# Enthusing Young Secondary Schoolers for Informatics Education

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04/08/2020

**Abstract**

Within modern-day society, there is hardly a way around the need for technology. Technology is implemented in a variety of areas from our personal lives but also our professional lives. It is important that children are educated about the various aspects of technology. They need to learn about the functions of technology, its influences on them as individuals but also on the society they live in and what influence they can have on it. Informatics is an elective subject within Dutch secondary school education and could greatly help with this education. Not only does informatics as a subject cover the more technical sides of technology, like computer networks and programming, it covers the societal aspects as well. It is important to educate these children that are growing up with technology as a large presence in their lives. This graduation project aims to find a way to enthuse these secondary school pupils to incorporate informatics within their upper secondary school curriculum. Looking at Dutch government reports an image of the current state of technology education is created. Through extensive surveys that target the main user-groups, the secondary school pupils and the informatics teachers this idea of the Dutch technology education is expanded even further taking their opinions and views of the informatics subject into account. By referencing scientific papers about effective computer science-related education improvements and effective teaching methods are found. The resulting quartets card game aims to do exactly that. By accompanying the information provision of the secondary school, the quartets game helps present the various topics covered within the informatics subject to the pupils. As it stands presently, the card game works as intended and presents these topics in a fun, attractive and interactive way. As a stand-alone game it cannot provide enough information about informatics, especially since the contents of the subject can vary per school. However, as an addition to the information already provided by the school, it can help the pupils make a more informed decision on whether to include the subject within their curriculum.

**Acknowledgement**

Throughout different stages of this graduation project guidance was provided to help get this project to where it is standing now.

First of all, a word of thanks has to go to dr. Angelika Mader, assistant professor at the Human Media Interaction Group and professor at Creative Technology, both at the University of Twente, who served as the main supervisor of this graduation project. Her guidance of the process from a Creative Technology graduation project perspective helped this project come to close. Presenting new perspectives and ideas of how difficulties within the project could be tackled helped greatly.

Secondly dr. Ingrid Breymann, informatics subject didacticist from the Master Science Education & Communication at the University of Twente who served as the critical observer of this graduation project. Her insights of the state of informatics subject within Dutch education helped to better understand what the subject is about and how it is implemented within the Dutch educational system. Her contacts also made it possible to help spread the survey for pupils amongst secondary schools.

Thirdly Ramon Moorlag from the trade union of informatics teachers I&I. He offered to spread the survey for teachers to informatics teachers throughout the Netherlands by including it in their weekly newsletter.

Fourthly all contacted informatics teachers that helped spread the survey for pupils within their secondary school. Thanks to them incorporating the survey within their last classes of the academic year a good number of responses were able to be gathered.

Fifthly, Lyceo for showing enthusiasm in working together for the initial project related to improving their informatics education module. Unfortunately, this graduation project took a different direction due to circumstances, but it was good to briefly experience their point of view on the subject.

Sixthly the Creative Technology Bachelor programme for the freedom they allowed in pursuing a graduation project shaped by personal motivation. Instead of applying for one of the supplied graduation projects, this project was brought to life on an individual basis. Furthermore, the bachelor programme needs to be thanked for all the knowledge and experience provided throughout its programme that made this graduation project end successfully.

Seventhly, the fellow Creative Technology graduates that helped through the hurdles of the graduation project process, encouraging and inspiring each other.

Lastly a word of gratitude towards all the other people who contributed to this project. Without all the contacts, survey respondents and user testers this project would not have been possible.

