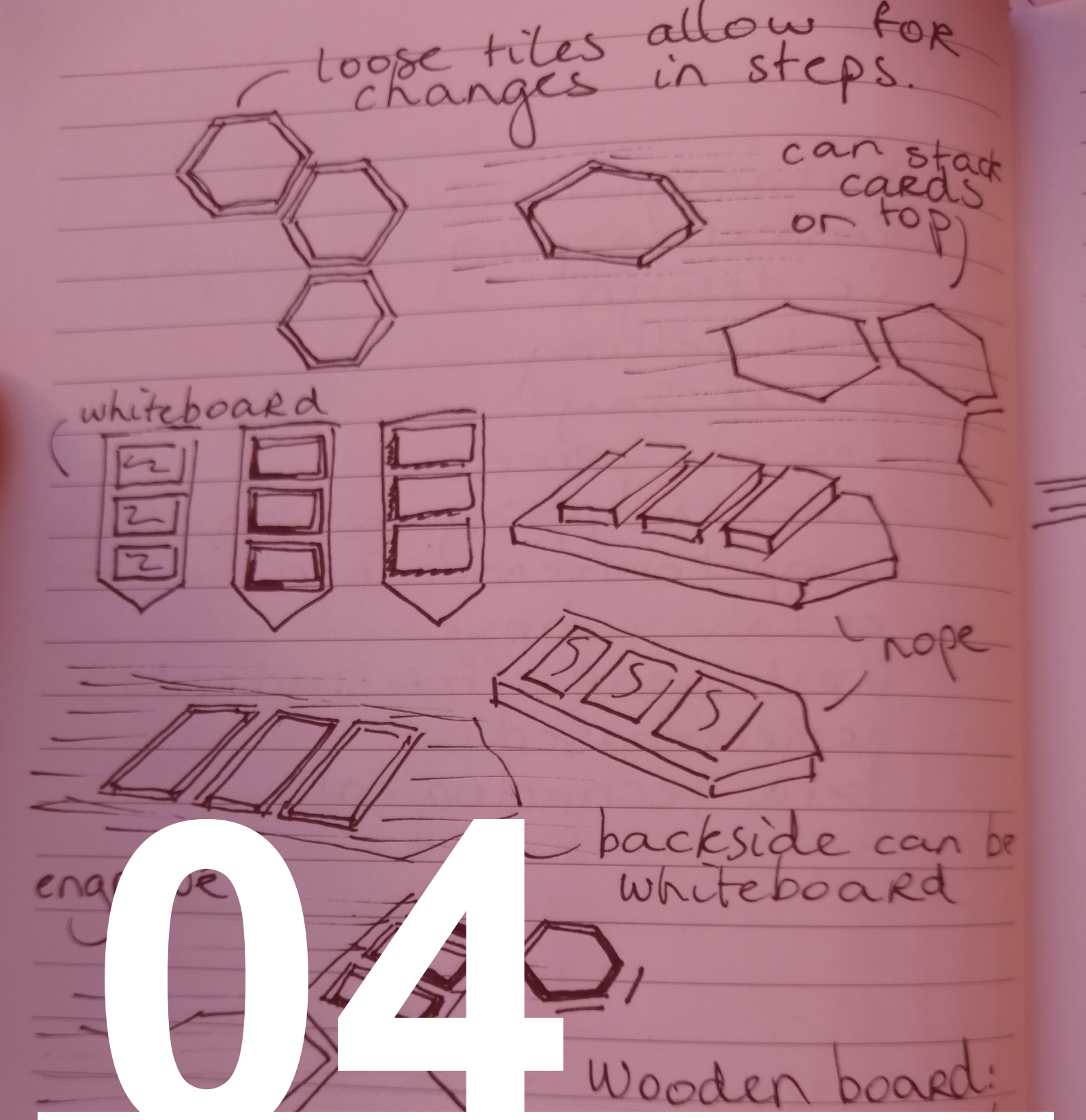


Figure 26, The expanded Didactische Driehoek, indicating external influences to the internal stakeholders

3.6 The Design Criteria

1. Ensure all three elements, competence, autonomy and relatedness are more explicit to students in the self-regulated learning process of Design&Technology.
2. Facilitate a coherent teamvision on the self-regulated learning process of Design&Technology students within the Design&Technology faculty.
3. Ensure the solution space is based on a unified view of the Design&Technology faculty. Opposite sides should be avoided as much as possible.
4. Create actionable scenario's for the Design&Technology teachers to support them in coaching the self-regulated learning process of Design&Technology students.
5. Ensure the Design&Technology students do not experience the coaching they receive from their teacher as an intrusion, a checkpoint or lacking.
6. Rather than creating a fixed toolbox, facilitate the support of various digital tools and skillsets to assist and encourage the development of self-regulated tendencies within Design&Technology students.
7. Create a visible balance on skills/tools used within the Design&Technology course.
8. Encourage reflection on what tools are demanded, recommended or provided and allow for a possible division of expertise within the Design&Technology faculty.
9. Facilitate a safe space in which Design&Technology teachers are able to express their experiences, opinions and feelings.
10. Safeguard the current structure of Design&Technology. The development of digital literacy has to be an improvement to the course, not an extra workload.
11. Ensure the solution can be applied for at least ten years of slight development and change within the Design&Technology course and definition of digital literacy.



04

The fourth chapter describes the concept developed based on the problem statement presented in the previous chapters. After an initial concept vision, several existing examples are analysed for suitable elements that might be used. Lastly, four iterations are presented, including the most important decisions and argumentations for the development of the concept. This process mainly consisted of developing prototypes and discussing these with relevant stakeholders and experts.

Concept Development

4.1 The Concept Vision

In Chapter 1 the eventual outcome of the project is left unspecified intentionally. The curiosity-driven research and the expected influence of the teachers and students in the creative sessions would have been obstructed by determining a final format. Now that the Design Goal has been phrased together with eleven Design Criteria the final product also begins to take shape. The final design of this project aims at a product suitable for a team-reflection that allows the teachers to exchange expertise, perspectives, opinions and experiences.

Reflective Teaching

Teachers are encouraged to reflect on their teaching frequently. It allows them to check the validity and accuracy of their didactics. Brookfields' *Becoming a reflective teacher* (2017) explains the theory behind self-reflection and critical reflection in education and expresses the importance of taking students' and colleagues' perspective into account when doing so.

"Reflective teaching involves examining one's underlying beliefs about teaching and learning and one's alignment with actual classroom practice before, during and after a course is taught."

Reflective Teaching, 2021

Max Manen presents this reflection under the study of phenomenology; reflecting on the lived experience after it happened to be better prepared for a reoccurrence. He describes the importance of pedagogical thoughtfulness and pedagogical understanding in education and presents reflection as a tool to reach such understanding (Van Manen, 2016).

A reflection-format often seen in secondary education is peer-meetings and workshops. During these gatherings the teachers can bring up troublesome situations they encountered and exchange advice or feedback. According to Brookfield peers can highlight hidden habits and provide innovative solutions. This then leads to increased teacher confidence, motivation and improved learning outcomes.

Asking a team to create something tangible during a reflection further stimulates progression of developmental thinking. This was also noted by the participants of session 1, paragraph 3.2. The teachers that participated mentioned the variation in perspectives and the ample discussion the session facilitated in sharing these perspectives through the creation of an artefact. Van der Meij, Broerse and Kupper (2017) summarize the two factors that contribute to this process accordingly: See Figure 27.

"Social effects: shared or common thinking acknowledging diversity and individual differences, and the creation of respect within the group by the negotiation during the performance of the group task.

Visions or tangible products, as base for further reflection or as concepts for real applications that learners collaboratively consider suitable for a particular purpose."

Figure 27, The two factors that contribute to the succes of co-creation, Van der Meij, Broerse & Kupper, 2017, p.53-54

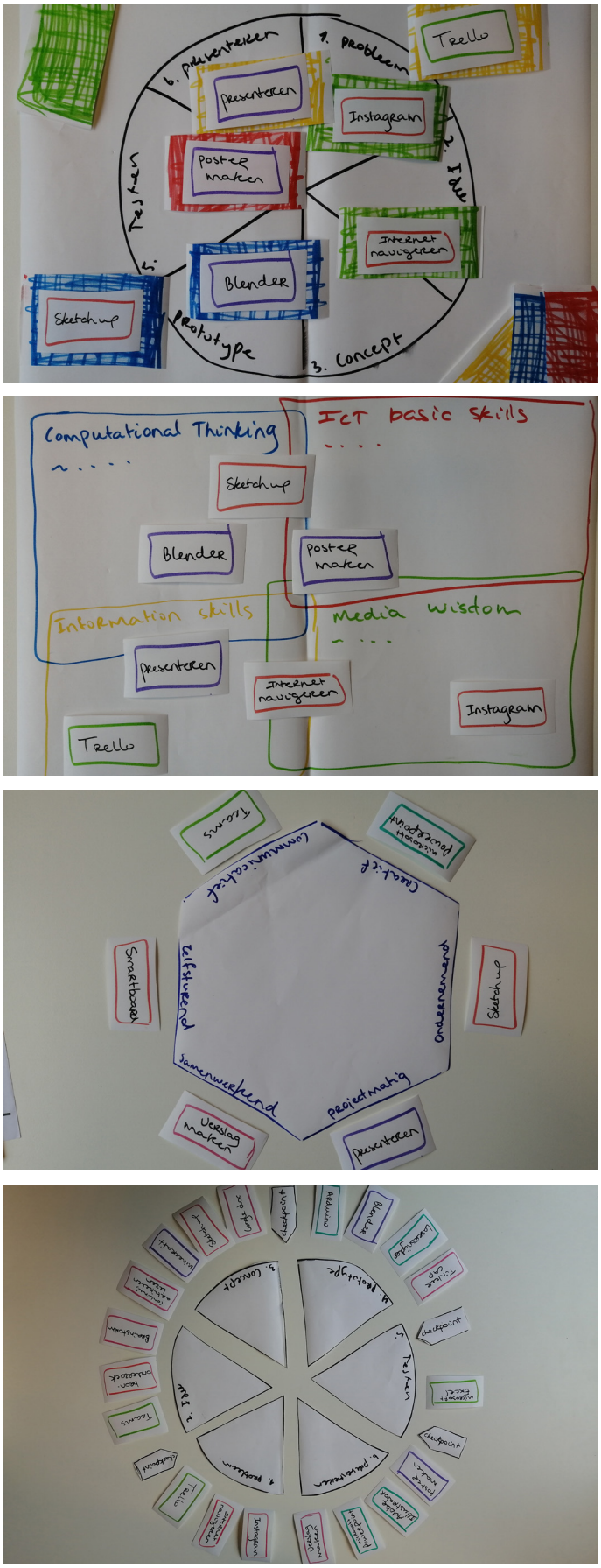
In addition to this co-creation of tangible reflection is the influence of 'gamification'. Gamification is the application of game design elements in non-game context which can highly improve interest, joy and satisfaction (Morschheuser et al., 2014). Using gamification to support self-reflection has recently seen a surge of research and has been applied successfully in practise.

This paragraph can be concluded by stating that the reflection of teachers will be greatly improved by including peer perspectives, tangible elements and gamification. These elements will be applied to the design of this thesis.

Facilitating conversation and collaborative creation

The first brainstorm is aimed at creating a gamified situation in which the Design&Technology faculty is able to include opportunities for self-regulation in students. Connecting this self-regulatory aspect to digital tools students learn during the D&T course will make it more visible and clear to teachers how the method works. Based on the session with the teachers, this discussion should strive to be open, inclusive and without judgement to the many perspective found in the D&T education. It should prompt the teachers to reflect on the interventions they undertake with the student design teams and how effective these might be so the self-regulated journey so valued in the D&T vision.

D&T is a course with a lot of facets, lists, activities and competences that are suitable for matching, placing or sorting into categories. The first try-outs of a game take aspects such as the four digital literacy categories (paragraph 2.1), the six main competences in D&T (paragraph 2.4) and the six design steps of the Ontwerpcyclus (paragraph 2.4), see Figures 28-31.



Figures 28-31, First brainstorm on creating a game based on four digital literacy categories, the six main competences in D&T and the six design steps of the Ontwerpcyclus

4.2 Similar Products

The are various products already on the market that have the similar goal of facilitating discussion though serious gaming. A couple of these products were analysed and compared to see what elements are usually present to stimulate conversation.

1. Media Visiespel – Slim met Media (Slim met Media, 2019)
2. Reflectietool teams – Waardigheid en trots voor de toekomst (Waardigheid en trots voor de toekomst, 2021)
3. Visiekit – Vernieuwenderwijs (Vernieuwenderwijs, 2022)
4. Visiespel – SLO (Visie op educatie/onderwijs aan jonge kinderen, 2021)
5. GROOW – Studio Tast (Studio Tast, n.d.)

Two of the existing products are most similar to the concept vision of this report and were available for in-person use. The next paragraph gives a more detailed insight in the workings of these vision games and explains how the concept of this report will differ.

Visiespel - SLO
(Visie op educatie/onderwijs aan jonge kinderen, 2021)

The SLO vision game is intended for the teacher faculty of an elementary school, aimed at improving digital literacy in their curriculum. Based on nine areas of teaching (time, materials, goals, etc.), the players can divide statements in a range of how well they apply to their school's methods.

Figure 32, The SLO Visiespel using the sorting of statements to express prioritization within a school

Elements in this game are:
Discussion: Statement cards & visual division
Topic: Attention to digital literacy
Result: The result is a division of priorities. There is no visual result/balance.
Teams: Larger group is divided into pairs or teams to discuss the area's separately.
Template: Available at SLO. Usually requires taking a workshop to obtain it.

The game differs from the intended result of this report on the following elements:
- The topic is digital literacy, yet it is spread over the entirety of the school's subject.
- The game is meant for elementary teaching.

Although the final result of the game is a spiderweb physically on the table, with cards that have been placed and divided according to teacher insights and opinions, the layout does not indicate a conclusion on the topic. The physical output is not supportive of the underlying discussions.

GROOW – Studio Tast
(Studio Tast, n.d.)

The GROOW game is a tool that allows design students to create a planning on their research- or design project. It consists of five main phases and a selection of forty activities. The students visually plan the steps and activities their project will make use of, and are able to decided which would be best suitable for their project prompt. The game also includes the option of teacher checkpoints, and the addition of emotion-tiles that allow students to express their feelings.

Figure 33, The Studio Tast GROOW building a project planning by using activities and checkpoints

Elements in this game are:
Discussion: No direct eliciting of discussion
Topic: Planning a design project
Result: Planning of a design project visual on the board
Teams: All players on one team
Template: No template, tiles are laid out according to discussion

Other notable elements are:
- Emotions and feelings are included in the discussion.
- Two example topics are given, but students can also use one of their own.

The game differs from the intended result of this report on the following elements:
- The game is applicable to all students from secondary education to higher education.
- The influence of the teacher on the predicted process is not structured.

The final result of the game is a visual project-plan laid out on the table. Students are able to choose relevant activities according to their own insights and theories and the result can be checked and understood by the teacher. There is little prompting or guidance on the flow of discussion within the game.

Take-aways

The primary objective will be prioritizing/grouping/sorting elements of digital literacy and self-regulated learning in D&T as a game played with teachers – Design Criteria (DC) 1, 6, 8
The game should provide a visual, meaningful balance or conclusion on the table – DC 7
The game should invite the players to lead an effective discussion. This can be done through statement cards – DC 2
The Design&Technology faculty plays the game as a whole team, not divided into smaller ones – DC 2, 9
There shall be no punishments or rewards in the game. There is also no winning or losing – DC 2, 9
At the end of the game, players should be able to formulate what has been discussed and reflect on the effectiveness – DC 2

4.3 Ideation

The Theories
Throughout the report many different theories and views have been discussed. The design that starts to take shape merges many of these elements. Because explanations become scattered and confusing when keeping all these elements in mind, this paragraph summarizes them briefly with the underlying theorem.

(Design) Didactics
De Didactische Driehoek, Tielemans (1999)
The Ontwerpcyclus, Ontwerpend leren in de klas (2018)

Self-Regulated Learning
Self-Determination theory, Ryan & Deci (2000)
Meta-cognitive learning, Quigley, Muijs & Stringer (2018)
De Begeleidingsladder, Joosten (2021)

Reflection
Peer Reflection in education, Brookfield (2017)
Phenomenology, Van Manen (2016)
Playful reflection, Van der Meij, Broerse & Kupper (2017)
Gamification, Morscheuser et al. (2014)

The Game
Resulting from the research into facilitating conversation and the positive influences of gamification the final product of this thesis will be classified as a game. To lead the game to a fruitful discussion it needs a solid foundation in which all teacher can emphasize. The groundwork for the concept needs to be a framework currently in use in Design&Technology.

If the solution space is approached from a design-mindset the adaptation to the course will not be encumbering to the school or teacher. Looking back at the quick trials from paragraph 4.1 one approach immediately stands out. Using the Ontwerpcyclus as a base will allow the design to be an addition to the current structure of the course and build the game upon a path that students follow in the course.

The titles of each phase are clear and flexible enough that even schools or teacher who do not use or directly recognise the circle will realise it does apply (at least in part) to their projects as well. By basing the game on a time-wise concept such as the Ontwerpcyclus, the players are able to discuss a situation in one snapshot moment or situation.

Added to these six steps must be smaller activities that students perform to give more shape to the discussion and allow players to point out where in the process you are discussing. These activities are practical examples and are less prone to personal interpretation, facilitating a clear and focused conversation where all players are on the same line. The activities increase the quality of the design-thinking and provide an opportunity to attach the digital tools. These are important because it can help focus the teachers on improving their coaching on a skill that is more tangible and easier to perceive than the D&T competences for instance. The digital tools can also allow the discussion to expand and include a division of responsibilities or expertise.

To be able to reflect on the coaching and support the teachers provide on self-regulated learning, there needs to be an aspect where the students meet the teacher in a check-up conversation. Lastly the game needs to connect to the teachers personally without giving them a stake in the play. The teachers will need a way to place themselves or their didactics in the played situations and be able to discuss these practical experiences without fear of judgement or backlash.

Working with shapes and relevant strategies within the course, an initial layout was created. To stimulate co-creation, many prototypes and versions were presented to relevant stakeholder and experts on topics such as D&T, self-regulated learning and game-design. The prototypes were kept simple to invite creativity and allow each expert to interpret it differently. After each meeting, relevant comments and feedback they had given were applied to the concept. To simplify the continuous development, four iterations are presented.

4.4 Iteration 1

Game Content
Game is played with the Design&Technology faculty at a school. The aim is to create a clear vision on coaching students to autonomously learn a digital tool.

Game Hardware
The basis of the board is the aforementioned six design steps. Teachers are linked to this process through six check-ups where they have contact with the student teams. Between these check-ups are tiles that represent student-activities. Attached to these activities are digital tools that the faculty offers or demands.

Game Mechanics
The entire game is based on open discussion. No turns are established.

The Informed Consent form for the co-design sessions can be found in Appendix L.
Extra images on the iterations and prototypes can be found in Appendix M.

Prototype
A cut-out paper prototype to play with the shapes of the tiles.

Co-Design 1
Expert: Eveline Holla, SEC
Date: 21/03/2023
In person

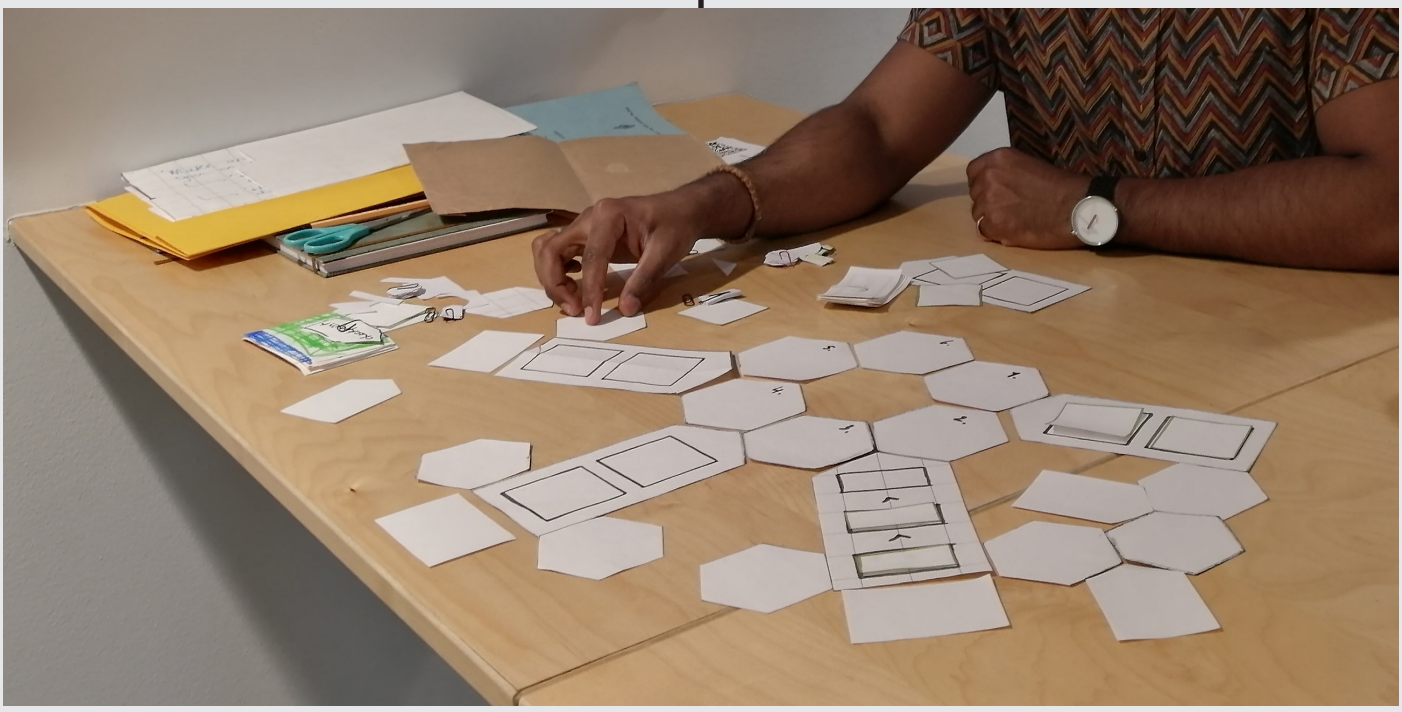
"De docent is de pijl en de leerling de zeshoek!"