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## Chapter 1 – Introduction

Technology is playing an increasing role in society. The Netherlands recognizes these technological influences and advancements, especially within its educational system. According to the Organisation for Economic Co-operation and Development (OECD), the Netherlands is one of the most progressive countries worldwide in terms of education innovation. This is reflected in the incorporation of new Information and Communication Technology (ICT) applications in schools (Ministerie van Onderwijs, Cultuur en Wetenschap, 2019). The Dutch government realizes that there is a need for more ICT trained professionals in the job market, but ICT skills become more relevant within professions where it might not seem obvious that it is needed. It is not all about technical professions, but also those of healthcare, transport or sales (Ministerie van Onderwijs, Cultuur en Wetenschap, 2019). An understanding of these technologies facilitates faster, more efficient, or easier work. Increasing the knowledge of young secondary school pupils could prepare them to better perform within these professions, while further developing themselves in secondary school. That is because a basic understanding of technology enables problem-solving in a technology-rich environment, an ability that is assessed in the Programme for the International Assessment of Adult Competencies (PIAAC) (Ministerie van Onderwijs, Cultuur en Wetenschap, 2016).

Ramon Moorleg, chairman of the trade union of informatics teachers called I&I (I&I, 2020b), says that computer science as a secondary school subject has added value for the development of the pupils. The pupils also recognize this value (BNR Nieuwsradio, 2019; Niehe, 2019). Additionally, according to Derk Pik from the University of Amsterdam, “informatics is not only about programming, but also about social media, information processing, privacy and encryption. You want every student to get a grasp on those basics” (Zeemeijer, 2019).

Unfortunately, there is an enormous shortage of informatics teachers who are trained to educate secondary schoolers, within upper secondary education especially, and predictions for the future seem even worse. According to the Dutch Ministry of Education, Culture and Science (Ministerie van Onderwijs, Cultuur en Wetenschap) 73 vacancies for fulltime computer science educators within secondary school education will not be filled by 2024, increasing to 116 vacancies in 2029 (Ministerie van Onderwijs, Cultuur en Wetenschap, 2019). Furthermore, according to CentERdata, the informatics subject is impacted the most by so-called ‘vacancy pressure’, meaning unfulfilled demand as a percentage of the total employment opportunities and can be classified as one of the six subjects with ‘permanent shortages’ (Ministerie van Onderwijs, Cultuur en Wetenschap, 2019). These enormous shortages force schools to exclude informatics from their curriculum if they are not able to find a teacher, which is unfortunate.

Additionally, it seems difficult to motivate pupils to learn about the inner workings of technology. Informatics is seen as a very technical subject, which could be a reason. The motivation problem could have several causes. Lack of interest in technology in general. Not being able to see the value of the subject for the pupil individually or within society. Next to that, the difference in individual qualities of the pupil and educational level comes with its challenges. Attention span, knowledge and logical thinking can differ the educational levels informatics is taught at. In the Netherlands these are the HAVO (senior general secondary education) and VWO (pre-university education) level. How can informatics be made interesting for and appealing to all types of pupils from a variety of different backgrounds and experiences?

Pupils that do not have a background in gaming, for example, might be harder to enthuse for informatics whereas students that do often play games might be more interested in it. That is because these pupils might have different ideas about the possibilities informatics can offer.

One aspect that is also important to take into consideration is the enthusiasm of girls. Gender, or gender ideologies, can play a crucial role. “Gender ideology is an important concept in shaping boys’ and girls’ competence beliefs” (van der Vleuten et al., 2016). That influences the views these genders have towards certain subjects. This is also the case within the computer science industry. Only 24% of computer science jobs are currently held by women (Girls Who Code, 2020).

This research aims at gathering existing information and researches concerning the topic of enthusing young secondary school pupils, especially girls, for the informatics course within secondary school. Finding out how children in the age-group are enthused, how they can be enthused about informatics curricula, the position and possible (gender) stereotypes revolving around informatics and technology, but also how a good curriculum is constructed and evaluated within modern education. Combined this leads to the question: “How to design a way to enthuse young secondary schoolers for informatics education?”.

# Chapter 2 – State of the art on informatics education

## 2.1 Literature review

This graduation project aims to enthuse more secondary pupils for the informatics subject because an understanding in technology is important in modern-day society. This literature review aims at gathering existing information and researches related to the topic of programming education. A focus is put on programming education because it is one of the most tangible topics within informatics. It also is one of the more researched topics in terms of technology education for young children. Further exploration of the context of informatics within Dutch education will be discussed later within this report. Finding out how a good curriculum is constructed for this age-group, how these children can be enthused about programming curricula and the position of the subject and possible stereotypes revolving around technology that influence initial interest. Therefore, this review will be divided into three sections: effective teaching methods for programming, programming motivation and gender differences within programming.