Co-Design 2
Expert: Pieter Jan Stappers, IDE
Date: 23/03/2023
In person

Co-Design 3
Expert: IDE student 1
Date: 23/03/2023
In person

"You need a way to show the conclusion."

Figure 34, IDE student 1 with the cut-out paper prototype



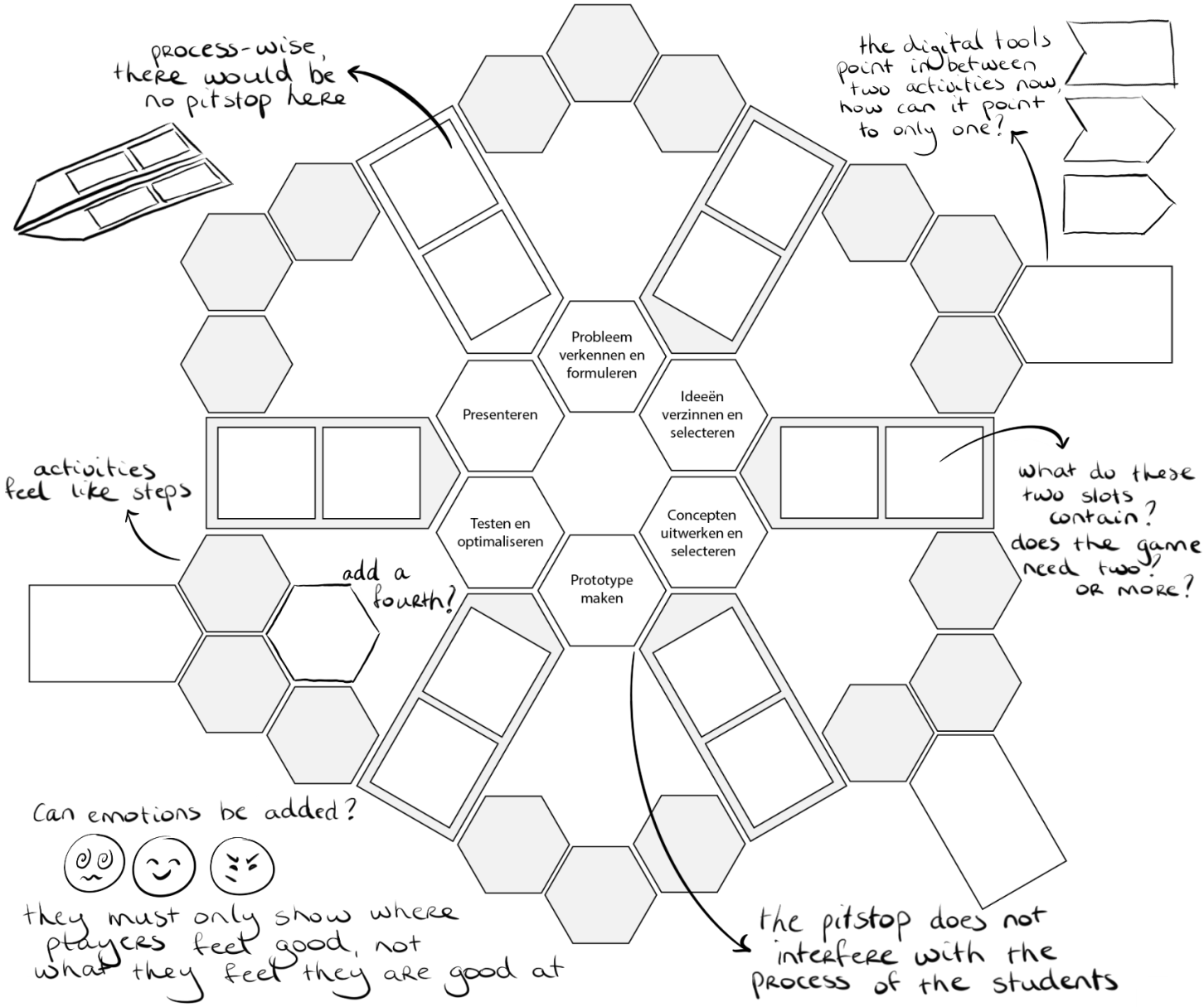


Figure 35, Iteration 1 and the elements that are discussed during the co-creations

Take-aways

Check-ups should be modelled as pitstops as to not obstruct the student in their process - DC 5

There should not be a pitstop in between the sixth and first project step since there is no continuous circle in the course – Argumentation from the course

The digital tools have to link to one activity, not point to two. A change of shape can allow this - Argumentation from the game

The asymmetry of the digital tool tiles can differentiate a workshop from within the teacher team or one from experts outside the school – DC 8

An addition of emoticon-tiles can indicate where teachers feel good or bad in the process – DC 3, 9

Activities should be with four tiles, not three, to make the game less step-wise – DC 3

The conclusion needs to be an abbreviation of the board, something that can quickly be scanned or recalled – DC 7

4.5 Iteration 2

Game Content
Game is played with Design&Technology faculty at a school. The aim is to create a clear vision on coaching students to autonomously learn a digital tool without obstructing the design process.

Game Hardware
The start and end of the projects are visible and differentiated in the circle. The six process-steps are rotated to play around the table and contain icons for recognition. The pitstops have three open slots where coaching-activities can be placed. Seven emotions are added that teachers use around the board to indicate confidence or feeling overwhelmed.

Game Mechanics
The entire game is based on discussion. No turns are established. The teachers have to place the activities and digital tools at the right places and fill in the method of coaching at the pitstops all according to their unified perspective.

Prototype
A cut-out paper prototype to play with the shapes of the tiles and a printed version with content examples.

Co-Design 1
Expert: IDE student 2
Date: 28/03/2023
In person

"Who chooses what digital tools are placed?"

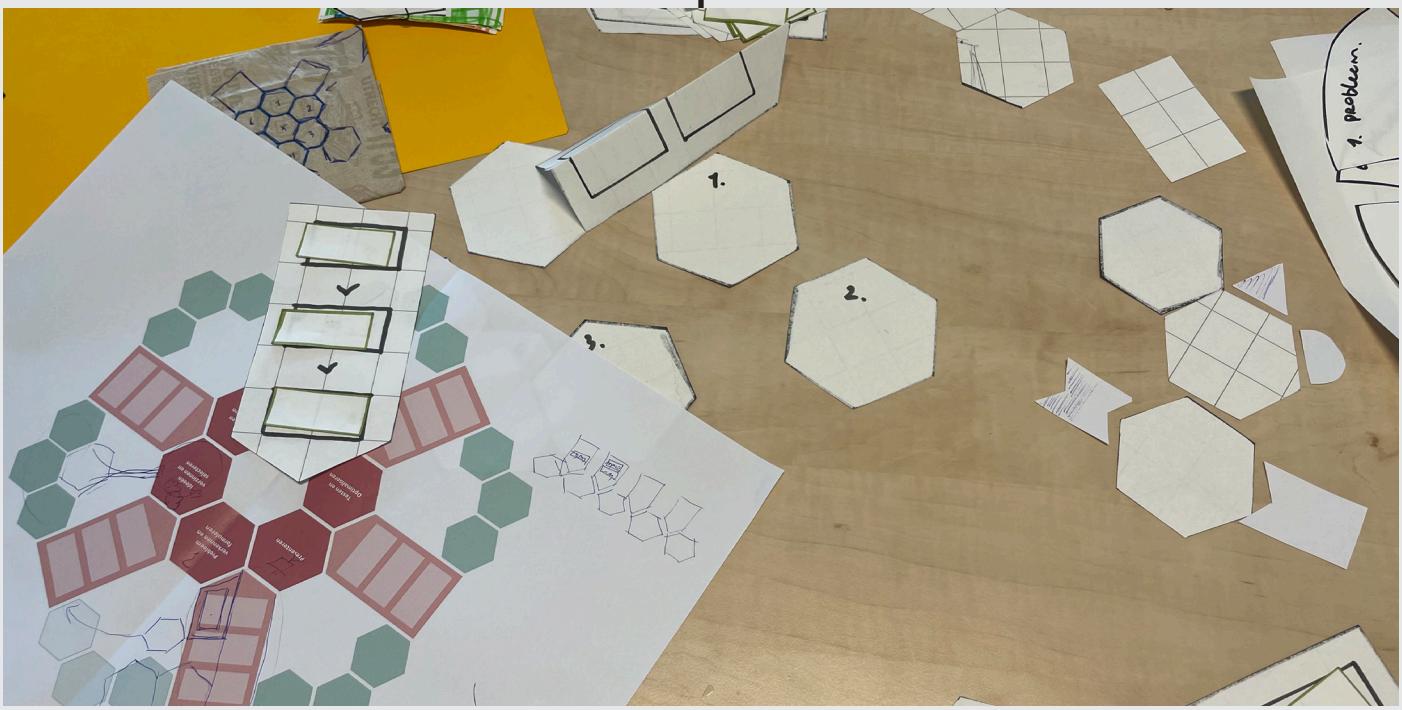
Co-Design 2
Expert: Stefan Persaud, IDE
Date: 30/03/2023
In person

"Bij een spel heb je wel dat iedereen een keer aan de beurt is."

Co-Design 3
Expert: Remke Klapwijk, SEC
Date: 04/04/2023
In person

.

Figure 36, The cut-out paper and printed prototypes during a co-creation



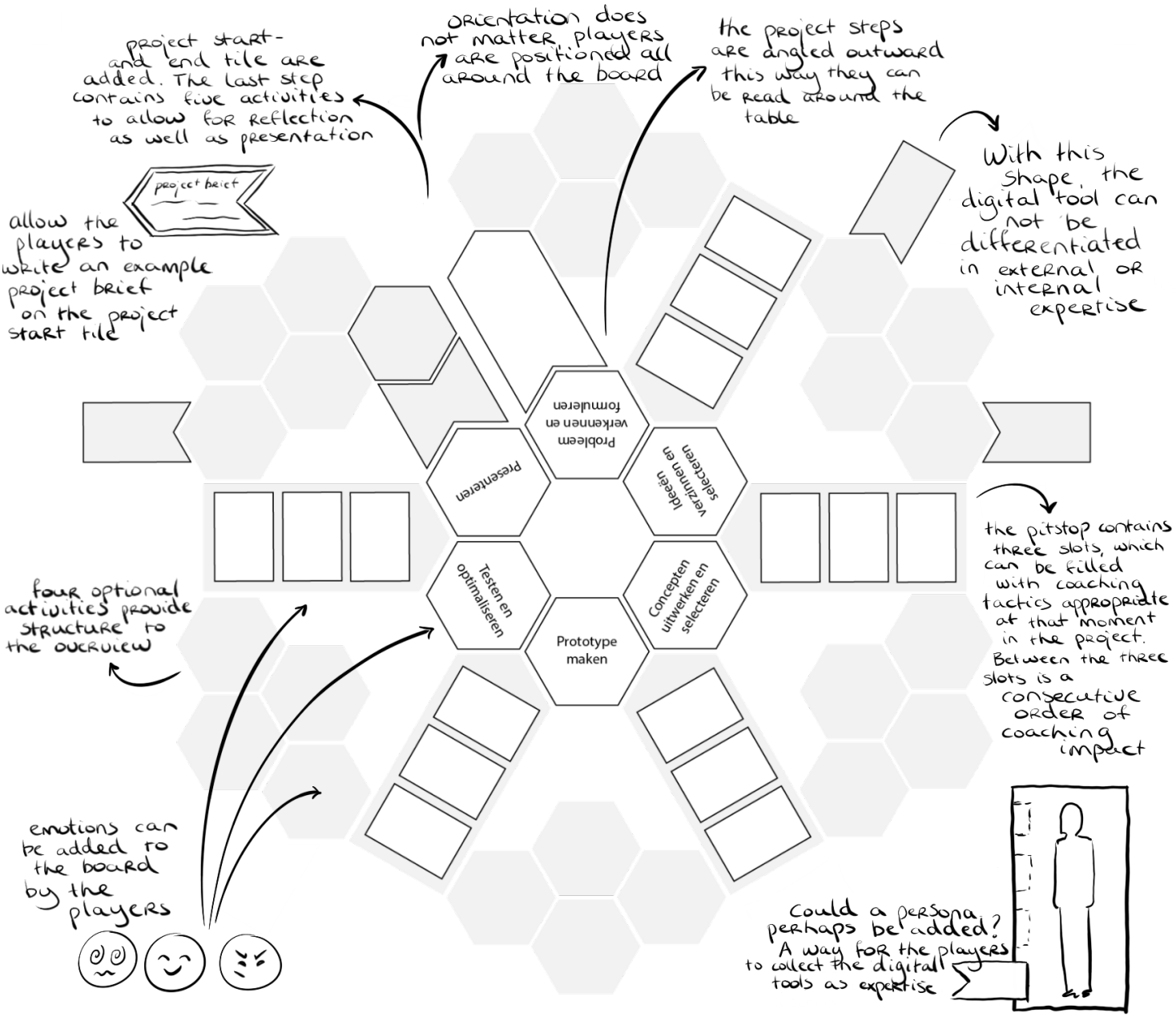


Figure 37, Iteration 2 and the elements that are discussed during the co-creations

Take-aways

Determine very clearly when the game is played: 'Is it an example project? Do they play per project or per group? Are there fixed activities or open? What about transparency to students?' – DC 1, 4

Is it possible to have the game-participants collect their personal skills at the start of the game? – DC 3, 7, 9

Incorporate taking turns to give the game more structure – Argumentation from the game

Provide filled in actions for the pitstops. Base these on current and relevant methods – DC 4

It is also possible to play this game with students, or allow them to play it themselves to plan their project? – DC 1, 5

The emotions need to stimulate the conversation, not make it more personal or subjective – DC 3, 9

Create cards with scenario's or dilemma's the teachers can discuss to attune the game more to their personal experiences and show the result in a less abstract way – DC 2, 4, 10

4.6 Iteration 3

Game Content
Game is played with Design&Technology faculty at a school. The aim is to create an actionable vision on coaching students to autonomously learn a digital tool within the design project. It aims to help the teachers to reflect on this coaching by taking a step back.

Game Hardware
The basis of the game is the six project steps a student takes. Hooked onto those steps are the pitstops with three tiles upon which the teachers can differentiate between autonomy shown in the student groups. In-between the pitstops are four activities for each project step.

Game Mechanics
The activity tiles and the digital tool tiles are divided randomly among participants. Each teacher is made responsible for a pitstop; they will lead the discussion on that particular pitstop and can have the final say.

Prototype
A laminated prototype to play with the content of the tiles and enable the writing and erasing with whiteboard markers. Inviting creativity and playfulness.

Co-Design 1
Expert: IDE student 3
Date: 31/03/2023
In person

"Leg de tegels open op tafel"

Co-Design 2
Expert: Expert Universiteit Leiden, cognitive development (children)
Date: 04/04/2023
Online

"Ook het plezier kan verminderen als je ze [leerlingen] niet bijstuurt of aanstuurt."

Co-Design 3
Expert: Expert Stichting Technasium, Self-regulated learning
Date: 13/04/2023
Online

Figure 38, The laminated prototype with coloured try-outs and an underlying game-'board'

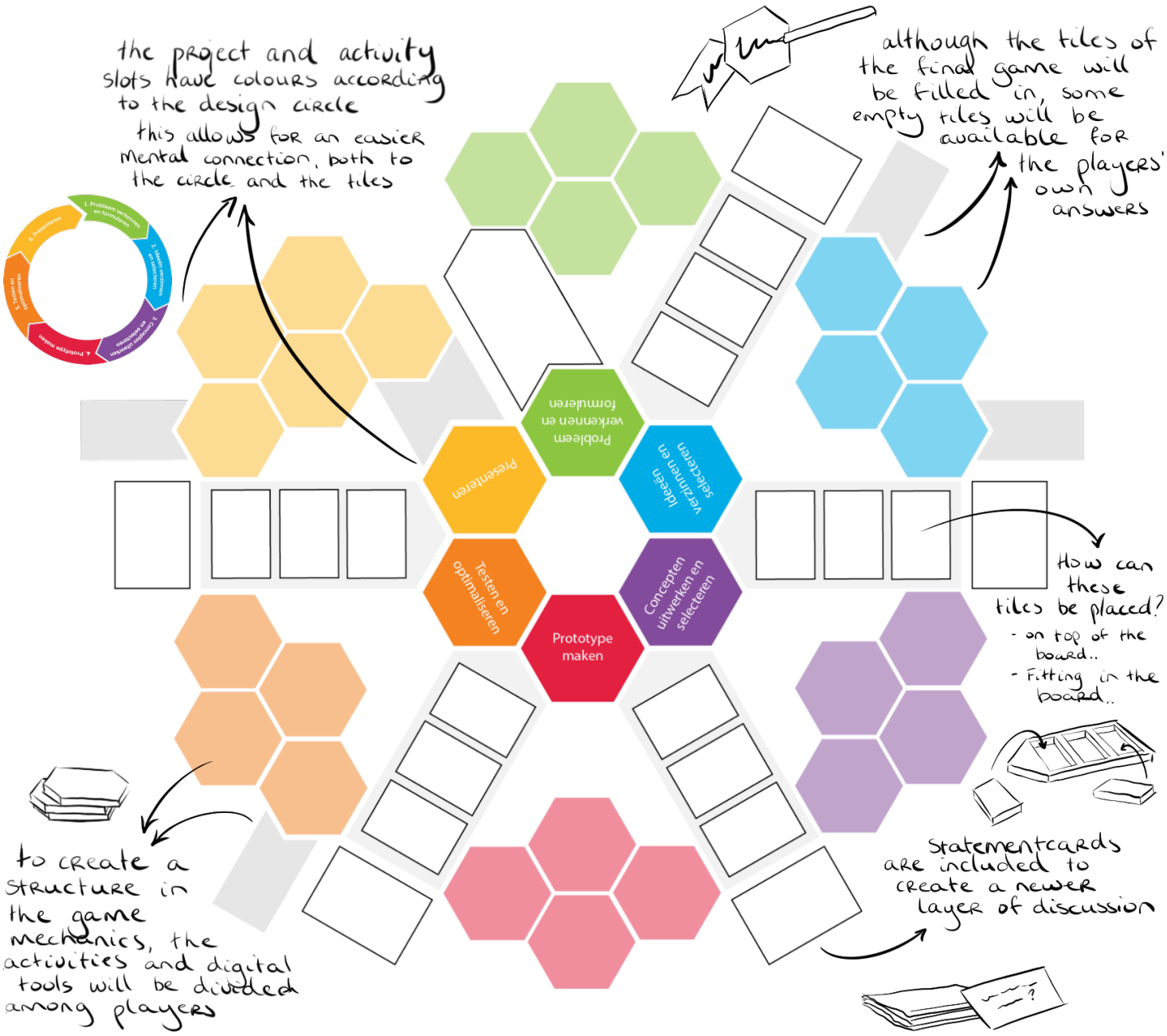


Figure 39, Iteration 3 and the elements that are discussed during the co-creations

Take-aways

To create a more coherent feeling between the project steps and the design circle, use the same colours – DC 10, 11

Also use these colours in the activity tiles to make them belong to the project steps more – Argumentation from the game

Allow for the participants to fill in their own tiles when needed – DC 11

This game will not make everyone's perspective the same. It merely allows for discussion, contemplation and the sharing of experiences and opinions – **DC 2. should be changed to:**
Facilitate a productive discussion on the self-regulated learning process of Design&Technology student within the Design&Technology faculty.

Feedback should be given on the level of self-regulation, this is more efficient with students – DC 1, 5, argumentation from literature

In the pitstops, can there be differentiation between student years? (levels of self-regulation skills) – DC 2, 8

4.7 Iteration 4

Game Content
Game is played with Design&Technology faculty at a school. The aim is to facilitate a productive reflection on teachers' coaching when students autonomously learn a digital tool in support of the design process. It should also help the teachers to find opportunities and chances in the process for this autonomy by taking a step away from their daily didactics and reflect on past experiences.

Game Hardware
The basis of the game is the six project steps a student takes. Hooked onto those steps are the pitstops with three tiles upon which the teachers can differentiate between autonomy shown in the student groups. In-between the pitstops are four activities for each project step. The game includes statements or scenario's that the teachers can use to link the discussion to recognisable situations.

Game Mechanics
The activity tiles and the digital tool tiles are divided randomly among participants. Each teacher is made responsible for a pitstop; they will lead the discussion on that particular pitstop and can have the final say. They are also responsible for reading the statementcards at that point.

Prototype
A laminated prototype to play with the content of the tiles and enable the writing and erasing with whiteboard markers. Inviting creativity and playfulness. Adding coloured tiles and other try-outs with cardboard and whiteboard sticker-sheets.

Co-Design 1
Expert: D&T teachers School 1
Date: 12/04/2023
In person

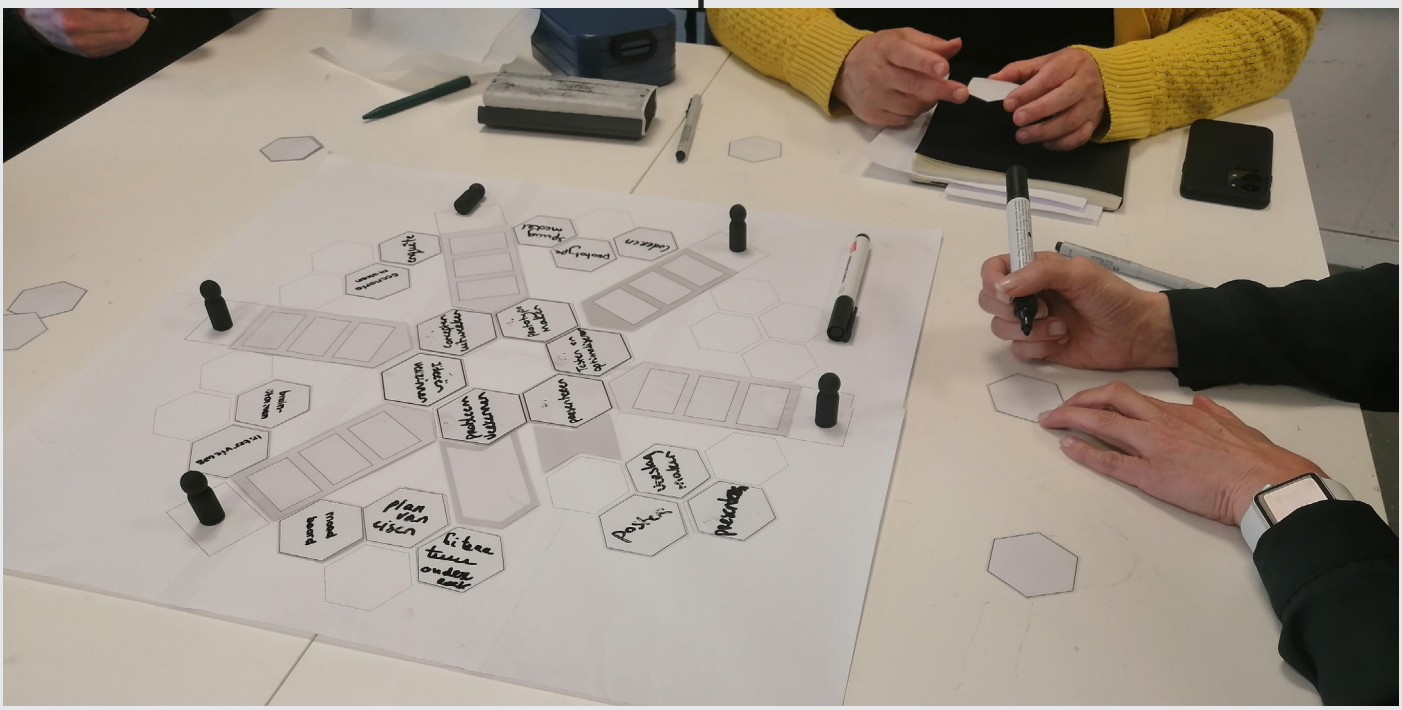
"Er is wel een soort format gegeven, maar je kan er ook zelf mee klooien, dat is toch leuk."

Co-Design 2
Expert: Project Coaches
Date: 14/04/2023
In person

"Geef ze eigenaarschap, niet een invuloefening."

Co-Design 3
Expert: D&T faculty School 3
Date: 20/04/2023
In person

Figure 40, The laminated prototype at school 3, discussing tiles content



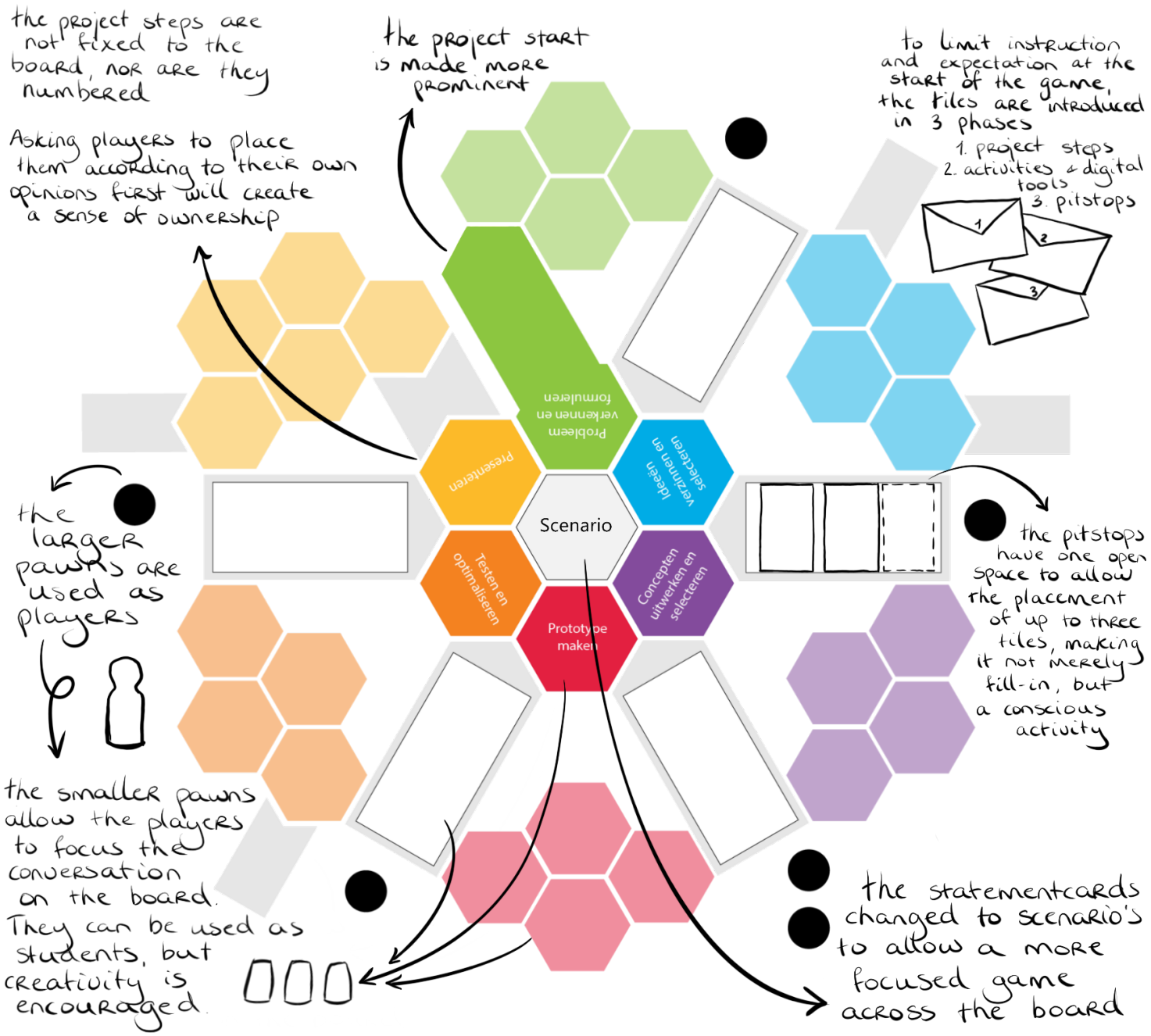


Figure 41, Iteration 4 and the elements that are discussed during the co-creations

Take-aways

By letting the participants play with the process-steps first, they will feel a sense of ownership and accomplishment – **NEW DR: 12**. *Ensure the solution brings relevance, support and a sense of satisfaction to the Design&Technology teachers during and after use.*

Use recognisable and understandable language – Argument from the game

Find the right balance between instruction and openness. Too much instruction will make the teachers play to be right and not wrong, instead of playing according to their own vision – DR 2, 3, 9

Building the game in phases will allow the play to start without too much instruction at the front – Argument from the game

Keeping the pitstop open makes it something they build, not just something to fill – DR 12

Scenario's will ensure the players can better relate the situation to their own experiences – DR 4

By providing pawns to the participants, the game becomes more personalized. Players presented with these pawn are expected to use them to support their stories and arguments – DR 4

05

The final design is presented in this chapter. Based on all argumentation and development of the preceding steps and methods, the game endeavours to make the coaching of teachers on a self-regulated process in Design&Technology more explicit to the students. Similar to the iterations in the previous chapter, the final design is construed by three subjects; game content, game hardware and game mechanics.

Final Design

5.1 The Concept Description

Game Content

The final design of the game allows a Design&Technology faculty at one school to discuss and share perspectives, opinions and experiences on the self-regulated learning process of their students. The goal is to allow a collective distancing from daily practises at the start of the year, ensuring a reflection on the intended approach on coaching as a team. The game is based on the six steps of the design process and visualises how teachers can influence and coach the students in their self-regulated project. The content laid out on the table between the players showcases a general shape of a project, allowing a visualisation of the project steps as well as activities and the coaching that could be applied.

Through prioritizing/grouping/sorting the players discuss and express their vision on the D&T course. The main topics in this are the self-regulated journey, how to coach that and the inclusion or demand of digital literacy in that process.

Figure 42, The game 'board', the box with three phases and the general intruction

Game Hardware
The game contains a board to play on, tiles to sort and discuss, scenario cards and pawns. The centre of the board is shaped to the six Ontwerp Stappen of a project which students roughly follow.

Attached to those are the Pitstops, where the teacher generally meets with the students. The Pitstop is an open shape on the board, the players can discuss which Coaching tiles to place in the Pitstops and how many with a maximum of three.

These Coaching tiles contain methods on coaching a self-regulatory process of students particularly suitable for learning Digitale Tools. The players have to sort these tiles according to which level of independence or coaching a student needs at certain moments in the design process.

In between these Pitstops, within the arc of one project step are four optional Activiteiten. Discussing the Activiteiten will allow the players to prioritize or emphasise and express variations between projects.

Attached to the Activiteiten tiles are Digitale Tools to support the design process. Again, sorting these Tools allow the players to discuss demands or learning curves they wish to implement in their classes. The final arrangement of these Activiteiten and Digitale Tools will also give and overview or balance within the process.

Each player can take a Pion and there are six smaller Pionnen to represent students.

Lastly there are several cards with Scenarios of interactions with students that teachers might come across in their classroom. These Scenarios will allow the players to check whether their laid out ideal Coaching is applicable to real-life situations and not just an ideal according to theoretical models. The players can use the Pionnen and Scenario's to act out a situation and express importance or perspectives.

Figure 43, The Final Design after completing the game

Reflectiespel Digitale Tools en Zelfsturend Leren

Het doel van het reflectiespel is om discussie en reflectie te stimuleren en om ervaringen en methodes onderling te delen met collega's.

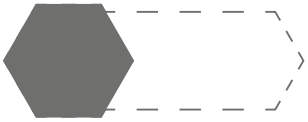
Het bord en de tegels helpen spelers om afstand te nemen van de dagelijkse handelingen en zo met een nieuwe blik naar het Technasium proces te kijken. Dit proces sluit vooral aan bij de introductie van Digitale Tools in het Technasium wat middels het spel kan worden besproken.

Het resultaat is niet een sturende visie, maar juist een verbinding met collega's en een heldere aanpak voor in de praktijk. Door je goed bewust te zijn van de methodes achter coachen kan je de leerlingen beter begeleiden en motiveren in hun zelfsturend leren.

Op de achterkant van deze introductie kan je een overzicht van alle elementen in het spel vinden.
Open nu het eerste vak in de doos om met Fase 1 te beginnen.

Elementen in het spel

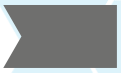
FASE 1:



6x Ontwerp Stap

FASE 2:

40x Activiteit



35x Digital Tool

FASE 3:

30x Coach Tegel

5x Pitstop (op het b

1

Het Ontwerpproces

In het vak van Fase 1 kan je 6x Ontwerp Stappen vinden. Dit zijn de stappen die leerlingen van het Technasium ongeveer zullen doorlopen tijdens een project.

Tijdens dit spel is het belangrijk telkens te overleggen met elkaar en te luisteren naar de andere spelers. Bovendien is de manier waarop het Technasium hier op school georganiseerd wordt vast anders dan op andere scholen. Bespreek telkens wat van toepassing is bij jullie op school.

Bepaal nu als eerste met elkaar in welke volgorde de leerlingen de zes Ontwerp Stappen doorlopen. Leg de stappen in die volgorde op het bord.

2

Het Ontwerpproces

De afbeelding hierboven laat de welbekende ontwerpcyclus zien met de zes Ontwerp Stappen.

Ontwerpen in de klas (2020)

Geef nu elke deelnemende speler een Docent Pion. Deze kan in Fases 2 en 3 gebruikt worden om de focus te leggen op een bepaald onderdeel in het gesprek. Gebruik je pion in Fase 2 bijvoorbeeld om aan te geven welke Activiteiten jij belangrijk, lastig of leuk ervaart.

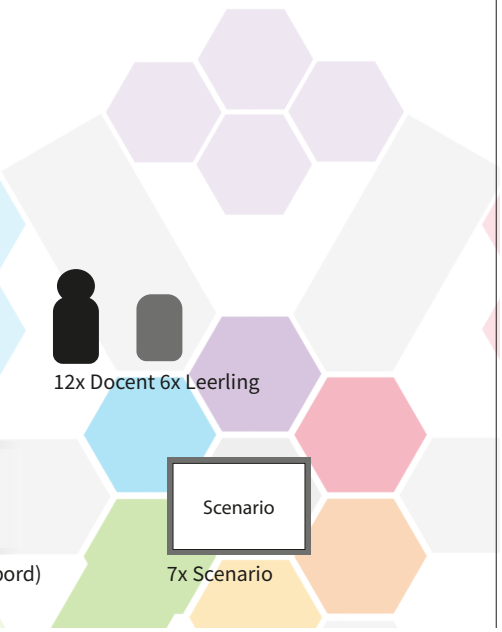
Project Activiteiten en Digitale Tools

Het tweede vak bevat twee verschillende soorten tegels; 40x De Activiteiten en 35x De Digitale Tools.
Verdeel beide soorten tegels op onder de spelers.
Bepaal als eerste welke Activiteiten veel door leerlingen ondernomen worden in elke Ontwerp Stap. Overleg met elkaar welke Activiteiten door jullie worden voorgeschreven of in welke mate leerlingen dit zelf kunnen bepalen.

Bespreek daarna welke Digitale Tools als ondersteuning kunnen worden gebruikt tijdens een Activiteit. Worden hier workshops in gegeven of krijgen leerlingen deze Tools vanuit een andere omgeving mee?

Bepaal voor beide tegels telkens met elkaar wat van toepassing is op jullie school en reflecteer op dit proces. Is het nog relevant? Ondersteunt het de projecten van leerlingen zo optimaal? Wees kritisch.

Figures 44-48,
The instructions of the game



3

Coachend Lesgeven

In dit vak kan je 30x Coach Tegels en 6x Scenario's vinden.
Verdeel de 5 Pitstops op het bord zodat elke pitstop onder leiding valt van tenminste één speler.
De Coach Tegels bevatten manieren van leerlingen coachen of begeleiden, oplopend van geen/weinig instructie tot meer instructie.
Bepaal welke manier van coachen toepasselijk is tijdens elke Pitstop.
De speler verantwoordelijk voor de Pitstop mag de discussie leiden en heeft het laatste woord.
In elke Pitstop passen maximaal 3 Tegels.

Pak de Scenario's wanneer alle pitstops naar tevredenheid zijn ingevuld. Een Scenario Kaart bevat een situatie die in de praktijk van een Technasium gevonden kan worden. Bespreek of de neergelegde Coach Tegels geschikt zijn in deze situaties en pas eventueel de Tegels aan.
Het is ook mogelijk eigen scenario's of situaties te bespreken en te delen.
Maak naar wens gebruik van de pionnen om het gesprek te ondersteunen.

Game Mechanics

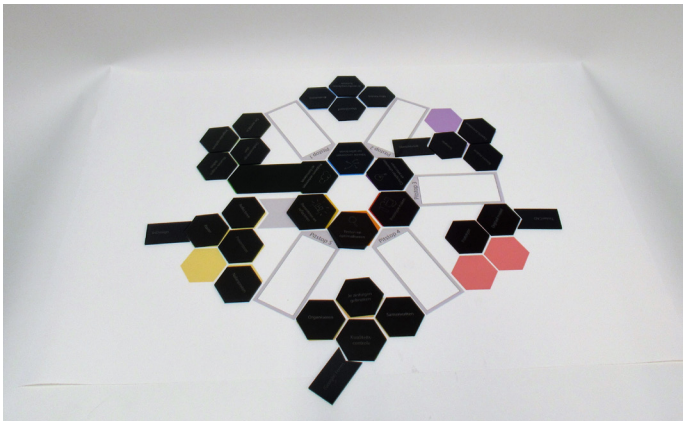
The complete game takes little more than an hour. The preparation of the game is small. There is one general instruction that welcomes the players and explains the intention of the game, see figure 44. The backside shows an overview of all elements and tiles in the game, see figure 45.

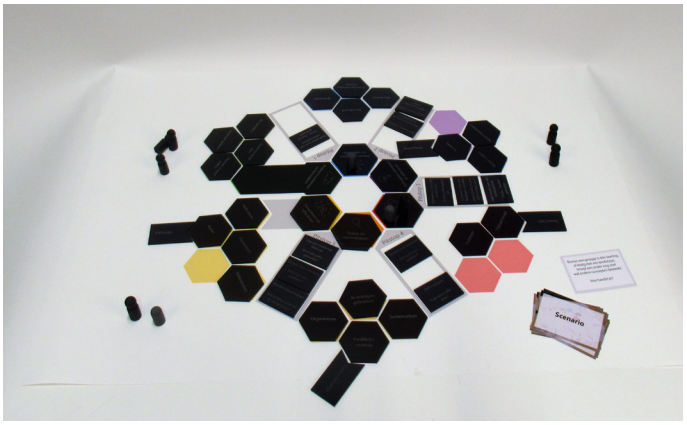
The final design of the game is then build in three phases. These phases are literal closed-off smaller boxes in the larger game box to establish a sense of expectancy. Each phase has their own instruction, see figures 46-48. These instructions are brief but clear and often emphasize the importance of communication and reflection on how Design&Technology is taught at their particular school.

Phase 1 contains the Ontwerp Stappen and asks the players to construct the right circle according to their opinions. Allowing this openness at the start, giving little instruction, will give a sense of ownership to the players and connects them to the creativity of the assignment.

Phase 2 is then initiated by a small check of the Ontwerp Stappen. The second box also contains the Activiteiten tiles and the Digitale Tools, asking the players to sort these, again, according to their vision and opinion, discussing the best placements among themselves. To ensure all players are participating and the tiles are not too large a mass to pick from, the tiles and tools are divided randomly among the players. The Pionnen are introduced in Phase 2 as well, explaining to the players these can put emphasis somewhere on the board and instructing them to divide the Pitstops among the players.

Phase 3 follows, giving the players the Coaching tiles. The player responsible for the first Pitstop starts, leading the discussion on the completion of their Pitstop. When it is filled, the discussion shifts to the next Pitstop, allowing a new player to lead. Once all Pitstops are filled with Coaching tiles the players can draw Scenario-cards. The use of the Pionnen in this phase is encouraged, but the game aims to be open for creativity and playfulness in this area.





Figures 49-52, The process of the game in three phases

Tiles:

- Ontwerp Stappen (7x): The content of the Ontwerp Stappen are based on the Ontwerpcyclus (ontwerpen in de klas, 2020).
'Probleem verkennen en formuleren', 'Ideeën verzinnen en selecteren', 'Concepten uitwerken en selecteren', 'Prototype maken', 'Testen en optimaliseren', 'Presenteren'.

- Activiteiten (40x): The content of the Activiteiten are based on the responses and ideas of participants during the iteration phase in Chapter 4.
'Schetsen', 'Planning', 'Verslag', 'Feedback verwerken', 'Samenvatten'.

- Digitale tools (35x): The content of the Digitale Tools are based on the responses and ideas of participants during the iteration phase in Chapter 4.
'InDesign', 'TinkerCAD', 'Sketchbook', 'Canva', 'Keyshot'.

- Coaching (30x): The content of the Coaching tiles are inspired by the Begeleidingsladder provided by De Docenten Academie (Joosten, 2021).
'Benoemen wat jij als docent ziet: Ik hoor jullie zeggen dat ...', 'Verwijs naar de client/expert: Hebben jullie al met ... gesproken?', 'Geef advies over een inhoudelijk keuze: Als ik jullie was zou ik ... doen'.

Scenario's (7x):

The content of the Scenario's are based on the responses and ideas of participants during the iteration phase in Chapter 4 and personal experiences in the Design&Technology course.
'De meeste groepjes zijn al bij de vierde stap in het proces. Eén groepje is pas bij de tweede stap. Hoe handel je?'
'Je hebt leerlingen in de klas die het niveau niet halen en nu weten dat ze blijven zitten. Hoe zorg je dat zij de pret niet uit de lessen halen?'

Pionnen:

- Docent, large (12x)
- Leerling, small (6x)

The Ontwerp Stappen, Activiteiten, Digitale Tools and Coaching tiles all contain empty tiles as well, allowing the players to fill in their own content, see image 55 on the next page.

5.2 The Envisioned Interaction

The game is played with a Design&Technology faculty of a school. The intended use is playing the game at pivotal moments such as the start or end of the year when new faculty formations are established and perhaps new teachers are introduced to the team. Moments such as those are excellent situations to discuss, share and dissect past experiences and future intended didactics.

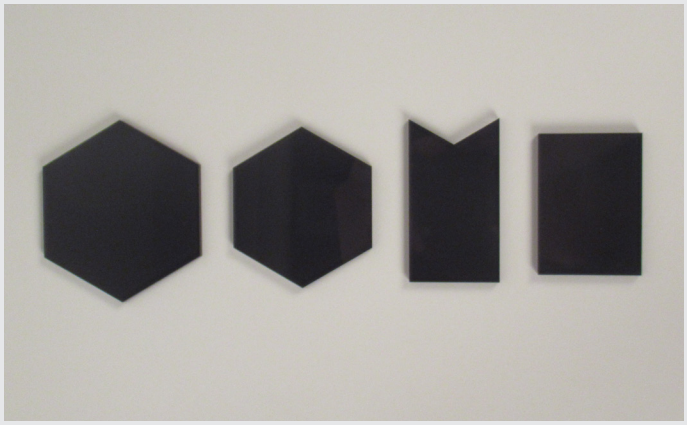
As established in the Design Criteria in Chapter 3, the game is meant to provide a safe space for players to express their personal opinions and viewpoints. Game elements purposefully exclude any means of punishment or segregation within the team.