### *2.1.1 Effective teaching methods of a programming course*

The target group in question is young secondary school pupils. Effective teaching methods are very important for the learning process and can help with motivation. Guidance within the subject is required to make sure this motivation can be encouraged. Like Hermans, founder of the Programming Education Research Lab (PERL) at Leiden University, says “I compare it to learning to play a musical instrument. It is not effective to just give a child a guitar and say: “do your thing”, isn’t it?” (2019). To do so, an effective way of teaching the complex programming concepts is desired.

Powers et al. (2007) note that for novices to become familiar with programming, it is important to reduce syntax complexity so that students can focus on problem-solving and program design instead. Programming should be offered "at a simple level: problem analysis, documentation, test design and the evaluation of test results" (Powers et al., 2007, p.561). Visual programming and visual programming environments are more accessible, making computer programming more accessible to youngsters (Kaučič & Asič, 2011). However, “imagery does not always enhance comprehension” (Navarro-Prieto & Cañas, 2001, p.823). Visual programming can also lead to the creation of bad habits that are at odds with accepted practices within computer science, like algorithm design to solve a problem and use cleanly structured programming constructs (Meerbaum-Salant et al., 2011). If not caught, they could affect the performance of the pupils in later textual programming languages and it is the responsibility of the teachers to portray good programming methodologies (Noone & Mooney, 2018). We must, therefore, look with a critical eye when deciding what the benefits and downsides are for using the visual programming language.

The Dutch Association for Curriculum Development (Stichting Leerplan Ontwikkeling, SLO) says that to be able to provide such a course, core concepts of informatics need to be taught, possibly with different levels, but there must also be enough options to personalize the curriculum. Personalization options within the curriculum could further motivate the pupils as they are in control of what they want to learn. It can also help to make the curriculum more appealing to the different educational levels (Tolboom et al., 2014). In Tanzania for example, the level of educational background seems to be the main problem for difficulties in programming education (Apiola et al., 2011).

### *2.1.2 Programming motivation*

Enthusiasm for programming should be formed early on so that these pupils will hopefully choose the informatics course later in their secondary school career. Effective teaching methods can already help in this regard, making the subject more fun to learn. Additional methods can help further increase motivation. “Motivation and involvement are crucial factors in retaining students in a particular program” (Rajaravivarma, 2005, p.98). This can be dependent on the type of assignment or the way the programming syntax is experienced, increasing the time spent on a task, which has been proven to be key in positive learning outcomes (Powers et al., 2006). Gamification can further increase this motivation and engagement leading to repeatedly exposing the pupil required for effective drill-based rote learning (memorizing based on repetition) (Parsons & Haden, 2006). This is supported by Rajaravivarma (2005): working on making a game can also create “passion to want to do more, a crucial factor sought after in an introductory programming course” (p.101).

Performance evaluation can affect the motivation and task involvement of students and may influence their interest in that task (Law et al., 2010). This is based on the reinforcement theory, where behaviour and its consequence play an important role (Skinner, 1969). Immediate feedback on potential errors can aid in this regard, helping the student to better grasp programming concepts (Mannila et al., 2006; Powers et al., 2006).

Self-efficacy is “a person’s belief that they can be successful when carrying out a particular task” (“Self-efficacy,” n.d.). When teaching an introductory programming course we must challenge student but not overwhelm them with complex programming task that undermined their self-efficacy (Ramalingam et al., 2004). Motivation can benefit from increasing the belief of the pupil in their success.