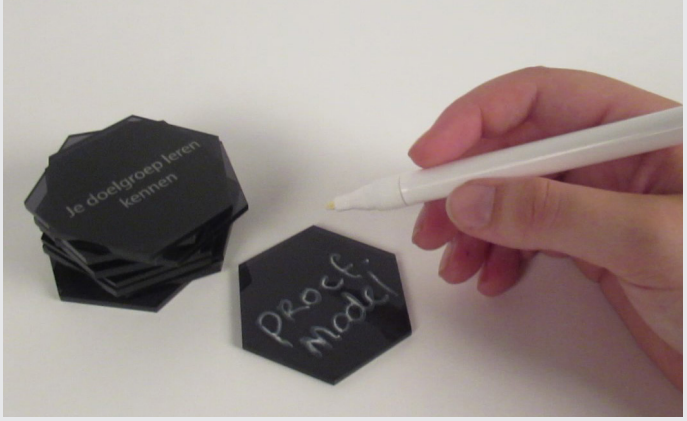
Before playing the game there should be a sense of purpose and expectancy. The context of both the teachers personally and the faculty as a team will play a large role in how the players will approach the game.

At the start of the game the clear but short instruction and quick start is expected to increase the interest of the players. The three phases within the box also create a sense of suspense and curiosity which will motivate the teachers to keep playing.

Afterwards the players are left with a sense of competence and a clear course of action should difficult situations occur in their classroom. They are now better prepared to respond to situations that have a danger of nullifying self-regulation in students.

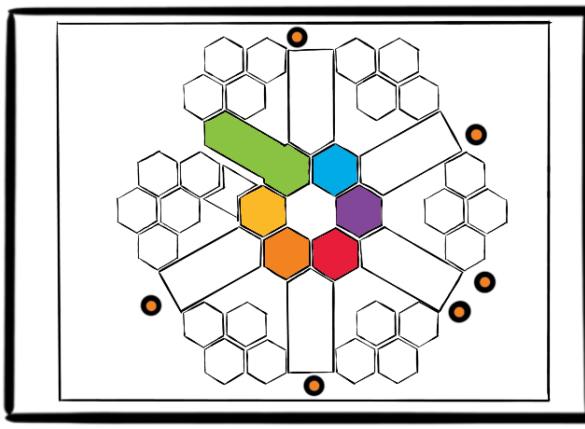
Figures 53-56, The three phase-instructions, the various tiles, the freedom of writing your own input, the scenarios with the pionnen





Scenario

1. The envisioned interaction starts with the current situation where there is frustration in the student.
2. There is also little exchange of didactics among teachers, leaving some of them with uncertainties, especially on the topic of digital literacy and digital programmes.
3. The Design&Technology faculty decides to play the Reflectiespel and prints all the tiles, instructions and even the box.
4. The players start with Phase 1, in which they are tasked to map the six Ontwerp Stappen according to their opinion.
5. After finishing the first phase they open box 2. This instruction shows the Ontwerpcyclus but does not judge on right or wrong. The instruction explains the Pionnen can be used to express onesself on the board.
6. Phase 2 also contains the Activiteiten and Digitale Tools. Players are each given a number of these tiles and are tasked with placing them in the right position according to the D&T course at their school.
7. This phase encourages discussion and consideration on which Activiteiten are important. Furthermore are players asked to reflect on the relevance of the current situation. The Digitale Tools allow the players to select which will be taught by the teachers and discuss expertises or uncertainties.
8. The game then continues to Phase 3 which first asks the players to divide responsibility on the Pitstops over the present players. They then collectively select Coaching tiles according to how they would approach students during each Pitstop.
9. The Scenario cards are introduced and allow the players to determine if the ideal placement of the tiles on the board are applicable to realistic situations.
10. During the scenario-discussions the players can make use of the Pionnen to visualize on which Ontwerp Stappen they are conversing.
11. The final overview of the board can provide insights on the balance of Activiteiten and Digitale Tools within the course.
12. Playing the game will then result in an improved coaching on self-regulated learning in students.



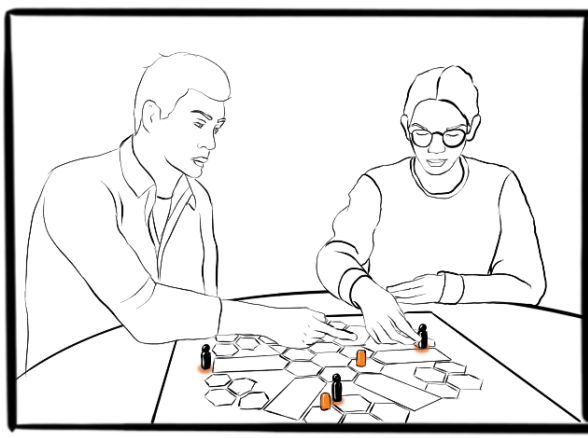
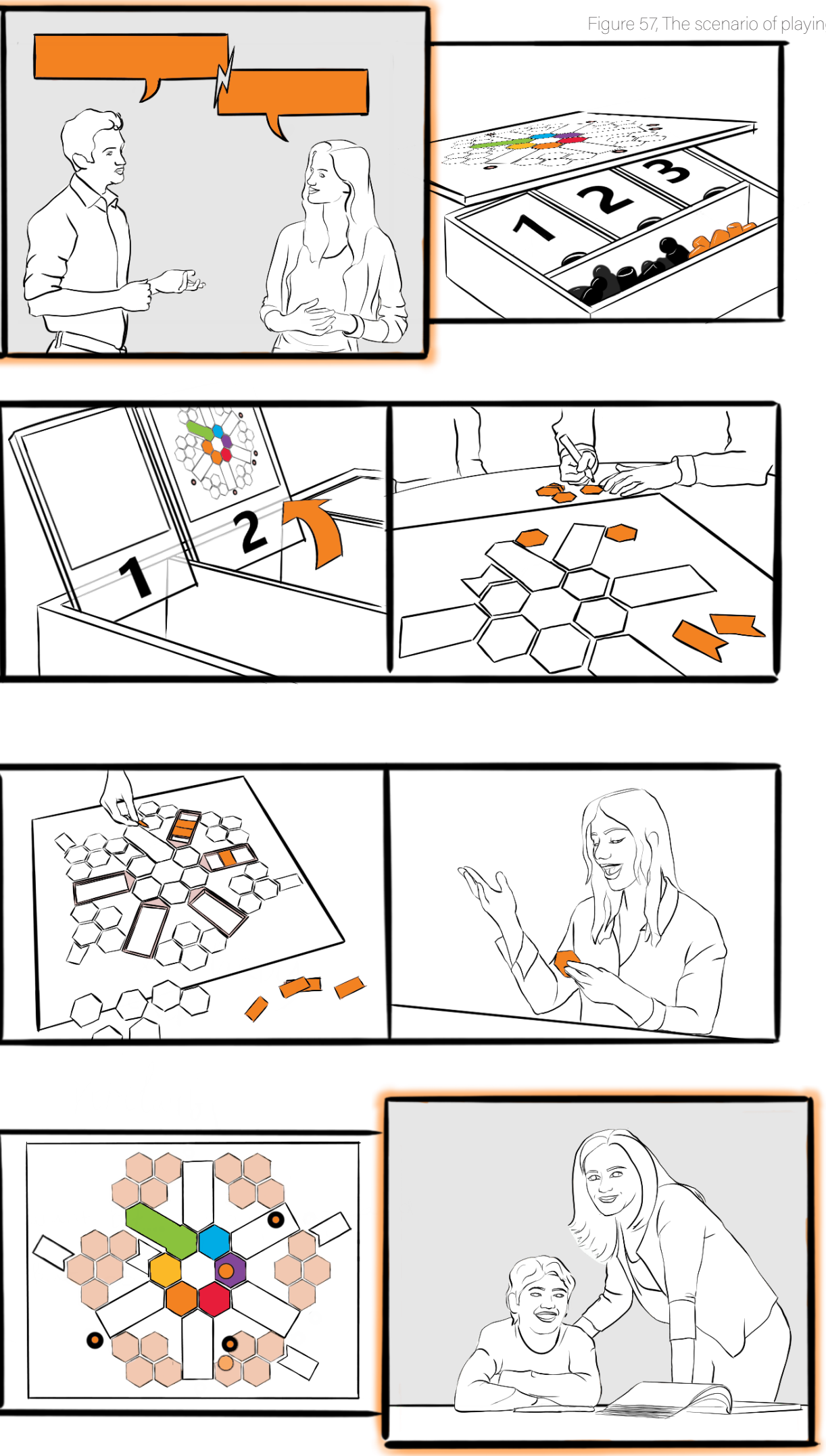


Figure 57, The scenario of playing the game step-by-step



5.3 The Viability

This paragraph contains two possible business cases for the final design of the project. The most important aspect of these two variations is the means of production and distribution.

The first is a system similar to the presented SLO and GROOW games where a team of teachers/ players can enrol for a workshop on the topic of self-regulated digital literacy, receive a brief talk on the subject and play the game under supervision of a professional. The advantage of such a system is the expertise input and outlook the team receives after playing the game since the present professional can explain overarching themes and establish conclusions for the team. These workshops do require monetary contributions from the attending participants which will be used for the production of the game and the payments of the professional. Since the production costs are not much this system is viable. The existing workshops and products such as the SLO digital literacy game can act as examples for this design.

A second option would be to present the game as open source. Educational product or project findings are often presented open source to allow all educational institutes to make use of them. Almost all elements of the game are printable, especially since most school have (access to) a lasercutter nowadays. This type of distribution is suitable for the target audience of Design&Technology teachers and is expected to raise enthusiasm. The files containing the tiles and tools can be accessible online as well as the goal and instructions of the game. A school can print all necessary elements and would only need to find whiteboard markers and something to act as Pionnen.

Science Education and Communication, the client of this project, has expressed a preference for this system, believing in the value of sharing information and the professionalization of teachers.

All lasercut and printed parts of the Final Design can be found in Appendix N.

Figure 58, All elements in the game can be lasercut or printed

06

After the presentation of the final design, it is evaluated in the intended, relevant context. The final prototype is created and a test setup based on the topics of the previous chapter is described in the second paragraph.

Usability Evaluation

6.1 The Setup

The Prototype
The prototype consists of a wooden pre-production prototype with all components of the game present and an almost finalised appearance. The prototype in the evaluation is used to test both the understandability and use-cues of the game as well as the shape and fit of the tiles, board and box.

The Setup
Session-Data
Date: 10/05/2023
Duration: 1 hour and 30 minutes
School: School 4
Participants: D&T teachers
Group: 4 participants
Data Gathering: Audio recording, Video recording, Pictures
Informed Consent Form: yes
Analysis: Qualitative Analysis supported by evidence and Clustering

Main Goal: Observe the usage of the Final Design in a realistic context

Research Questions
- Does the intended user-group understand the content of the concept?
- Does the intended user-group understand the hardware (usability) of the concept?
- Does the intended user-group understand the mechanics of the concept?
- Does the concept fulfil the main Design Goal?
- Does the concept adhere to the 12 established Design Criteria?
- Does the concept result in the envisioned interaction?

The informed consent form can be found in Appendix O.
The complete evaluation setup can be found in Appendix P.

Figure 59, The evaluation setup with audio, video and the prototype

6.2 The Analysis

Understandability

Game Content

Game Content evaluates if the text and descriptions on the tiles and cards are clear, understandable and create the right flow of conversation. The Ontwerp Stappen are quickly related to the Ontwerpcyclus (Ontwerpen in de klas, 2020) by players. The best thing about this circle is that the description of each step is recognisable for players even those that do not regularly or explicitly use the Ontwerpcyclus.

The Activiteiten tiles are mentioned multiple times to have the ability to be placed in multiple positions on the board. The players do not use the whiteboard-tiles to create a second version however. This could be because the whiteboard tiles are not introduced clearly enough, or because the Activiteit can be placed in multiple positions, but is not performed twice by students, thus not needing two versions. The Activiteiten do lead to a deeper reflection on the process. Players discuss whether students actually take these steps or if they, the teachers, only envision and intend for students to take them. Relevance is not a topic that gets addressed, presumably because the board is not based on a specific project and players cannot judge the relevance without an appropriate context.

The content of the Digitale Tools is noticeably based on paid programmes that generally evoke recognition. Players quickly mention similar, free digital programmes that they use instead. Some players do not recognise programmes and ask explanations from others. The Digitale Tools that no-one recognises get laid aside.

Lastly, the Coaching tiles in Phase 3 are understood correctly based on content and evoke relevant discussion.

"Ik wil deze wel graag bij jou neerleggen, die komt wel twee keer voor."

"Bij Pitstop drie zou ik zoiets dus wel doen omdat je gewoon toch iets meer kennis en ervaring hebt zou ik dat juist gebruiken om ze iets effectiever en gerichter te laten werken."

Notably, the tiles that contain content where the teacher insists, demands or even takes the action themselves get laid aside after a quick discussion among players. The tiles are deemed unsuitable to the course Design&Technology, where self-regulated learning is central.

"Doen wij dat nou echt? Liever niet toch?"

"Die 'leg op' zou ik zelf niet gebruiken."

"Dat is niet wat wij doen nee."

The Scenario's need to be concrete to be useful in providing a practical situation to the game. What is observed in the evaluation is that players quickly mention situations they have experienced or are currently experiencing similar to the scenario. The players then start discussing the right course of action for that situation. The Coaching tiles are used in this discussion, helping the players reflect if their intended coaching is suitable in this scenario or experience.

"Wat ik ook veel zie ..."

"Oh die [situatie] heb ik ook!"

"Maar hoe kan ik dat dan oplossen?"

Game Hardware

The evaluation of the Game Hardware is aimed at the correct understanding of the tiles shapes, forms, sizes and placements.

The first tile of the Ontwerp Stappen evidently differs from the other five and the same shape is expressed on the board. The problem arises with placing the second tiles and determining the direction. The game is based on a clock-wise rotation, similar to the Ontwerpcyclus, but players have the intuition of placing the tiles counter clock-wise. During the evaluation another player pointed out the logic of placing them clock-wise, and the tiles-placement was changed.

The Activiteiten and their placement did not pose any trouble or hesitation and the Digitale Tools got attached correctly right away.

Both the Activiteiten and the Digitale Tools, however, do not provide any differentiation in being used in the lower year classes or the upper year classes. This difference does exists according to the teachers, as well as Tools the teachers offer or know and Tools student have used on their own. Differentiation between these cases could lead to a clearer starting point of any next steps the players will want to take after finishing the game. An argument against this differentiation that has been observed in the evaluation however, is that the game allows for players to be introduced to new Activiteiten or Digitale Tools that they may have never heard of before, and lower class teachers and upper class teachers have an opportunity to share and compare.

The Pitstops cause slight confusion as they are part of the board and not loose tiles. The instruction does describe the Pitstops as they are important aspects, which leads to players looking for potential tiles.

The Pionnen are also a bit unclear. Players follow the instructions on these well but mention after playing the game that they did not understand the meaning or the intention of the Pionnen in aiding the game. After an explanation of the Pionnen, some players say they understand the reasoning but do not personally feel the need of distancing on the board.

"ik denk dat daar best wel wat in zit bij sommige mensen."

Lastly some tiles get placed outside the designated areas, not due misunderstanding the shapes, but due to the limited space the board offers. This shows the players do not feel the need to adhere to the rules too strictly, indicating ownership and creativity among the players and no immediate negative effect is expected to arise due to the overflow of tiles.

Figure 60, The Pionnen placed on the board

Game Mechanics

Game Mechanics mostly aim at the understandability of the instructions and the flow of the game. It evaluates if the phases are understood correctly and if the division of responsibilities are clear. The instructions are taken out of the box and often passed around. The instruction of one phase sometimes consist of multiple parts (for instance the Activiteiten and the Digitale Tools are described in the same instruction). This does not present any problem with understandability.

The division of tiles among the players lead to most of the players initially looking for the right placement individually but eventually the conversation starts when someone has an uncertainty or an improvement as to the placement. The instruction in Phase 2 does not mention a limit of tiles that can be placed. The players are inclined to place (almost) all Activiteiten tiles and seem to sort the Digitale Tools as to where they could be used. After some time, however, a player will remind the others that the tools need to be ones they use at their school. The sorting of these tiles can indicate the intention of players to play the game 'right' which leaves little room for reflection on their particular situation.

The intention of the tiles being placed according to the situation in the Design&Technology classes at that particular school is also clear to most players. At any misunderstanding clarification quickly comes from other players.

"Zou het horen bij..' 'Het maakt niet uit wat hoort, het is wat wij vinden."

"Ik denk dat dat bij ons wel feit is hoor, dat dat pas daar komt."

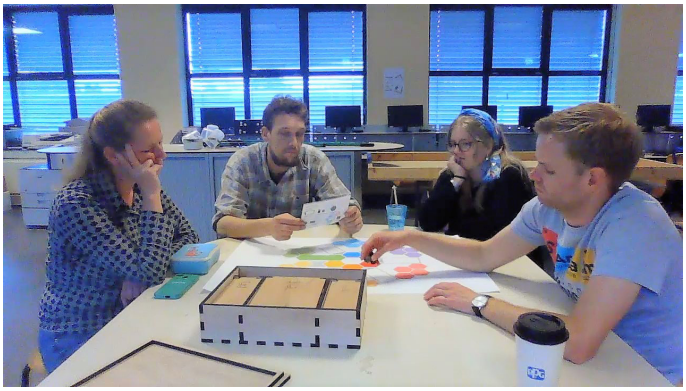


Figure 61, The players reading the first instruction

Design Goal

Reflection on Teaching

While playing the game, the teachers are observed to reflect on their everyday communication with students. What the players mentioned about the Digitale Tool for instance, the difference in what students use and what the teachers know/offer, shows there is a distinction and allows the players to reflect on the circumstances to this situation. Is this intended? Should the teachers encourage this development or is it obstructive to the self-regulated learning of the student?

"Ik denk wel dat dat een eis is hoor, vooral als we willen dat ze een prototype maken om testen dan moeten wij er wel voor zorgen dat zij de tools hebben om de prototypes makkelijk te maken."

The topics of the Activiteiten and Digitale Tools also facilitate an exchange of knowledge and experience of some tools. During the observation a teacher of the lower classes admitted to not knowing a lot of the Digitale Tools a teacher of the upper classes placed on the board. Due to the Reflection Game they were now able to raise this topic without judgement.

Offering a 'toolbox' of the Digitale Tools can also remind players on the existence and relevance of some programmes. One player saw the 'Adobe Illustrator' Digitale Tool tile and started reflecting on why their school did not use this, discussing with their colleagues and expressing the wish that they should start to offer this programme to students.

"Waarom gebruiken wij dit eigenlijk niet?"

In the observation the playing of the game led to the realisation how important the structure of the Ontwerp Stappen is to both teachers and students and the players resolved to make these Stappen clearer to students in the upcoming projects.

Figure 62, The players discussing the Scenarios

As mentioned before, the scenario's are very helpful in facilitating a discussion on current or past experiences. Furthermore they allow the players to apply the Coaching tiles to everyday situations, stepping back to their own didactics in the classroom.

"Zou je niet wat meer dwingend worden? Van; ik wil dat je nu dit en dit gaat doen.
Ja ik doe dat wel."

A danger to the game could be that players only think about the coaching and tiles abstractly or theoretically and fail to connect these to their own experiences in the future. The scenario's allow the players to step back into their own teaching within the context of the game and create a bridge between the reflection and their teaching henceforth. Players mention the usefulness of seeing the entire situation on the table and exchanging and discussing with their collagues, but recognize that what they placed down can never be the complete situation in real life. It is an ideal they try to work towards.

Visiespel

During the evaluation, the game was promoted as a Visiespel to the teachers participating in the evaluation. Afterwards they reflected, however, that the game never takes the step to actually create a vision.

"Je benoemd het een visiespel dus ik had verwacht dat je meer echt over wat vinden wij eigenlijk waar we naartoe gaan werken als technasium terwijl ik het gevoel had dat ik hier meer bezig was met het puzzelen van hoe ziet het er nu uit. Ik had gehoopt dat je ook die stap zou doen van: hoe willen we dat het er straks uitziet?"

The players therefore decide the game is more of a Reflectiespel, helping teachers reflect on their current and ideal teaching, leaving them to determine their own course of action in applying it. During the observation they mentioned a couple of action-points they were considering, such as researching Adobe license possibilities for schools, but never wrote any of these down. When asked if the game felt obstructing in this matter the players answered it did not, they just did not feel the need to write it down at that point.

Design Criteria

The next page contains brief evaluations on each design criteria (DC) from paragraph 3.6.

1 The research points to the assumption that making the current situation and ideal situation more explicit to teachers this will improve their communication to the students.

2 The evaluation showed an increase in discussion and reflection on didactics as well as the exchange of expertise, knowledge and experiences.

3 Elements of the game do not lead to any segregation in the team and instead allow differences to be mentioned safely and solved in case that is needed.

4 The scenario's quickly led to teachers mentioning similar, experienced examples and asked their collegues for advice. The Coaching tiles supported this conversation.

5 The evaluation could not test this recommendation. Expectations are that the explicitness of coaching didacts will create less imposing checkpoints for students.

6 The game includes many digital tools and allows the flexibility of players adding their own ideas. By having a few fixed the teachers are reminded and stimulated to add tools.

7 Depending on how well players follow the use-cues of the board the overview provides a cleaner or messier overview. In the evaluation a visual disbalance was spotted.

8 The discussion mostly led to whether students actually used the tools teachers provided them with. No expertise was discussed or divided.

9 The conversation during the evaluation did not contain awkwardness or anything related to anger. Players expressed wishes and uncertainties.

10 The Ontwerp Stappen allow for players to relate even if they don't personally make use of the Ontwercyclus. The game can be played in little more than an hour.

11 The evaluation could not verify this recommendation. Expectations are that the flexibility of the tiles will intercept possible course developments.

12 The communication of the main goal shifted to a Reflectiespel. Players mentioned feelings of enjoyment, curiousity and satisfaction.

Envisioned Interaction

Context

The context in which the game is played has a large influence on the reflection that might occur and the manner in which the envisioned interaction is reached.

Firstly the intention behind playing the game has had a large role in the development of the game. Due to the research being part of a thesis-project, there is a chance players might play the game in order to support the researching student. Furthermore, this sense of playing 'for' the student might cause players to want to play the game 'right' in order for the student to be able to evaluate the concept as being a sufficient solution of the design problem.

The players that took part in the evaluation had not been included in previous parts of the project and had volunteered to partake in the research due to their own need of a team-activity that lead to the creation of a vision. It is therefore concluded these effects were minimal in the final evaluation of the concept.

Secondly, the immediate context in which the game takes place also influences the result. The Design&Technology course is famous for having students walk in with questions or to work on their projects all the time. During the evaluation occurrences like this also happened. No immediate influence or disruption to the game was observed, students even showed interest in the activity.

Figure 63, The context of the game, the teachnasiumlokaal

Personalities

Due to the large mix of teachers that can be found in a Design&Technology faculty, the game aimed at a productive discussion and the stimulation of a safe environment. Personalities and mood do influence this result. During the evaluation a sickly player sometimes influenced the game by giving short answers and moving on to the next phase quickly, cutting the discussion off. Presumably these things would also happen when there is little time available or of a player does not see the activity as productive.

Time of year

The players of the evaluation had all been working with each other for three years and regularly exchanged experiences, difficulties or questions. The game did lead to the intended reflection but resulted in little new insights or exchanges for the players. Again, when explaining the intention of the game being played at the start of the year, with new colleagues, the players expressed enthusiasm and understanding.

"Ik denk op zich wel dat het leuk is om aan het begin van het jaar zo'n gesprek te hebben met je team."

"Ik kan me voorstellen dat nieuwe collega's zoiets heel erg zou helpen."

6.3 Teachers in Training

After the final evaluation, the game was played with a group of Design&Technology teachers in training. Because they all intern at different schools, the set-up of determining what happens at one school specifically was completely changed. Instead, the game allowed the players to express differences and discuss why they were different or what might perhaps be better. It still facilitated a lot of exchange in experiences and gave perhaps a more fruitful discussion on this as the players were eager to reflect.

"Juist omdat je nu ook verhalen hoort van andere scholen."

As a last comment they mentioned that such a game could very well be used for reflection during intermission meetings. The interesting aspect to the game is that it states what works well, leaving the teachers with a competent feeling afterwards whereas those intermission meetings usually focus on difficult or disrupting experiences and scenario's.

"En dan [tijdens een intervisiebijeenkomst] is het inderdaad een casus waar je niet helemaal tevreden over bent terwijl nu gaat het ook over iets waarvan je denkt 'ja dat werkt juist goed', meer een trots ook."

Afterwards one players asked if they could borrow the game to play within their D&T faculty, indicating desirability to the concept.

"Mag ik hem toevallig gebruiken? Ik vind het leuk om het ook bespreekbaar te maken bij ons in het docententeam."

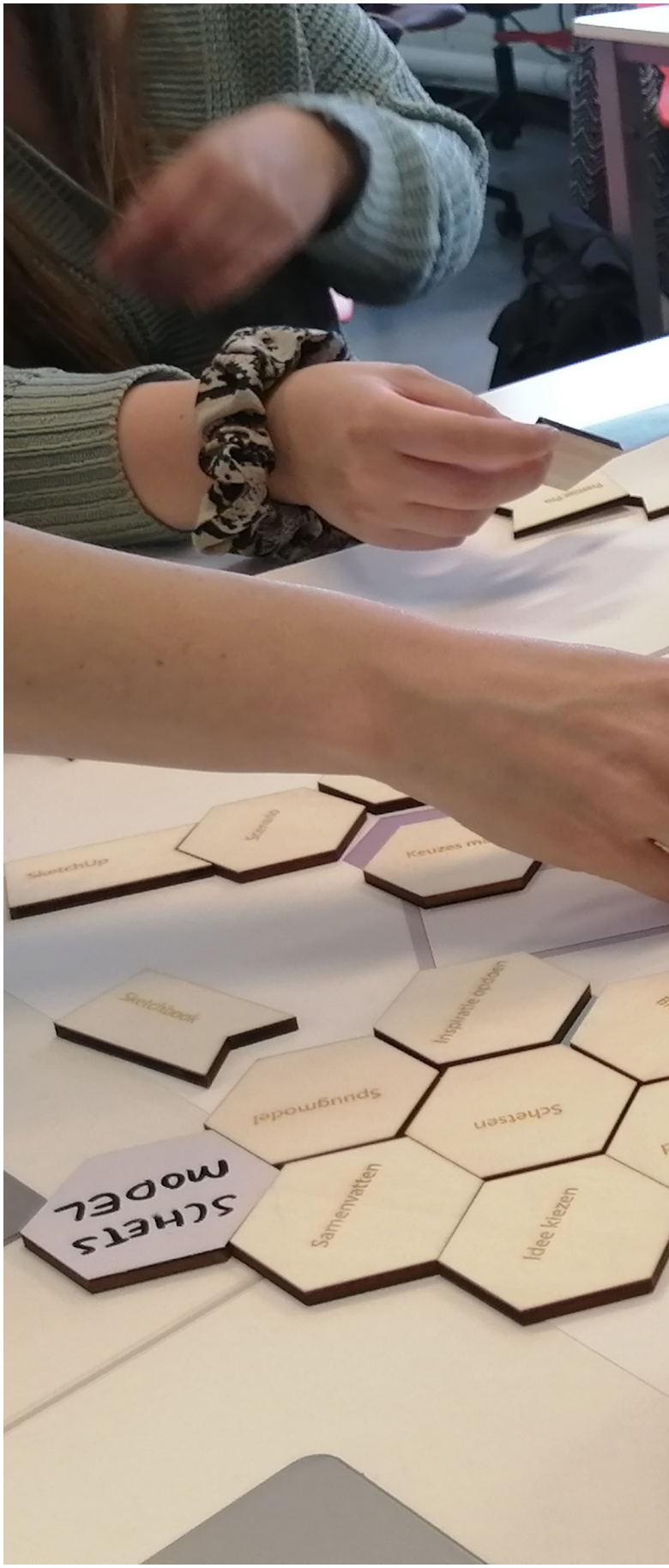
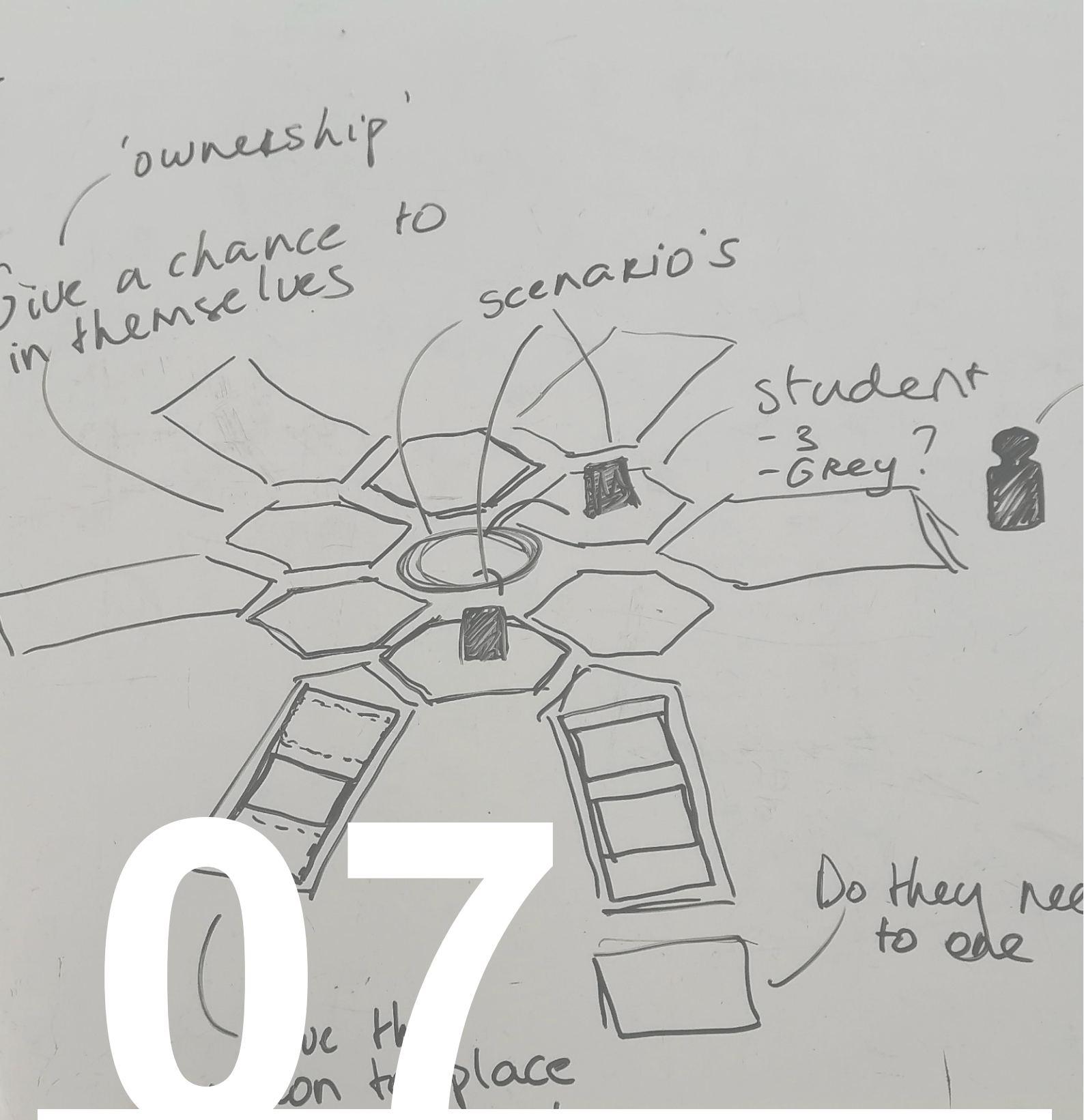


Figure 64, the game played with teachers in training allowing them to discuss differences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Conclusion

7.1 The Conclusion

At the start of this project there was a perceived opportunity in the inclusion of digital literacy in the secondary education design course Design&Technology, yet the inclusion raised challenges. The precise nature of these challenges was refined during the interviews and contextmapping sessions by perceived miscommunications between teachers and students when attempting to apply the autonomous learning process to digital literacy.

The goal of the project was then established to be the aiding of a D&T faculty to collectively distance themselves from their daily practises and facilitate a reflection on the handling of problematic situations in this self-regulative process of students. In addition to that are the criteria on how to shape this solution, especially taking into account frequent troubles a D&T faculty run into such as little time, irregular meetings and a low exchange of educational tactics.

Chapter 5 of this thesis then presented the Reflection Game as an answer to that established design goal. The game is intended to be played at pivotal moments in the faculty such as the start of a schoolyear so teachers can exchanges views and perspectives and all players will have a unified outlook on what the Technasium means at their school. It prompts the teachers to reflect on the interventions they undertake with the student design teams and how effective these might be to the self-regulated journey so valued in the D&T vision. The game is also meant to provide a safe space for players to express their personal opinions and viewpoints. Game elements purposefully exclude any means of punishment or segregation within the team.

By making their actionable coaching more implicit to teachers, they will be able to communicate expectations more clearly to students. A clearly communicated unified goal allows the students to consciously apply self-regulation strategies, resulting in an improvement in intrinsic motivation and general wellbeing.

The evaluation in Chapter 6 shows the players understood the main goal of the game to be reflecting on current didactics and comparing these with colleagues, allowing a Design&Technology faculty to promote a unified approach. The players of the evaluation reflected on their own teaching according to current scenario's they struggled with, made judgements and raised questions and uncertainties. Although the game does not prescribe the teachers how to include digital literacy, it supports them in mapping out approaches and priorities. This way they are better prepared to handle unexpected occurrences when students need exactly the right support in their self-regulated learning.

The original research question *What elements currently challenge the inclusion of digital literacy in the Design&Technology course and what enabling characteristics can these elements have for a solution* can now be answered: The inclusion of digital literacy requires the D&T teachers to discuss, reflect and compare didactics with colleagues. This conversation should also critically reflect on the activities they promote or demand in their course, as well as an approach to self-regulated learning and digital programmes attached to that.

The additional question of *How can Design&Technology teachers and/or students be aided in surmounting these challenging elements* is answered accordingly: By enabling the teachers to complete their comparison and discussion in a short amount of time in a setting that allows them to be open, creative and collaborative. The game allows players to guide their reflection within given boundaries and encourages a variety of uses and creativity through its tiles.

By employing the Reflection game the Design&Technology teachers can structurally overcome elements that challenge the inclusion digital literacy. Engagement with the game will improve flexibility, innovation, motivation and allow the teachers to provide student-centred education. Digital literacy can now be taught in design education without limiting the self-regulated design process of its' students.

7.2 The Discussion

Student Results
A strong limitation to this project is that the effect of the game could not be measured on the students. Due to the timespan of the project and the time-delay it would take to influence the student through the teachers no effect could be feasibly measured. The final design is based on the assumption that making the strategies more explicit to the teachers will result in a better communication to students.

Context
The influence of the context to the game has never been adequately measured. Instances where the context touched the play have been observed in the evaluation but the difference between context has not been quantitively or qualitatively related to the outcome of the game. Furthermore have all instances of collaboration or evaluation been in the presence of the researching student. Motivation influenced by context can be expected to have a wider range from low to high motivation should the research not have a role in the intention of playing. The mood of the group and what specific members bring with them to the play can also largely influence the outcome of the game. Some might want the game to be a challenge, others might be seeking approval instead.

Lower/Upper Classes
During the evaluation the players expressed the difference between the lower and upper years in the Design&Technology course. The students follow a progressive learning curve over the course of years and what is taught in the first year can barely be compared to the last. The Activiteiten and Digitale Tools in the game do not allow for any distinction in this factor. This could lead to a less specific exchange of expertise since the game attempts to cover a large subject. However it has also been observed to lead to a fruitful exchange of knowledge, in particular on Digitale Tools that are used in the upper classes but not the lower. Allowing no distinction between lower and upper forces the players to not separate the two and ensure the student transfer from third to fourth is not too abrupt.

Methods on Coaching

Although extensive research has been compiled and presented in this report, the game does not provide any of these insights. Other than communicating the goal and intention of the game, no underlying coaching-methods or practises are presented to the players. Should teachers feel the need to look into certain aspects after playing the game it is currently not supported by the game or the instructions.

Furthermore does the game not explain the current situation where the teachers' coaching can hamper the self-regulated process of students. The final design of the game is based on the assumption that explicit reflection on didactics will enable the players to improve how they operate in their classes, thus mitigating unfavourable effects on the students' self-regulation. No elements of student dissatisfaction or student perspectives are included in the game.

Visiespel/Reflectiespel

As also mentioned in the analysis of Chapter 6, the game was originally promoted as a Visiespel (vision game) whereas the players during the evaluation assessed it was more of a Refletiespel (reflection game). This assessment is deemed correct, but does not change the intention of the game nor the stamp of approval it received after the evaluation. The title of the game merely carried with it false expectations.

The reason the game is more reflective is because the players are asked to portray what currently is. Not an ideal or a wish, what is. The game leaves the push into action and the intention of changing of what is to what could be to the players. It gives no incentive to do this while playing the game, but the game also does not obstruct it.

Adding this incentive could be done at the closing of the game, turning the reflective phase more thoughtful towards innovative action. This can be initiated by asking the players to write down the first step they will take after playing. It pivots their thought from *what is* to *what can I improve*.

Coach or Teacher?

A difficulty the players raised during the evaluation is the many hats they wear as Design&Technology teachers. As explained in the conclusion of session 2 (paragraph 3.3), the teachers are expected to coach the student through their design projects, but they also have to keep the student in line and perform a judging role at the end of the project. These are difficult roles to keep in balance and sometimes the teacher and student do not know which is needed at that time.

The game is solely based on establishing the right way of coaching during a project. It does not take into account that sometimes a teacher has to step out of the coaching role to be a managers, an expert or even a client.

7.3 Recommendations

More Usability Evaluations

As mentioned in the discussion; the final concept was not evaluated on its influence on students. A recommendation for further research would be to set up such an evaluation after the influence of the game has taken hold in the teachers of a Design&Technology class. The evaluation should be focused on the miscommunication between the teacher and the student and establish if the implicit coaching for the teachers has improved the way they promote their expectations. As a result the intrinsic motivation of students should be able to prosper thus allowing students to produce better results and experience an improvement in their wellbeing.

Secondly, the final design has only been evaluated at School 4. Over the course of the project teachers and D&T faculties have been involved in many instances. School 2 and 3 even contributed to the development of the concept, strengthening the connection of the design to practical experiences and educational contexts. Despite this, more overall evaluations at schools with no previous involvement in the project would have substantially strengthened the statements of achievement in the evaluation.

These extra evaluations are needed especially on the topic of flexibility. The report has periodically communicated that flexibility in the application of the final design is of great importance to the D&T course structure. By having evaluated the game at only one school the achieved flexibility has not been evaluated accurately. More evaluations with a special focus on the flexibility and suitability of the tile content and optional deviations are necessary for a final approval.

Variations

Over the course of the project, the possible application of the game to other situations has been noted many times. Due to the design goal and very clear miscommunication stated in Chapter 3 the goal of this project has kept focussing on the D&T faculty of a particular school playing the game.

There are two variations, however, that merit a mention in this chapter.

The first is the option of playing the game with D&T students. It would allow the students to visually plan their activities together and determine which will best contribute to their project. The upper levels especially have the skills and knowledge to be able to use the game to build their own project-plan for instance. The way they fill the Pitstops with Coaching tiles could be their communication to the teacher on how they would like to be coached, and the Digitale Tools could be a plan for which tools they will use during the project. It could be played with the teacher, using the game as a means of communicating the shared goal, or it could be played solely by a student team, allowing the teacher to analyse afterwards.

The second option is the one also briefly mentioned in paragraph 6.3; Playing the game with teachers in training. Because the teachers all intern at different schools, the game could be a tool of focussing the conversation and gradually exchanging material, advice or problem-statements. The timeframe for the game is expected to be much longer then because it aims at exchanging all perspective and these would all differ substantially. Meetings, tools and games such as this are often used with teachers in training to facilitate sharing experiences and help each other in finding the right didactics.

Both variations would provide interesting goals and result to the structure of the game but require more research before implementation.

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A Appendix A. The Original Project Brief - Chapter 1

TU Delft

Personal Project Brief - IDE Master Graduation

Digital Literacy in secondary education design projects — project title

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 18 - 11 - 2022 — 05 - 05 - 2022 end date

INTRODUCTION **

Please describe, the context of your project, and address the main stakeholders (interests) within this context in a concise yet complete manner. Who are involved, what do they value and how do they currently operate within the given context? What are the main opportunities and limitations you are currently aware of (cultural- and social norms, resources (time, money,...), technology, ...).

Since the year 2004, secondary education schools in the Netherlands started offering a new course called Design&Technology (D&T for short). In this course, students are often divided into teams of around 4/5 people, and they work on béta-technological problem-statements in a project that takes about 10 weeks time. The course aims to solidify skills such as communication, entrepreneurship, creativity and independence. Most projects are given by actual clients such as organisations or companies and most are set up by the D&T teachers themselves through connections or personal interest. Due to this, a large variation of projects are given to students, mostly differentiating per year, per level and per school, and it is difficult yet important for D&T guidelines and methods to apply to all projects.
Originally a lot of D&T-teacher were lateral entrants from subjects such as physics, chemics and maths, currently it has expanded to art-, economics- and D&T specifically educated teachers as well.
Most D&T-schools have a specific classroom to accommodate the team-driven work and required prototypes or physical models for the presentation of the designs, see image 1. The subject is in very large part a direct preparation for the bachelor Industrial Design Engineering or related bachelors and most schools use a design-process approach similar to the higher education, see image 2.
The course is given at 106 schools in the Netherlands and is still under major developments. One of the main drivers in the development of the course is Stichting Technasium. By valuing curiosity, innovation, co-creation and ownership, Stichting Technasium encourages D&T-teachers to do their own research and always look for improvements for the subject. Currently a department of Stichting Technasium is working on a research into implementing or improving basic skills such as language, maths, citizenship and digital literacy in the D&T-projects and process. In september 2023 they will start a pilot at 15 schools testing the results of this research.
4TU is a cooperation between the four technical universities in the Netherlands. They combine resources to research the innovation and improvement of higher education. For instance: their Sectorplan Education Betatechniek aims to create appeal for engineering studies among secondary students. The faculty Science Education and Communication is part of this 4TU cooperation and the subject of this research contributes to their attempts to improve techincal education.