### *2.1.3 Gender differences within programming*

In modern times the world has changed to be more inclusive, at least generalizing it is striving to be. This increase in diversity may lead to a larger variety of insights, creating more potential for solving problems, creating products etc. Computer science and technology-related fields could benefit from this increased diversity as well. However, from personal experience in a technical university environment, there are not a great number of women occupying computer science-related studies. Its gender-diversity is not that high. Similar low percentages can be seen within the work field as well. In the United States in 2015, only 18% of bachelor degrees in Computer Science were earned by women (National Girls Collaborative Project, n.d.). Similarly, in Europe in 2018 only 15.4% of the ICT labour force were women. This number has been decreasing from 2008 until 2018 by 0.8% per year (Eurostat, 2019), wherein the Netherlands 12.2% of the Computer Science Bachelor students were female (Centraal Bureau voor de Statistiek, 2019). These Figures indicate that women do not occupy a large part of the informatics domain, which is unfortunate. Mannila et al. (2006) already expressed their concern that of the 42 participants within their research, none were girls and they saw it as a future challenge to make programming more appealing for girls.

Academic stereotypes can be a cause for these low numbers, as it drives girls away from these fields (Cheryan et al., 2015). These stereotypes seem to cause something called *computer anxiety* causing them to have negative associations with computers (Cooper, 2006). Previous computer experience and encouragement also influence this attitude towards computers (Busch,

1995). This is worsened by the fact that women seem to have lower self-efficacy resulting in being less successful in trial and error, which is crucial to learning computer science (Fuentes et al., 2005). The research of Cooper (2006) states however that this trial and error ability to learning computer science is "strongest with regard to complex tasks" (p.6).

A concrete way to solve this is to create inclusive and diverse cultures and to represent these different values by someone within the computer science field (Cheryan et al., 2015; Peckham et al., 2007). Another way of tackling the problem is the aspects taught within the curriculum itself. Games, for example, can be used as a tool to teach programming to girls as well, as there seems to be an entertainment value associated with them and they can provide a relatively simple point for discussion (Carmichael, 2008). Storytelling within games seems to have particular appeal to female students, many of whom refer to *programming with a purpose* as a particularly attractive feature (Powers et al., 2006).

## 2.2 Current developments

The Dutch government thinks digital literacy or similar skills are important and needs to be implemented within school curricula. This section is to explore some of the current developments and implementations of programming education.

Even though there are varying opinions and reasonings why visual programming environments benefit programming education or not, they are currently used prominently within programming education for young children. Therefore their value in children programming education is recognized by incorporating it within this research. Several visual programming environments will be discussed and what their benefits and downsides are. These environments are categorised from mostly visual to more text-based.

### *2.2.1 From blocks to visuals and animation*

One of the visual programming languages with the largest user-base is *Scratch*, developed by the Massachusetts Institute of Technology (MIT) Media Lab. Available since May 2007, and currently available in more than 40 languages, including English and Dutch. It is available for both desktop and mobile platforms. It is a programming language developed for children from 8 to 16 years old in mind. Most of its users are 12 years old according to their statistics (Scratch, 2020b). "Scratch helps young people learn to think creatively, reason systematically, and work collaboratively — essential skills for life in the 21st century" (Scratch, 2020a). It does so by combining pre-shaped blocks to perform actions. Combining multiple blocks can lead to intricate programmes capable of a variety of things, like animation or interaction for example. The Scratch programming environment, also called the editor, can be seen in Figure 1[1]. A vast, active and inclusive community of people share their projects, provide feedback and help each other, which Scratch prides itself for. This community is not only comprised of children sharing all their projects, but there are also many educators from all over the world contributing to ideas within programming education using this programming environment. Discussions between these education-professionals are facilitated by conferences or meetups, some more local than others, where they come together to exchange their ideas and their worries and look towards improving the education system around Scratch (Scratch Meetup, 2020).

[1] https://medium.com/scratchteam-blog/3-things-to-know-about-scratch-3-0-18ee2f564278

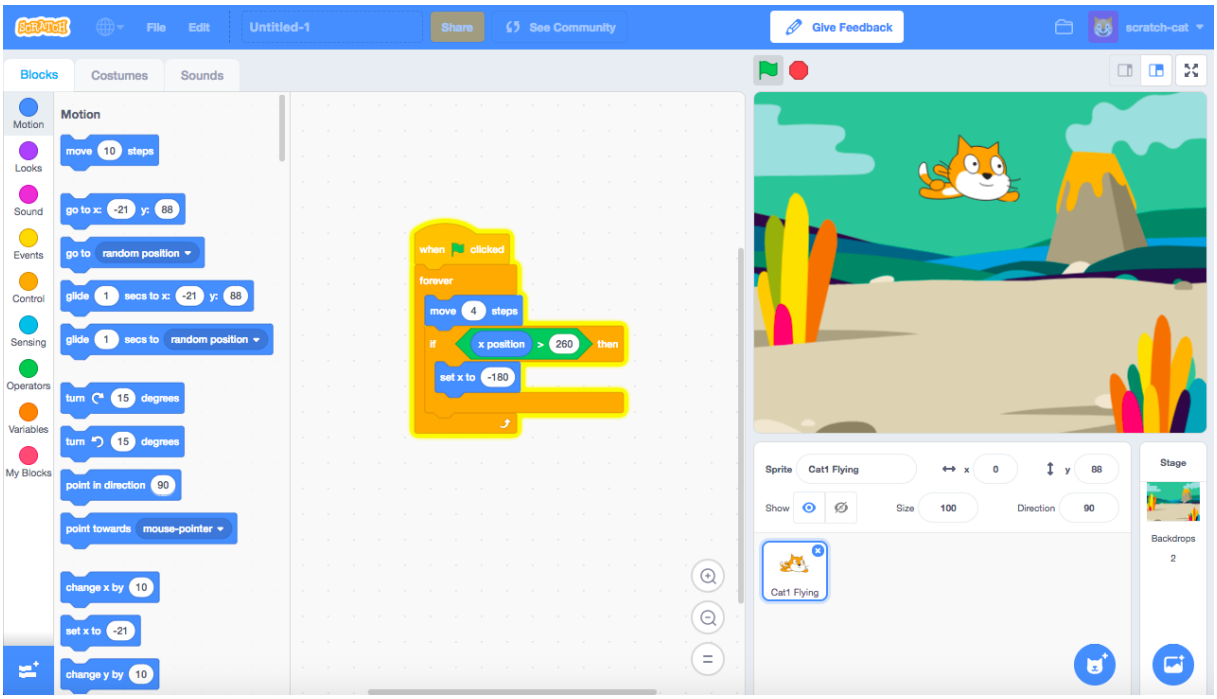


*Figure 1 Scratch 3.0 editor*

There is a large library of tutorials and teaching methods provided by the Scratch team themselves. But there are also a variety of external parties who use Scratch to provide programming education for beginners. One of which is the Harvard Computing Curriculum, developed by the Creative Computing Lab at the Harvard Graduate School of Education (Harvard Creative Computing Lab, 2020) with the goal to increase fluency with computational creativity and computational thinking and encourage the exploration of its key concepts. This English curriculum consists of six units and is available free of charge. A similar course is the CS First curriculum by Google (Google Inc., 2019b). One of the initiatives of Google focused on computer science education. It is a tool built by educators to empower teachers to teach computer science and integrate it into a wide range of classrooms. A total of 19 different subjects or packages are offered, containing hands-on activities with instructional videos to learn about computer science using the Scratch programming language. It is also in English and like the Harvard Computing Curriculum free of charge. The third example is offered by the Delft University of Technology (TUDelft). This Massive Online Open Course (MOOC) teaches programming in Scratch and aims to teach basic programming concepts like loops, variables and data structures (TUDelft, 2020). The course is developed and taught by dr. Feline Hermans, an educator and researcher at the TUDelft who stands at the forefront of computer science education implementation within the Dutch educational system. Not only is there a course available for children aged 8 and up, but there is also a course available for teachers to familiarize themselves with the basics of programming and how they can effectively educate the subject. Both courses are available in English and Dutch.

### *2.2.2 Blocks and text*

*Blockly* and *Snap!* and are both programming languages that work around puzzling blocks together to construct the program. This is similar to Scratch. However, Blockly has the added value of being able to show what these blocks would translate to in textual code directly. Snap!

is more focused on the aspect of clean coding with data structures, the skills required for good coding so to say.