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introduction (continued): space for images

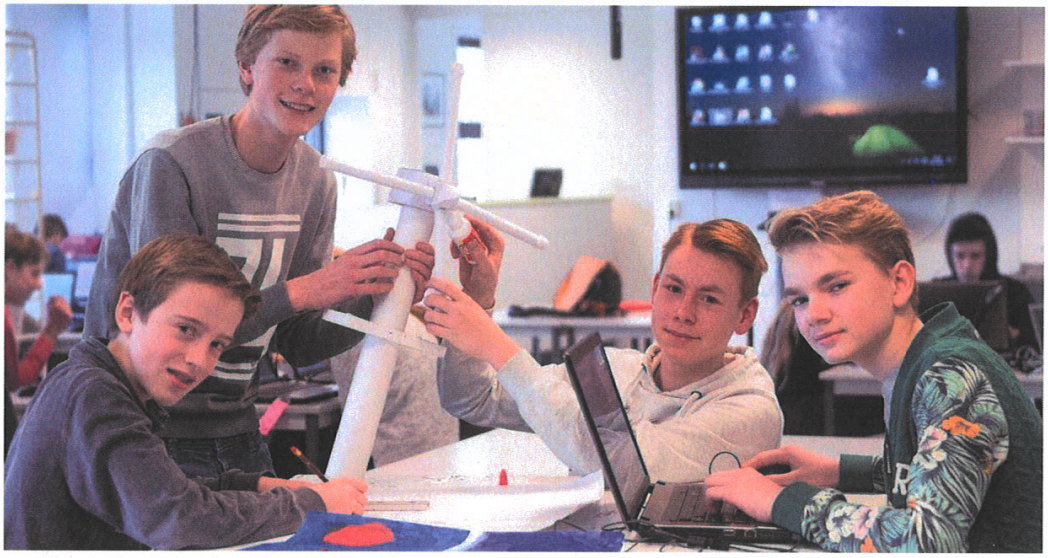


image / figure 1: D&T students working on their prototype

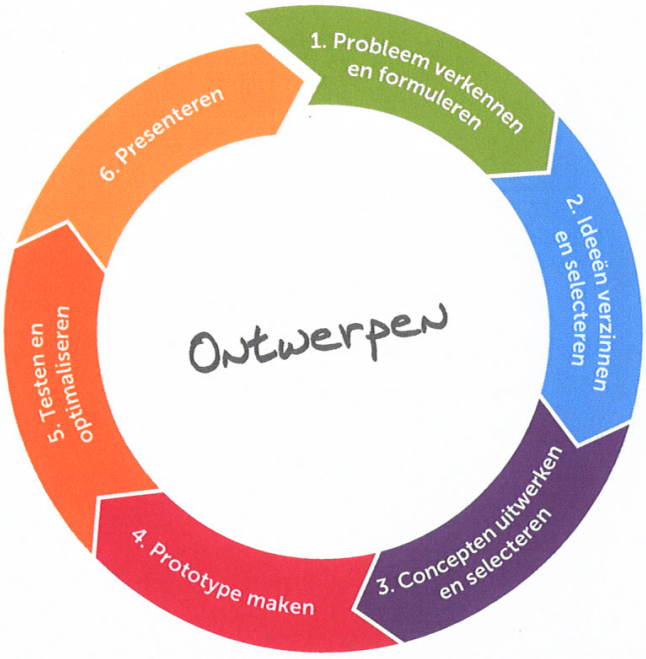


image / figure 2: Design-cycle Design&Technology

Personal Project Brief - IDE Master Graduation

TU Delft

PROBLEM DEFINITION **

Limit and define the scope and solution space of your project to one that is manageable within one Master Graduation Project of 30 EC (= 20 full time weeks or 100 working days) and clearly indicate what issue(s) should be addressed in this project.

Digital Literacy is being recognised as a 21st century skill, and has started to be included in Workforce and Educational acts, such as the 2021 - 2025 Course Plan established by Stichting Technasium in assignment to the Ministry of Education. This relates to the realisation that someone is more likely to be hired as an employee the more digital literate they are and thus secondary education should prepare their students in this aspect. In the still developing course of D&T, teachers see an opportunity to integrate this skill in the project-based design and reseach results (and sub-results) they ask of their students. The course offers opportunities to make use of basic digital skills such as searching, assessing and presenting information through digital tools or more intricate skills such as making use of a laser cutter or a 3D printer when making a prototype. Currently, the course set-up does not offer enough framework or support for teachers to integrate and teach these skills.
The solution space will not encorporate the other basic skills mentioned before, i.e. language, math and citizenship.
The solution space will not encorporate digital literacy in other subjects present in secondary education.

In this project, the lack of digital literacy in current D&T education will be researched and adressed.

ASSIGNMENT **

State in 2 or 3 sentences what you are going to research, design, create and / or generate, that will solve (part of) the issue(s) pointed out in "problem definition". Then illustrate this assignment by indicating what kind of solution you expect and / or aim to deliver, for instance: a product, a product-service combination, a strategy illustrated through product or product-service combination ideas, ... In case of a Specialisation and/or Annotation, make sure the assignment reflects this/these.

To improve the digital literacy of secondary students, I will develop a guide for D&T-teachers on how to encororate and stimulate the digital education in the D&T projects they personally develop.

I aim to deliver a guide for secondary education D&T teachers, that will help them implement teaching digital literacy to students in their established D&T projects. This means the guide will be a complementary step to the current process of building a D&T project. With the guide, the teacher can enrich their course with the added value of teaching the students digital literacy during the process of their projects. Due to the various natures of D&T projects, the guide should be openly interpretable enough to be able to fit to the various projects aims and steps, yet be consise anough for the teacher to adequately validate the digital literacy and evaluate the students' progress. This guide could be shaped as a step-by-step tool, a framework, a book or a website, depending on the results of the initial research and co-developed by the teachers themselves.
The guide will be disclosed on the 4TU-platform.

Initials & Name M.v.M. van Mook Student number 4673409

Title of Project Digital Literacy in secondary education design projects

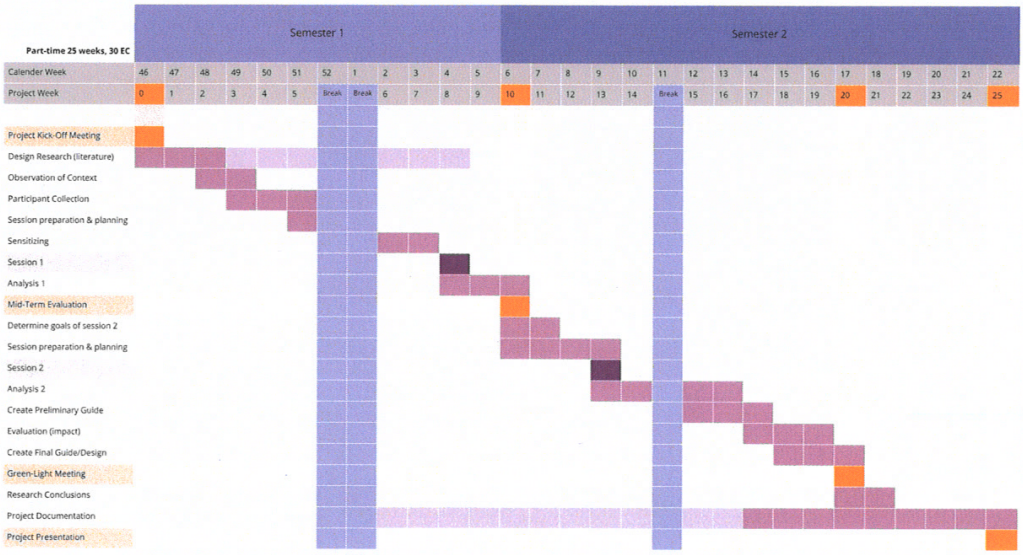
Personal Project Brief - IDE Master Graduation

TU Delft

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit within the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.

start date 18 - 11 - 2022 5 - 5 - 2022 end date



The scope of the project includes research in the current definition and status of digital literacy of students in the secondary education course D&T and will encorporate the vision and opinion of other stakeholders at the school such as D&T-teachers, technical assistants, department heads and deans.
During the graduation assignment, I aim to improve my skill as a designer using co-creation and the planning includes the mention of two sessions.
After the second session the guide will be developed in the shape as determined valuable by the stakeholders, and evaluated during the final period of the graduation.

The planning includes two holiday-breaks (blue in the Gantt-chart), Winter-holiday in calendar weeks 52 and 1, and spring-holiday in calendar week 11. The project will be carried out in a hundred work-days, taking four days a week due to a parallel activity, resulting in a period of 25 weeks.

Personal Project Brief - IDE Master Graduation

TU Delft

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, ... Stick to no more than five ambitions.

The motivation of this project is my personal interest and stake in secondary education. I am in possession of a teaching-degree for physics and currently I teach part-time physics and D&T at a secondary school in Schiedam. I took the course D&T when I was a secondary student myself, and it definitely inspired me to choose the bachelor industrial design engineering. So much of the skills and the process are similar in the subject and the bachelor.

When taking the elective 'Contextmapping and Co-design with children' at the TU Delft, it motivated me to look for graduation opportunities that allow me to help secondary students to design their own education. Are they not the experts on their own experiences of the past and wishes for the future? That is the main reason i wish to encorporate co-creation in this project, as well as my aim to imporve myself as a facilitator for design.

I have found the combination of Education and Design I was looking for at the TU Delft faculty of Science Education and Communication. They are a group of enthousiastic researchers, designers and educators and aim to combine a great deal of in-depth knowledge on the subject of D&T in a compact framework for teachers interested in always learning, always developing. My graduation project and research will play a part in this framework, as well as give a starting point for the Stichting Technasium pilot on the inclusion of basic skills in D&T projects.

FINAL COMMENTS

In case your project brief needs final comments, please add any information you think is relevant.

Initials & Name M.v.M. van Mook Student number 4673409

Title of Project Digital Literacy in secondary education design projects

B Appendix B. The Informed Consent Session 1 - Chapter 3

Digitale Geletterdheid in het vak Onderzoeken&Ontwerpen

Dit onderzoek wordt uitgevoerd als onderdeel van een afstudeeronderzoek voor de MSc Integrated Product Design aan de faculteit Industrieel Ontwerpen van de TU Delft.

Student: Megan van Mook

Toestemmingsverklaring participant

Ik neem vrijwillig deel aan dit onderzoek.

Ik erken dat ik vooraf voldoende informatie en uitleg heb gekregen over dit onderzoek en al mijn vragen zijn naar voldoening beantwoord. Ik heb de tijd gekregen die ik nodig had om in te stemmen met de deelname. Op elk moment kan ik vragen stellen met betrekking tot het onderzoek.

Mij is bekend dat dit onderzoek bestaat uit:

1. Een interactieve co-design workshop
2. (Interview)vragen beantwoorden tijdens de workshop

Ik ben mij ervan bewust dat tijdens het onderzoek gegevens worden verzameld in de vorm van bijvoorbeeld aantekeningen, foto's, video's en/of geluidsopnames. Ik geef toestemming voor het verzamelen van deze gegevens en het maken van geluidsopnames, foto's en video opnames tijdens het onderzoek. Gegevens zullen geanonimiseerd worden verwerkt en geanalyseerd (zonder naam of andere identificeerbare informatie). Deze gegevens zijn alleen voor het onderzoeksteam en hun TU Delft begeleiders beschikbaar.

De foto's, video's en/of geluidsopnames zullen worden gebruikt ter ondersteuning van het analyseren van verzamelde gegevens. Video opnames en foto's kunnen tevens worden gebruikt ter illustratie van onderzoeksbevindingen in publicaties en presentaties over het project.

Ik geef toestemming voor het gebruik van foto's en video opnames van mijn deelname:
(selecteer wat van toepassing is)

- ☐ waarin ik herkenbaar ben voor publicaties en presentaties over het project.
- ☐ waarin ik niet herkenbaar ben voor publicaties en presentaties over het project.
- ☐ enkel voor data analyse doeleinden en niet voor publicaties en presentaties over het project.

Ik geef toestemming om gegevens nog maximaal 5 jaar na afloop van dit onderzoek te bewaren en te gebruiken voor onderwijs- en onderzoeksdoeleinden.

Ik erken dat er geen financiële compensatie gegeven wordt voor deelname aan het onderzoek.

Met mijn handtekening bevestig ik dat ik de informatie over het onderzoek heb gelezen en dat ik de aard van mijn deelname heb begrepen. Ik begrijp dat ik mijn deelname aan het onderzoek op elk moment kan intrekken of kan stoppen. Ik begrijp dat ik niet verplicht ben om vragen te beantwoorden die ik niet wil beantwoorden en dat ik dit kan aangeven bij het onderzoeksteam.

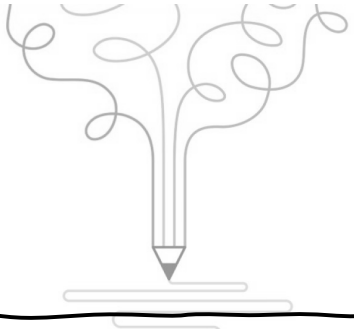
Een kopie van deze toestemmingsverklaring zal aan mij worden gegeven.

_____	_____
Achternaam	Voornaam
___ / ___ / 2020	_____
Datum (dd/mm/jjjj)	Handtekening

Time	Action	Goal	Script	Materials
5 min.	Welcome	Create safe atmosphere. Instill trust.	Smile, look comfortable. Materials all set.	
5 min.	Introduction	Ease participants, create trust in their own expertise and abilities	Explain set-up session, goal and topic. Participants are experts of their own experience. No wrong things to say.	Audio recording phone, teams meeting computer, camera?
10 min.	Discuss Sensitizing	Create connection between session and sensitizing activity. Start the session by them 'leading' me, setting the right ambiance. MAP?	*'You have all done a sensitizing activity, how was that for you?'* Can you all lead me through the digital appliances you marked?	Stickers.
10 min.	Make 1 - Experience 'timeline'	Create a visual explanation of a learning-curve on a digital skill. Visualise experience as an adventure. Include emotions in the experience and get a better insight in how students feel and reflect on these activities.	Mention the time intended for this exercise. Show the materials available to them. Explain we will discuss their creations after. *'You can pick one of the appliances you marked in the classroom.'*	A3 papers NOT EMPTY (extra) Emotions! Images & Words Stickers & sticky notes Scissors, glue, pens, pencils
15 min.	Say 1 - Present Collage	Presenting the maps creates explanation and statements. Responding to ones story or question them will create deeper insight.	Present and react to each others stories. *'How does that make you feel.'* *'Why is that important to you?'* STAY ON TOPIC	
10 min.	Make 2	Promotion of positive emotions shows how students see good stuff and improvement. Create a product that would help them negate negative emotions in the learning-curve.	Mention the time intended for this exercise. Show the materials available to them. Explain we will discuss their creations after. Don't think too long, the first thing they think of is the best.	Scissors, glue, pens, pencils coloured paper, toilet rolls, cardboard, boxes, some craft stuff from hema
10 min.	Say 2	Presenting the exercise creates explanation and statements. Responding to ones story or question them will create deeper insight.	Present and react to each others stories. *'How does that make you feel.'* *'Why is that important to you?'* STAY ON TOPIC	
5 min.	Closing the session	Satisfy participants what they did was important and will be taken into account	Thank participants for attendance and explain further steps in the research.	

D Appendix D. Sensitizing Session 1 - Chapter 3

Dit is het boekje van:



Hi!

Welkom bij de eerste stap van het co-design proces. Dit boekje is een oefening in wat we noemen 'Sensitizing'. Wanneer deelnemers van een co-design proces een 'sensitizing' oefening ondernemen, zorgt het ervoor dat zij aan de start van de korte tijd die is gepland voor de sessie, al meteen een gevoel hebben voor het onderwerp, en zo een betere bijdrage kunnen geven.

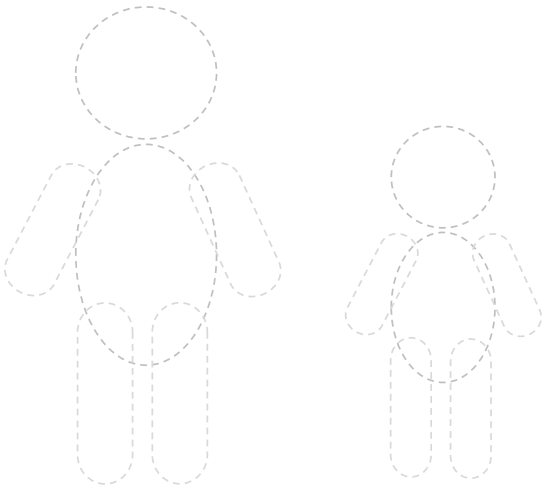
Het boekje bevat 5 oefeningen, elke dag van deze week doe je er ééntje. Het is niet nodig om hier langer dan een kwartier aan te besteden. Bovendien zal er geen enkel oordeel zijn over wat je hierin opschrijft. Niemand anders dan de onderzoeker krijgt dit te zien, als je dat niet wil.

Hopelijk heb je plezier in het maken van de oefeningetjes!

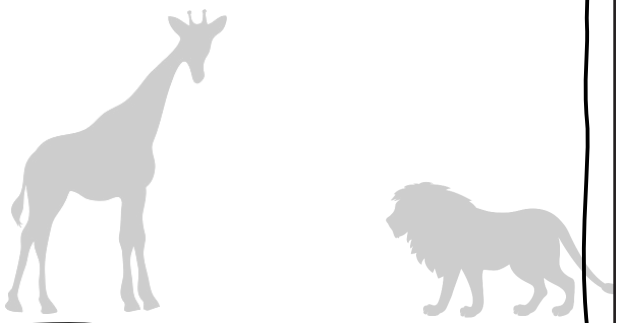
Dag 1: Teken hieronder een plattegrond van het Technasium lokaal bij jullie op school. Geef aan welke dingen in het lokaal het belangrijkst zijn voor jou en je lessen. Geef daarna aan waar de leerlingen graag zitten of mee werken.

Tip: Weet je geen dingen te bedenken, loop dan door je dag heen en kijk met welke spullen je in aanraking komt.

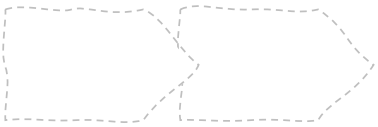
Dag 2: Teken hieronder hoe jij jezelf ziet als docent, met naast je een leerling. Geef al je eigenschappen een fysieke vorm en leg uit wie jij bent in verhouding tot leerlingen.



Dag 3: Als O&O een dier in de dierentuin is, teken welke jij denk dat het dan is. Beschrijf daarna waarom.



Dag 4: Teken hieronder het proces van een Technasium-project dat je een keer hebt meegemaakt. Wat waren de leuke, interessante of uitdagende momenten voor jou en de leerlingen?



Dag 5: Beschrijf hieronder de leukste leerervaring die je ooit hebt meegemaakt.

E Appendix E. Materials Session 1 - Chapter 3

Mediawijsheid Computational thinking ICT-basisvaardigheden Computer

Informatievaardigheden Hardware Software Samenwerking Verbanden

Probleemoplossing Creativiteit Blokkade Investering Moeilijk

Toekomstgericht Lastig Onduidelijk Onzekerheid

Waardevol Afhankelijk Onafhankelijk Coaching

Competenties Presenteren Rapporteren Ontwikkelen

Onderzoeken Ontwerpen Persoonsvorming Onderzoek

Krachtig Bloeien Blussen Kaderen Vrijheid

Mogelijkheid Toepassen Vakoverstijgend Middelbare School

3D printer Lasersnijder Materiaal Model Modelleren

Digitaal Model Digitaal werken Digitaal Mobiel Tablet

Telefoon Controle Chaos Internet Interweb

Coderen Programmeren Frustrerend Camera Digiboard

Techniek Microsoft Word Powerpoint Vaardigheden Blij

Adobe Creative Cloud Engineering Architectuur Betatechnisch

Wetenschap Samenwerken Groepswerk Nieuwsgierig Succes!

Vervolgopleiding Keuzevrijheid Expertise Skills Netwerk

Bedrijven Klant Client Partners

Kwaliteit Professionalisering Communicatie Verslaglegging

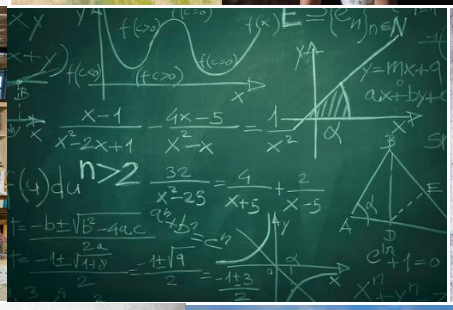
Flexibel Begeleiding Advies Context Sociaal

Maatschappelijk Gereedschap Klussen Werkplaats Teleurstelling




















FUTURE
NEXT EXIT





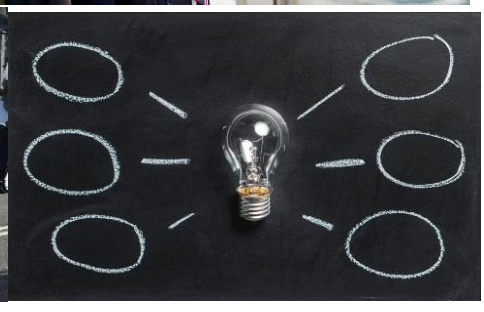


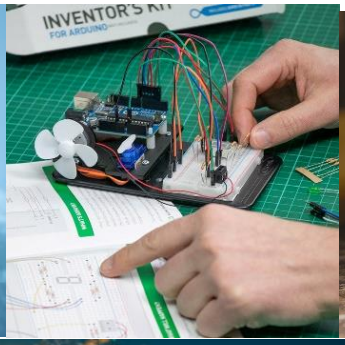










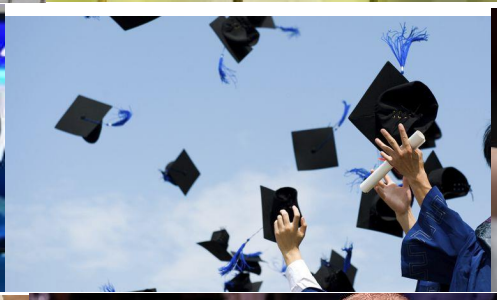


INVENTOR'S KIT
FOR ARDUINO









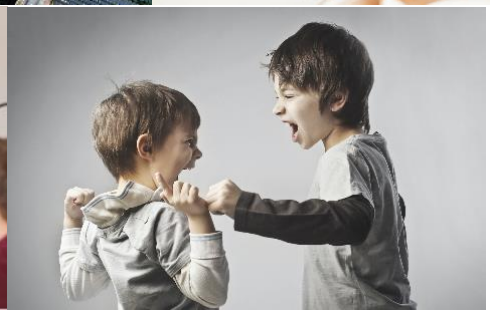





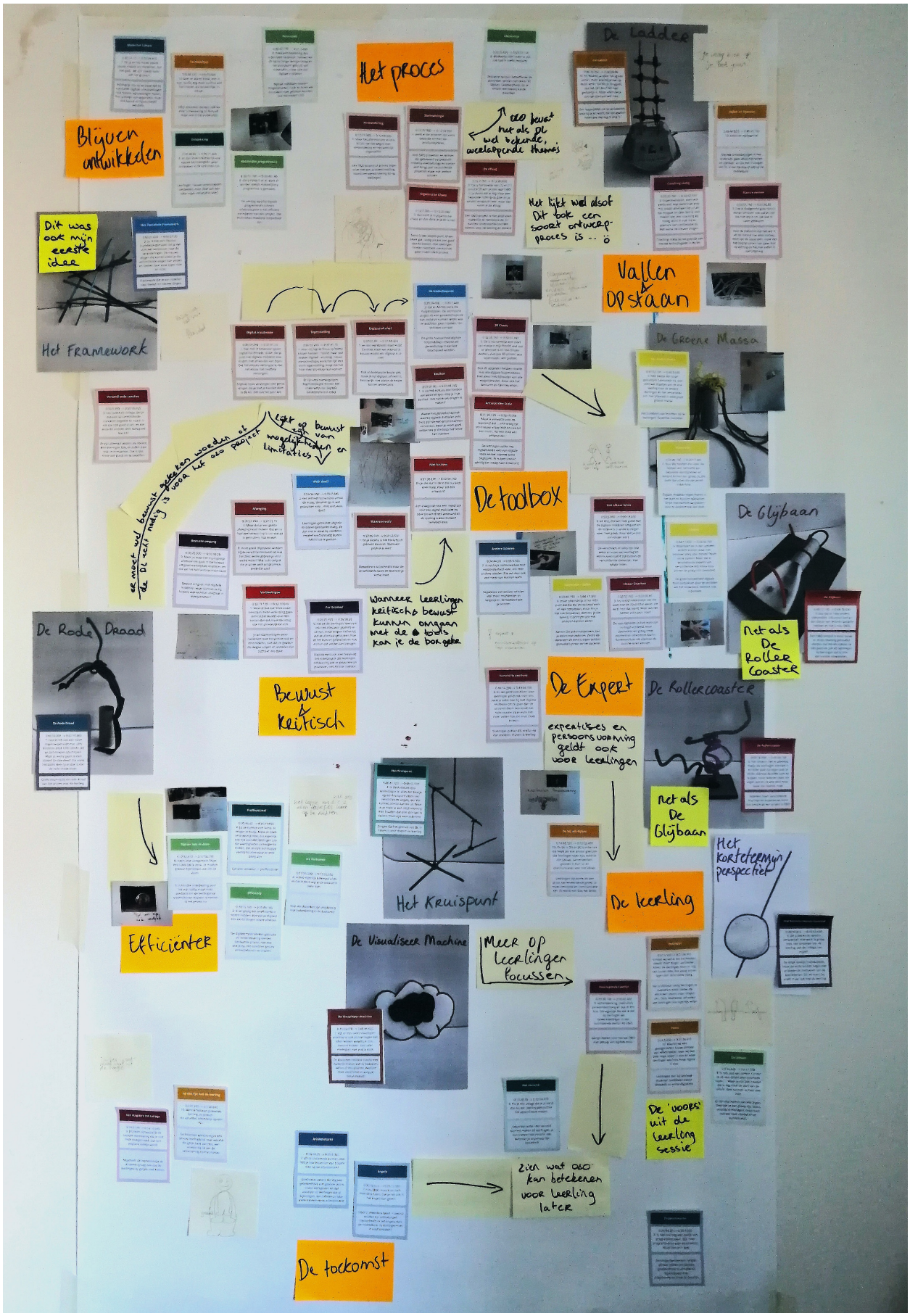






How do
robots work?