Blockly at its core is an open-source library developed by Google, enabling visual code editors to web and mobile apps. Available in more than 40 languages, the editor uses "interlocking, graphical blocks to represent code concepts like variables, logical expressions, loops, and more" (Google Inc., 2017). It removes the complexity of syntax using these easy to understand blocks. Additionally, Blockly can export the code to a variety of programming languages like JavaScript, Python and PHP for example to aid the transition to text-based programming. One example of an application that can introduce programming and syntax by visual means is Blockly Games (Google Inc., 2019a). Here the blocks are presented to solve various games, practising conditionals, loops, mathematical equations, and function as can be seen in Figure 2[2]. Some of the games force the user to switch between the block representation and the syntax writing. Blockly Games can be played in Dutch or any other of the available languages, the blocks that are clicked together will be translated to the respective language. However, the documentation explaining the theory behind certain aspects of the game is only available in English.

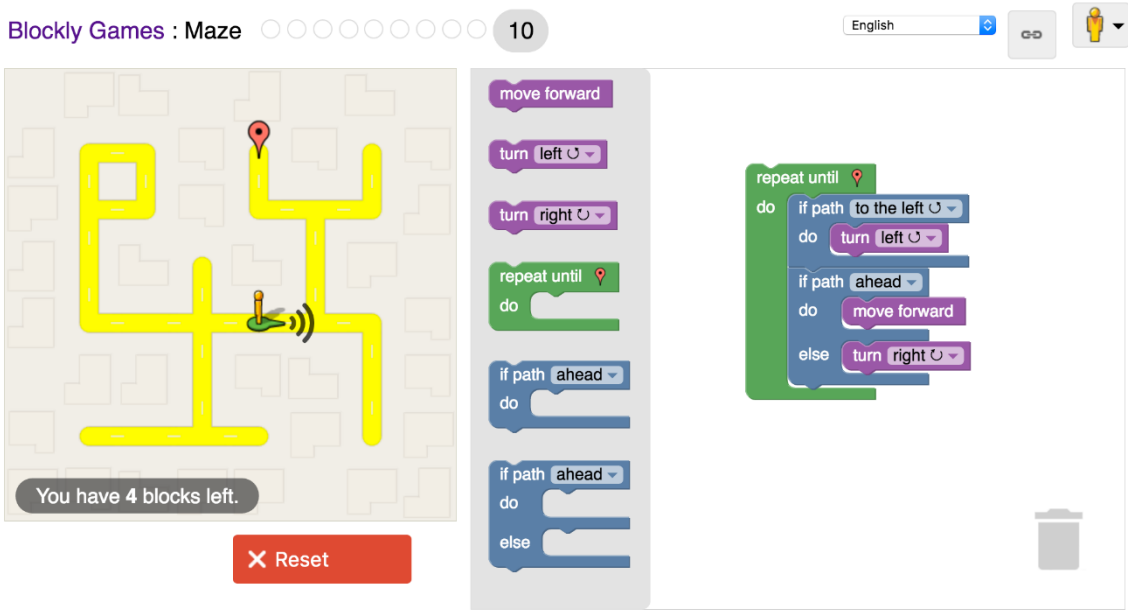


*Figure 2 Blockly Games editor*

Blockly is just a library, however. Snap! on the other hand is an integrated application. Developed by the University of California at Berkley as an extended reimplementation of Scratch, it allows you to program using your own blocks but also implements first class lists, procedure and continuation. (Snap!, 2020a). Because Snap! enables the use of lists, data structures, implemented as lists of lists, are possible. These data structures are not possible in Scratch (Snap!, 2020b). The blocks within Snap! are also shaped the way they are, not only as "a way to prevent syntax errors; they're a way to *teach* the idea that some procedures return values and others don't" (Snap!, 2020b). These blocks can be seen in Figure 3[3]. It extends the visual teachings to tackle concepts that were previously thought too hard for young people to

[2] https://developers.google.com/blockly
[3] https://en.scratch-wiki.info/wiki/File:Snap-shot.png

grasp. For example, blocks can not only be used as program control elements but can also be used as data (Snap!, 2020b). Especially if the user is already experienced with Scratch, they will recognize the block system, but now they are not only used as program control elements but also as data.

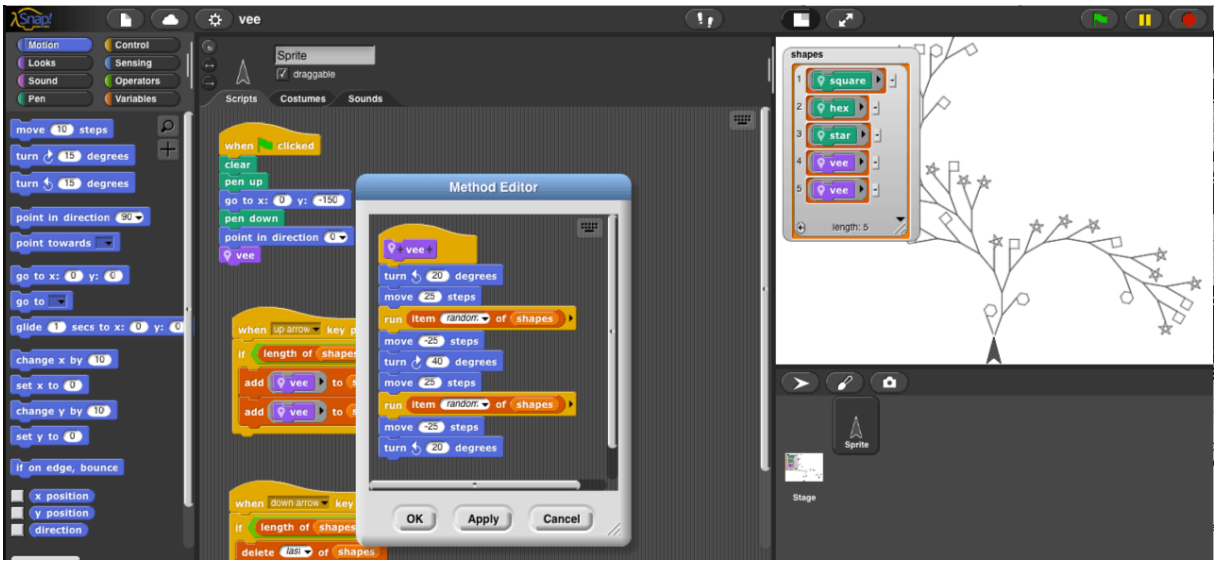


*Figure 3 Snap! editor*

### *2.2.3 From text to visuals and animation*

*Processing* is an excellent example of a programming language that helps teach coding by promoting programming literacy within the visual arts context and technology context. This is a text-based programming environment as opposed to the block-based environments mentioned above. While is resembles traditional coding much more, it is still considered a visual programming environment due to its focus on visual output. An example of such output can be seen in Figure 4[4]. It was initially developed as a visual teaching tool but has evolved into a tool that professionals are able to develop in. Since 2001 there are more than tens of thousands of users who use it for prototyping and learning. Its free, open-source, includes many libraries and is well documented (Processing, 2020a). Processing at its core was designed to be used in programming education as the first language being used. Similar concepts like those taught in high school and computer science are covered within Processing, but with a different emphasis as it is directed towards visual and interactive media. "This motivating curriculum has proved successful for leading design, art, and architecture students into programming and for engaging the wider student body in general computer science classes" (Processing, 2020b). It is a widely-used programming language within a variety of educational institutions. Not only does an understanding of Processing facility programming, by Arduino basing its development environment and syntax on Processing, it also enables students to play around with robotics and physical computing. Processing also enables a new wave of visual artist a various expression within (pop) culture but is also used by large companies (e.g. Google and the New York Times) to prototype new interfaces and services but also use it to analyse different kinds of data.