F Appendix F. Clusters Session 1 - Chapter 3



G Appendix G. The Informed Consent Sessions 2 & 3 - Chapter 3

Digitale Geletterdheid in het vak Onderzoeken&Ontwerpen

Dit onderzoek wordt uitgevoerd als onderdeel van een afstudeeronderzoek voor de MSc Integrated Product Design aan de faculteit Industrieel Ontwerpen van de TU Delft.

Student: Megan van Mook

Toestemmingsverklaring ouder/ voogd

Mijn kind kan deelnemen aan dit onderzoek als mijn kind ermee instemt om deel te nemen.

Ik erken dat ik vooraf voldoende informatie en uitleg heb gekregen over dit onderzoek en al mijn vragen zijn naar voldoening beantwoord. Ik heb de tijd gekregen die ik nodig had om in te stemmen met de deelname. Op elk moment kan ik vragen stellen met betrekking tot het onderzoek.

Mij is bekend dat dit onderzoek bestaat uit:

1. Een interactieve co-design workshop, waarbij mijn kind gevraagd wordt naar ervaring in de O&O-lessen op school
2. (Interview)vragen beantwoorden tijdens de workshops

Ik ben mij ervan bewust dat tijdens het onderzoek gegevens worden verzameld in de vorm van bijvoorbeeld aantekeningen, foto's, video's en/of geluidsopnames. Ik geef toestemming voor het verzamelen van deze gegevens en het maken van geluidsopnames, foto's en video opnames tijdens het onderzoek. Gegevens zullen geanonimiseerd worden verwerkt en geanalyseerd (zonder naam of andere identificeerbare informatie). Deze gegevens zijn alleen voor het onderzoeksteam en hun TU Delft begeleiders beschikbaar.

De foto's, video's en/of geluidsopnames zullen worden gebruikt ter ondersteuning van het analyseren van verzamelde gegevens. Video opnames en foto's kunnen tevens worden gebruikt ter illustratie van onderzoeksbevindingen in publicaties en presentaties over het project.

Ik geef toestemming voor het gebruik van foto's en video opnames van de deelname van mijn kind:
(selecteer wat van toepassing is)

- ☐ waarin mijn kind herkenbaar is voor publicaties en presentaties over het project.
- ☐ waarin mijn kind niet herkenbaar is voor publicaties en presentaties over het project.
- ☐ enkel voor data analyse doeleinden en niet voor publicaties en presentaties over het project.
- ☐ mijn kind doet mee met het onderzoek zonder dat foto's en video's van mijn kind gemaakt mogen worden

Ik geef toestemming om gegevens nog maximaal 5 jaar na afloop van dit onderzoek te bewaren en te gebruiken voor onderwijs- en onderzoeksdoeleinden.
Ik erken dat er geen financiële compensatie gegeven wordt voor deelname aan het onderzoek.

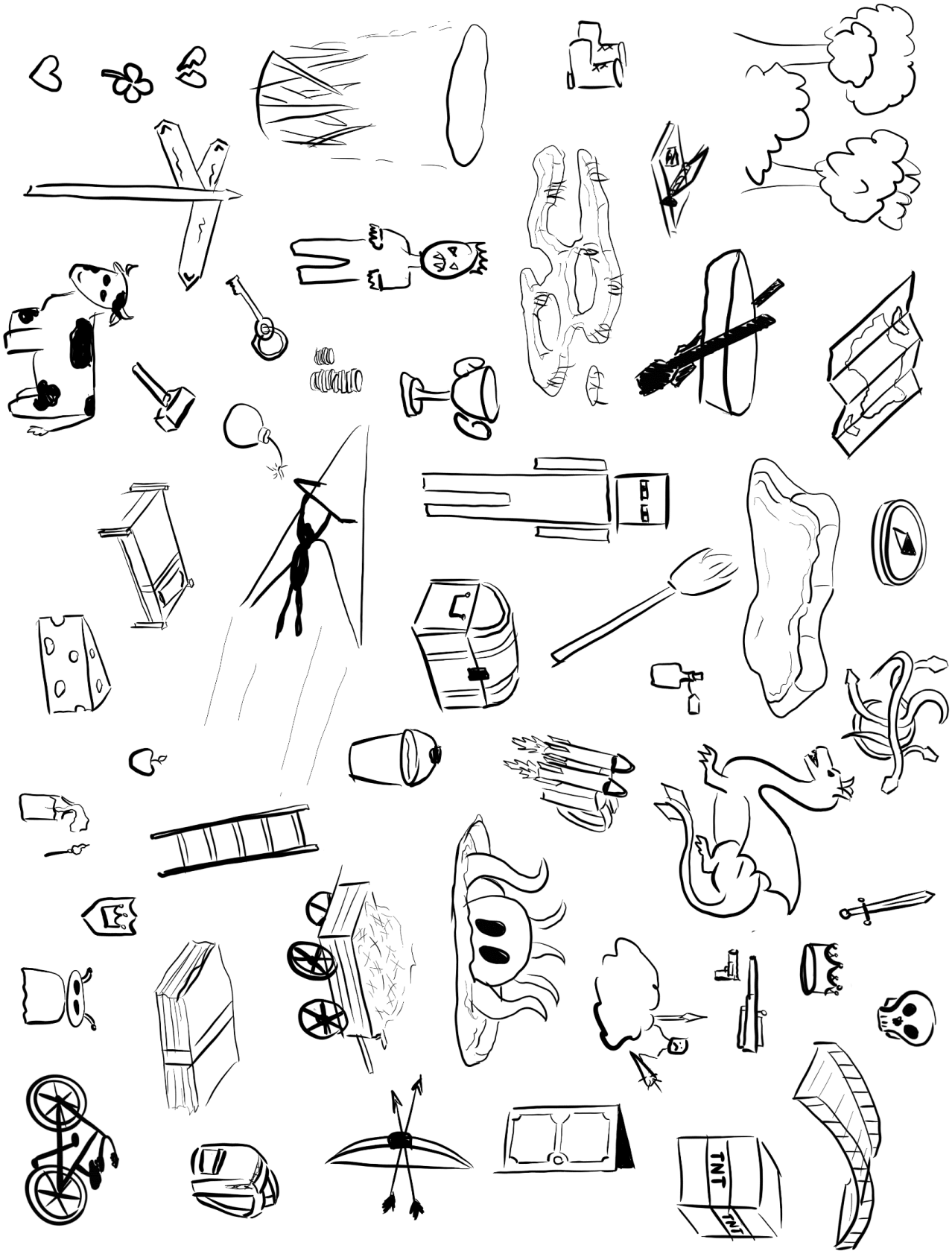
Met mijn handtekening bevestig ik dat ik de informatie over het onderzoek heb gelezen en dat ik de aard van de deelname van mijn kind heb begrepen. Ik begrijp dat ik de deelname aan het onderzoek op elk moment kan intrekken of kan stoppen. Ik begrijp dat mijn kind niet verplicht is om vragen te beantwoorden die mijn kind niet wil beantwoorden en dat ik of mijn kind dit kunnen aangeven bij het onderzoeksteam.

Een kopie van deze toestemmingsverklaring zal aan mij worden gegeven.

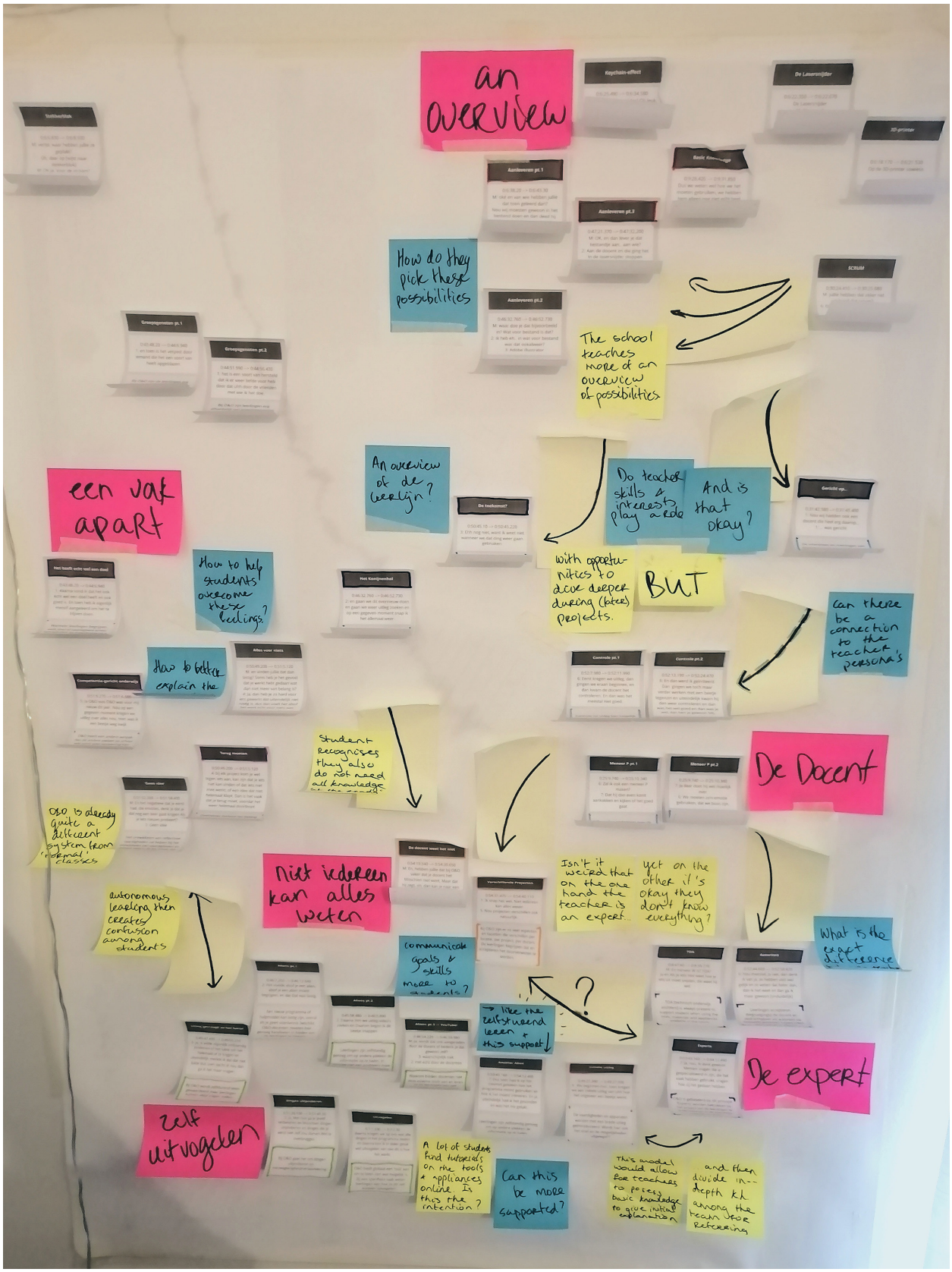
_____	_____
Achternaam kind	Voornaam kind
_____	_____
Achternaam ouder/ voogd	Voornaam ouder/ voogd
___ / ___ / 2023	_____
Datum (dd/mm/jjjj)	Handtekening

Time	Action	Goal	Script	Materials
5 min.	Welcome	Create safe atmosphere. Instill trust.	Smile, look comfortable. Materials all set.	-
5 min.	Introduction	Ease participants, create trust in their own expertise and abilities	Explain set-up session, goal and topic. Participants are experts of their own experience. No wrong things to say. Present the consentforms	Consentforms Audio recording phone, teams meeting computer, camera?
5 min.	Discuss Sensitizing	Get deeper insight when they explain activities to each other. Create connection between session and sensitizing activity.	You have all done a sensitizing activity, how was that for you? Let them introduce each other by booklet. Collect booklets.	Sensitizing booklet, have a couple of empty ones
10 min.	Make 1 - Collage	Collage on digital skills in O&O 'Make a collage that displays how digital literacy is currently embedded in O&O and how you would ideally embed it in O&O.'	Mention the time intended for this exercise. Show the materials available to them. Explain we will discuss their creations after. Don't think too long, the first thing they think of is the best.	A3 papers NOT EMPTY (extra) Images & Words Stickers & sticky notes Scissors, glue, pens, pencils
10 min.	Say 1 - Present Collage	Presenting the collage creates explanation and statements. Responding to ones story or question them will create deeper insight.	Present and react to each others stories. 'How does that make you feel.' 'Why is that important to you?' STAY ON TOPIC	Whiteboard with magnets
5 min.	Make 2	'Build a product that helps you move your classes from the now to the ideal!'	Mention the time intended for this exercise. Show the materials available to them. Explain we will discuss their creations after. Don't think too long, the first thing they think of is the best.	Scissors, glue, pens, pencils coloured paper, toilet rolls, cardboard, boxes, some craft stuff from hema
15 min.	Say 2	Presenting the exercise creates explanation and statements. Responding to ones story or question them will create deeper insight.	Present and react to each others stories. 'How does that make you feel.' 'Why is that important to you?' STAY ON TOPIC	-
5 min.	Closing the session	Satisfy participants what they did was important and will be taken into account	Thank participants for attendance and explain further steps in the research. Discuss sharing of conclusions.	-

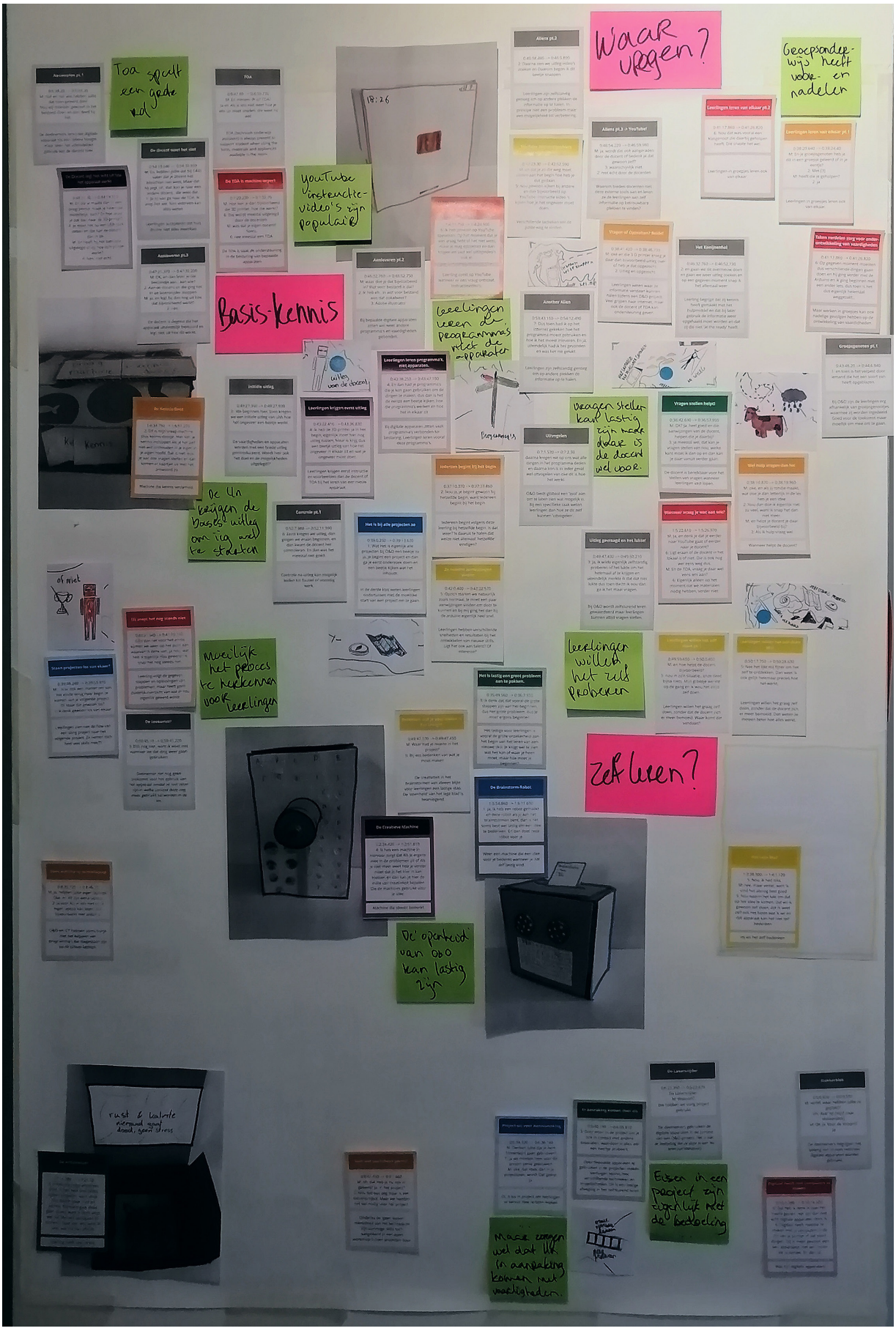
Appendix I. Materials Session 2 & 3 - Chapter 3



J Appendix J. Clusters Session 2 - Chapter 3



K Appendix K. Clusters Session 3 - Chapter 3



L Appendix L. The Informed Consent Co-creation - Chapter 4

Digitale Geletterdheid in het vak Onderzoeken&Ontwerpen

Dit onderzoek wordt uitgevoerd als onderdeel van een afstudeeronderzoek voor de MSc Integrated Product Design aan de faculteit Industrieel Ontwerpen van de TU Delft.

Student: Megan van Mook

Toestemmingsverklaring participant

Ik neem vrijwillig deel aan dit onderzoek.

Ik erken dat ik vooraf voldoende informatie en uitleg heb gekregen over dit onderzoek en al mijn vragen zijn naar voldoening beantwoord. Ik heb de tijd gekregen die ik nodig had om in te stemmen met de deelname. Op elk moment kan ik vragen stellen met betrekking tot het onderzoek.

Mij is bekend dat dit onderzoek bestaat uit:

1. Een interactieve visie-workshop ter ontwikkeling van het concept
2. (Interview)vragen beantwoorden tijdens de workshop
3. Verzamelen van beeldmateriaal voor de concept-video

Ik ben mij ervan bewust dat tijdens het onderzoek gegevens worden verzameld in de vorm van bijvoorbeeld aantekeningen, foto's, video's en/of geluidsopnames. Ik geef toestemming voor het verzamelen van deze gegevens en het maken van geluidsopnames, foto's en video opnames tijdens het onderzoek. Gegevens zullen geanonimiseerd worden verwerkt en geanalyseerd (zonder naam of andere identificeerbare informatie). Deze gegevens zijn alleen voor het onderzoeksteam en hun TU Delft begeleiders beschikbaar.

De foto's, video's en/of geluidsopnames zullen worden gebruikt ter ondersteuning van het analyseren van verzamelde gegevens. Video opnames en foto's kunnen tevens worden gebruikt ter illustratie van onderzoeksbevindingen in publicaties en presentaties over het project.

Ik geef toestemming voor het gebruik van foto's en video opnames van mijn deelname:
(selecteer wat van toepassing is)

- ☐ waarin ik herkenbaar ben voor publicaties en presentaties over het project.
- ☐ waarin ik niet herkenbaar ben voor publicaties en presentaties over het project.
- ☐ enkel voor data analyse doeleinden en niet voor publicaties en presentaties over het project.

Ik geef toestemming om gegevens nog maximaal 5 jaar na afloop van dit onderzoek te bewaren en te gebruiken voor onderwijs- en onderzoeksdoeleinden.

Ik erken dat er geen financiële compensatie gegeven wordt voor deelname aan het onderzoek.

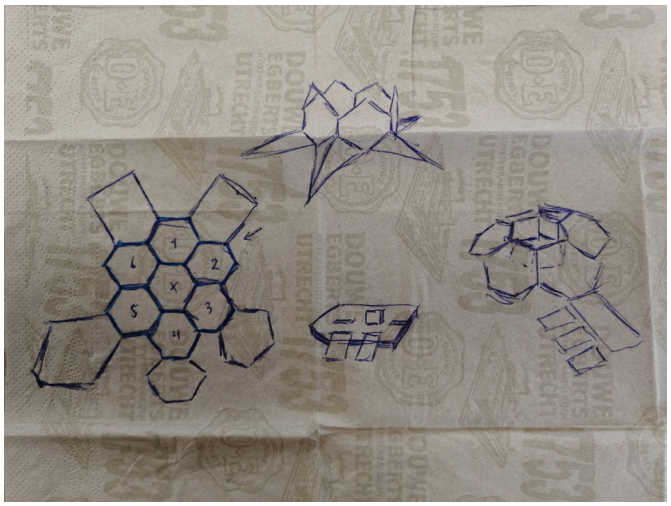
Met mijn handtekening bevestig ik dat ik de informatie over het onderzoek heb gelezen en dat ik de aard van mijn deelname heb begrepen. Ik begrijp dat ik mijn deelname aan het onderzoek op elk moment kan intrekken of kan stoppen. Ik begrijp dat ik niet verplicht ben om vragen te beantwoorden die ik niet wil beantwoorden en dat ik dit kan aangeven bij het onderzoeksteam.

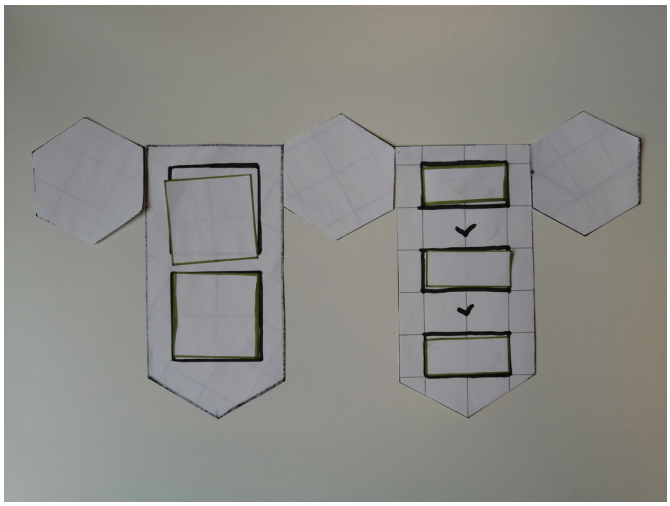
Een kopie van deze toestemmingsverklaring zal aan mij worden gegeven.

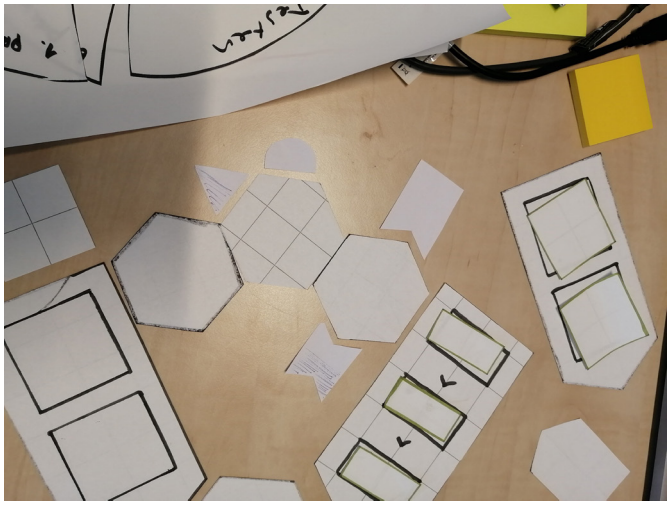
_____	_____
Achternaam	Voornaam
___ / ___ / 2023	_____
Datum (dd/mm/jjjj)	Handtekening

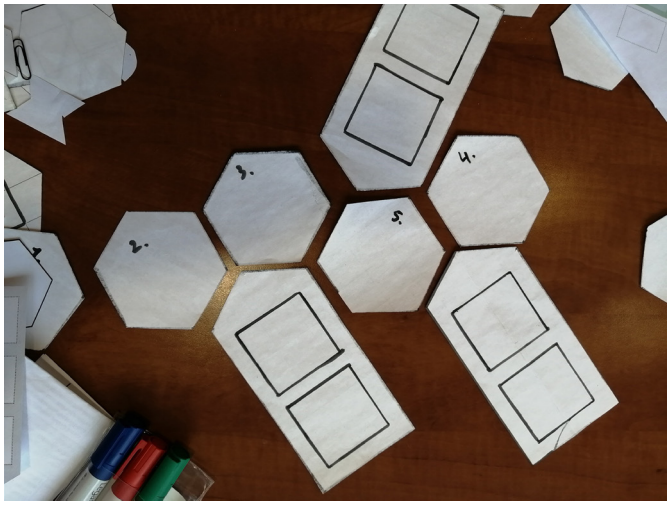
M

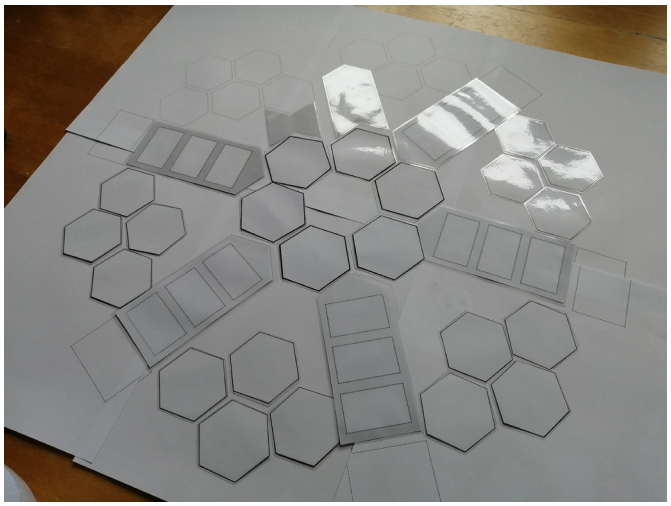
Appendix M. Iterations & Prototypes - Chapter 4



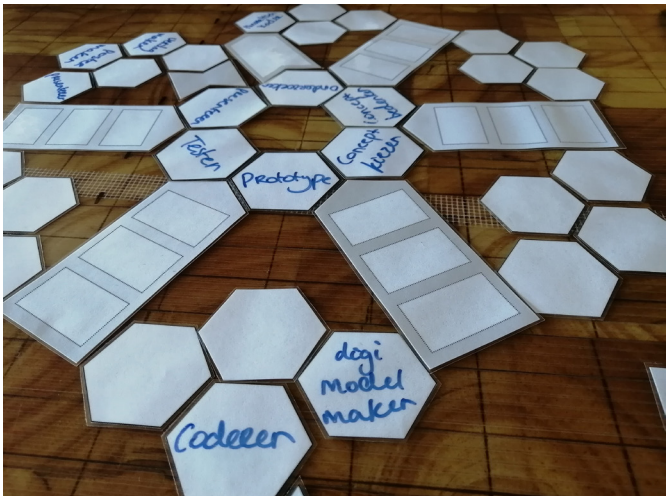


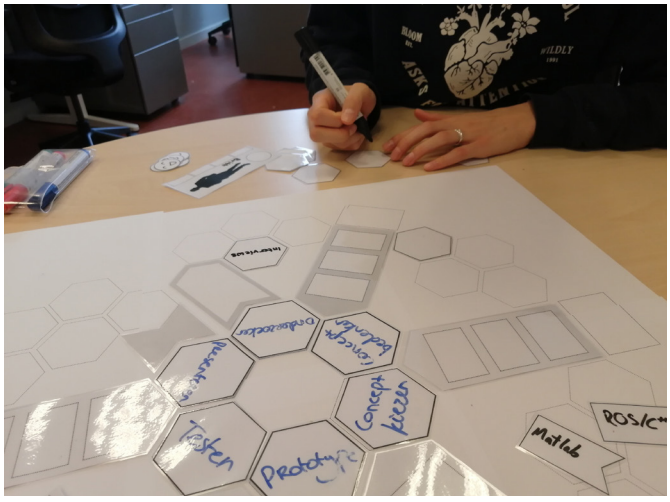


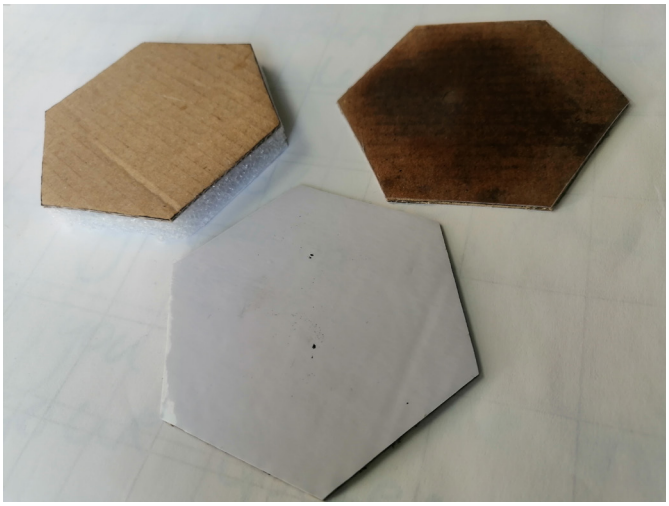





Presenteren
Testen

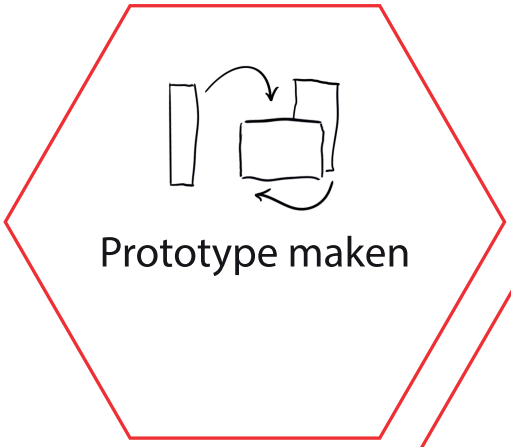

Testen
Prototype
Concept kiezen
dogi model maker
Codeeren


Testen
Concept kiezen
Matlab



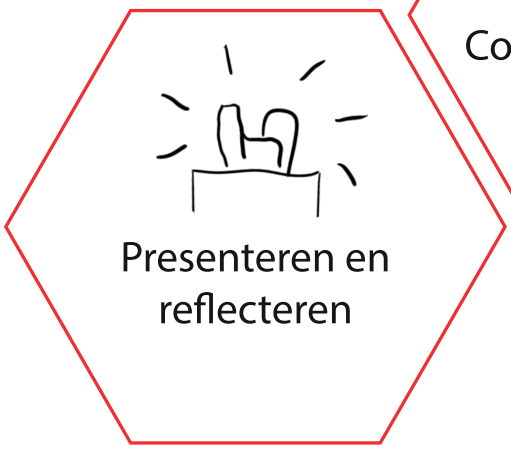

Concept Kiezen
Concept Kiezen
Concept Kieze


Probleem verkennen
en formuleren


Prototype maken


Testen en
optimaliseren


Concepten uitwerken
en selecteren


Presenteren en
reflecteren


Ideeën verzinnen
en selecteren


Organiseren
Idee kiezen
De wereld in
Persona maken
Ondernemings-
plan
Keuzes maken
Digitaal model
Planning
Je zintuigen
gebruiken
Schetsen
Spuugmodel
Onderzoeken


Reflecteren
Kwaliteits-
controle
Prototype
Filmen
Presenteren
Verslag
Waarom-vragen
stellen
Je doelgroep leren
kennen
Inspiratie opdoen
Moodboard
Plan van eisen
Mindmap


Scenario
Feedback verwerken
Nieuw leven inblazen
Brainstorm
Gebruikerstest
Enquête
Experts betrekken
Concept beschrijven
Samenvatten
Poster
Nabespreken

Canva	Word	Micro:bit	SketchUp
Powerpoint	Padlet	(Google) Forms	AI
Moviemaker	Trello	SolidWorks	Unity
Premier Pro	Arduino	Keyshot	Illustrator
InDesign	TinkerCAD	Blender	Sketchbook

Verwijs naar de client/expert

'Heb je al met ... gesproken?'

Zelf ingrijpen

'Ik ga voor jullie ... doen.'

Luisteren naar wat leerlingen vertellen

neemt fysiek afstand, kijkt leerlingen aan

Geef advies over de volgende activiteit

'Je zou ... kunnen doen.'

Leg de volgende stap /activiteit op

'Ik wil dat jullie ... doen.'

Benoemen wat jij als docent ziet

'Ik hoor jullie zeggen dat ... .'

Geef advies over een inhoudelijke keuze

'Als ik jullie was zou ik ... doen.'

Leg een materiaal /tool op.

'Ik wil dat jullie ... gebruiken.'

Voorkennis activeren

'Wat hebben jullie tot nu toe gedaan?'

Geef advies over een materiaal/tool

'Je zou ... kunnen gebruiken.'

Verwijs naar bronnen

'Heb je al naar ... gekeken?'

Open vragen stellen

'Wat waren jullie ideeën?'

De meeste groepjes zijn al bij de vierde stap in het proces. Eén groepje is pas bij de tweede stap.

Hoe handel je?

Binnen een groepje is één leerling al bezig met een prototype, terwijl een ander nog snel wat andere concepten bedenkt.

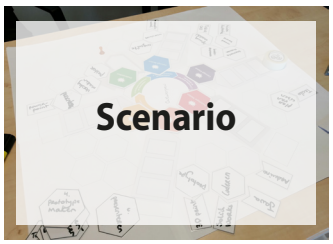
Hoe handel je?

Je hebt leerlingen in de klas die het niveau niet halen en nu al weten dat ze blijven zitten.

Hoe zorg je dat zij de pret niet uit de lessen halen?

Je hebt een project met veel stappen.

Hoe zorg je ervoor dat de leerlingen niet meteen een idee verzinnen en daar bij blijven?



Een groepje heeft een ingewikkeld idee en weten niet hoe zij een duidelijk prototype kunnen maken.

Hoe handel je?

Breng je eigen scenario in...

Een groepje heeft het testen van het prototype overgeslagen.

Hoe handel je?

O Appendix O. The Informed Consent Usability Evaluation - Chapter 6

Digitale Geletterdheid in het vak Onderzoeken&Ontwerpen

Dit onderzoek wordt uitgevoerd als onderdeel van een afstudeeronderzoek voor de MSc Integrated Product Design aan de faculteit Industrieel Ontwerpen van de TU Delft.

Student: Megan van Mook

Toestemmingsverklaring participant

Ik neem vrijwillig deel aan dit onderzoek.

Ik erken dat ik vooraf voldoende informatie en uitleg heb gekregen over dit onderzoek en al mijn vragen zijn naar voldoening beantwoord. Ik heb de tijd gekregen die ik nodig had om in te stemmen met de deelname. Op elk moment kan ik vragen stellen met betrekking tot het onderzoek.

Mij is bekend dat dit onderzoek bestaat uit:

1. Een interactieve visie-workshop ter evaluatie van het concept
2. (Interview)vragen beantwoorden voor/tijdens/na de workshop
3. Verzamelen van beeldmateriaal voor de concept-video

Ik ben mij ervan bewust dat tijdens het onderzoek gegevens worden verzameld in de vorm van bijvoorbeeld aantekeningen, foto's, video's en/of geluidsopnames. Ik geef toestemming voor het verzamelen van deze gegevens en het maken van geluidsopnames, foto's en video opnames tijdens het onderzoek. Gegevens zullen geanonimiseerd worden verwerkt en geanalyseerd (zonder naam of andere identificeerbare informatie). Deze gegevens zijn alleen voor het onderzoeksteam en hun TU Delft begeleiders beschikbaar.

De foto's, video's en/of geluidsopnames zullen worden gebruikt ter ondersteuning van het analyseren van verzamelde gegevens. Video opnames en foto's kunnen tevens worden gebruikt ter illustratie van onderzoeksbevindingen in publicaties en presentaties over het project.

Ik geef toestemming voor het gebruik van foto's en video opnames van mijn deelname:
(selecteer wat van toepassing is)

- ☐ waarin ik herkenbaar ben voor publicaties en presentaties over het project.
- ☐ waarin ik niet herkenbaar ben voor publicaties en presentaties over het project.
- ☐ enkel voor data analyse doeleinden en niet voor publicaties en presentaties over het project.

Ik geef toestemming om gegevens nog maximaal 5 jaar na afloop van dit onderzoek te bewaren en te gebruiken voor onderwijs- en onderzoeksdoeleinden.

Ik erken dat er geen financiële compensatie gegeven wordt voor deelname aan het onderzoek.

Met mijn handtekening bevestig ik dat ik de informatie over het onderzoek heb gelezen en dat ik de aard van mijn deelname heb begrepen. Ik begrijp dat ik mijn deelname aan het onderzoek op elk moment kan intrekken of kan stoppen. Ik begrijp dat ik niet verplicht ben om vragen te beantwoorden die ik niet wil beantwoorden en dat ik dit kan aangeven bij het onderzoeksteam.

Een kopie van deze toestemmingsverklaring zal aan mij worden gegeven.

_____	_____
Achternaam	Voornaam
___ / ___ / 2023	_____
Datum (dd/mm/jjjj)	Handtekening

Final Concept Usability Evaluation

Date: 10/05/2023
Participants: Design&Technology Faculty School 4
Time: 1 hour
Data Collection: Video, Audio recording, pictures and observation-notes
Informed Consent: Yes
Concept Representation: High fidelity final prototype (both on content and hardware)

Main goal of the Evaluation
Observe the usage of the concept in a realistic situation
- Does the concept answer the main research question?
- Does the concept adhere to the 12 Design Requirements?
- Does the intended user-group understand the goal of the concept?
- Does the intended user-group understand the usability of the concept?
- Does the concept result in the intended influence on the intended user-group satisfactory?

Researcher is directly present to the usability test but does not interrupt to ask questions. Instructions given to participants beforehand include the encouragement to think out loud.
Researcher observed participant perform the main task of the concept (playing the game) and asks clarifying questions afterwards.

Script

Voor: Verwelkomen/bedanken voor het langskomen
Start en proces van project uitleggen: Remke in oktober, verschillende scholen docenten & leerlingen meegenomen in proces
Nu een vrijwel afgewerkt prototype wat ik graag zou willen testen
In totaal zal het een uur duren; eerst spelen jullie zelf het spel, daarna heb ik wat vragen.
Mocht het niet snel genoeg gaan, dan zal ik dat aangeven.
Het spel spreekt voor zich, ik leg niets uit en zal niet betrokken zijn bij het proces.
Speel het dus vooral met elkaar, denk hardop en wees niet bang fouten of onduidelijkheden aan te wijzen, dat helpt mij alleen maar.
Voor we starten: Informed Consent
Het doel van het spel: Door middel van overleg en het delen van ervaringen reflectie op het begeleiden van het zelfgestuurde proces van leerlingen te stimuleren.
Ofwel: Reflecteren op het begeleiden en coachen van leerlingen tijdens een zelfgestuurd ontwerp-proces en hoe digitale middelen die jullie gebruiken hierin bijdragen.

Na: *Wanneer niet beantwoord dikgedrukte vragen stellen.*
Zijn er nog vragen of opmerkingen?
Dit was de laatste evaluatie in mijn proces, ik ga het nu afronden en in een verslag zetten.
Mochten jullie geïnteresseerd zijn kan ik de uitnodiging voor de presentatie of mijn verslag sturen.
Heel erg bedankt!

Use Cues

Question	Observation	T	I/O
What do they use as use cues in the preparation?			
What do they use as use cues in phase 1?			
How do the teachers reflect on the Ontwerp Stappen?			
What do they use as use cues in phase 2?			
How do the teachers reflect on the activiteiten?			
How do the teachers reflect on the Digitale Tools?			
What do they use as use cues in phase 3?			
How do the teachers reflect on their own coaching?			
What do they use as use cues on the pionnen?			
What do they use as use cues on the whiteboard stickers?			

Enivisioned Interaction

Question	Observation	T	I/O
How does the conversation flow?			
Which different characteristics are represented in the group?			
How do the characteristics influence the game?			
Which different experiences are represented in the group?			
How do the experiences influence the game?			
Which different background are represented in the group?			
How do the backgrounds influence the game?			
What is the vibe of the group during the game?			
Is the discussion qualified as effective?			
What do the players take away from this game?			

Understandability

Question	Observation	T	I/O
How do the players understand the Ontwerp Stappen?			
How do the players understand the Activiteiten?			
How do the players understand the Digitale Tools?			
How do the players understand the Coach Tegels?			
How do the players understand the Scenario's?			
How do the players understand the Pionnen?			

The Design Goal

Question	Observation	T	I/O
What do the players understand as the main goal?			
How do the players feel they have reached the main goal?			
How does the game allow the players to reach the main goal?			
How do the players understand the division of responsibilities?			
How do the players understand the effectiveness of discussion?			
How do the players understand the effectiveness of stepping out of character?			