[4] https://lwn.net/Articles/522079/

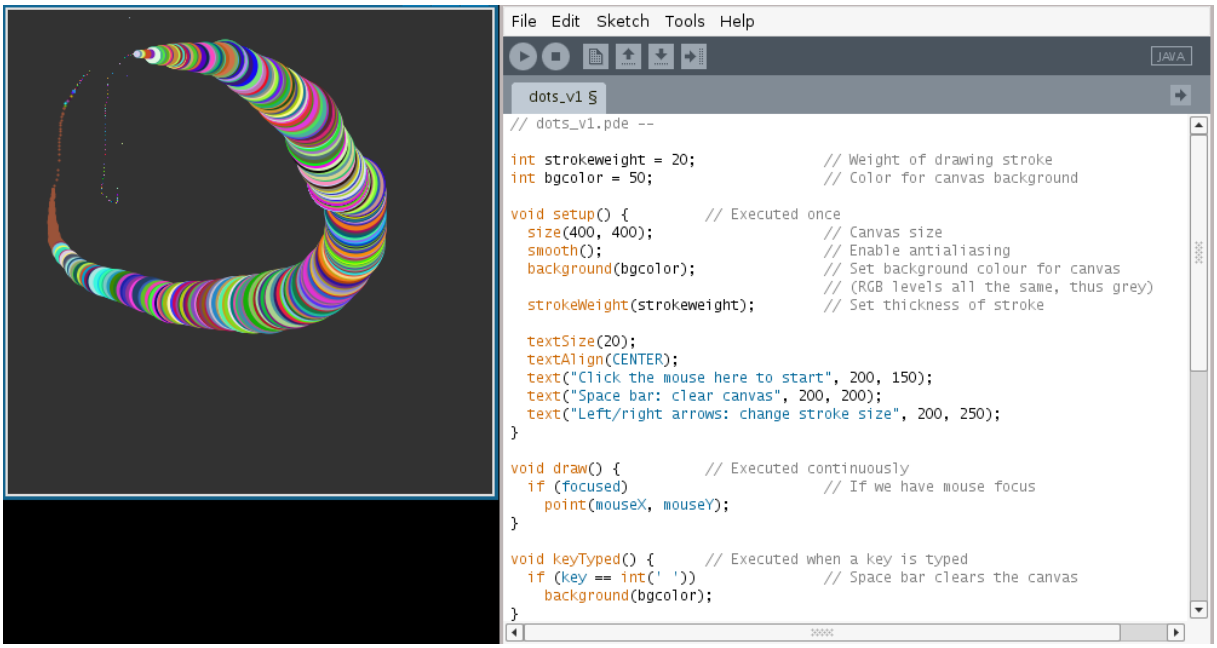


*Figure 4 Processing editor*

*Greenfoot* is another example that, at its core, is based on textual syntax displayed visually. As a programming environment, it uses elements of both Processing and Blockly to teach coding. It is discussed here because it uses textual programming together with assets to visualize the structure of the program created. Greenfoot is a project that originated at the University of Kent in the United Kingdom from its School of Computing department (Greenfoot.org, n.d.-a). It "was designed by analysing and combining the most beneficial aspects of several existing tools" (Henriksen & Kölling, 2004). Its programming environment, which can be used online as well as offline, is aimed at ages 14 and up, but is also suitable for college- and university-level education (Kölling, 2010). It is accompanied by a textbook used by both teachers and students (Greenfoot.org, n.d.-b). At its core, Greenfoot is a textual based programming environment based on Java, similar to processing. The programming environment "includes project management, auto-completion, syntax highlighting and other tools" that are most common with similar programming environments (Greenfoot.org, n.d.-a). Additionally, it visualises the code structure by the means of blocks that aim to show object orientation, which is a bit similar to how Blockly shows the program structure and can be seen in Figure 5[5]. "Greenfoot is used by thousands of institutions around the world" and it allows easy use for beginners but trains code-writing skills to write sophisticated applications (Greenfoot.org, n.d.-a). To support learning, there are many tutorials and resources available for students to learn new techniques or discover new skills. A community of teachers also shares their "teaching resources and discussion surrounding teaching with Greenfoot" (Greenfoot.org, n.d.-a).

[5] https://www.greenfoot.org/topics/54456/0

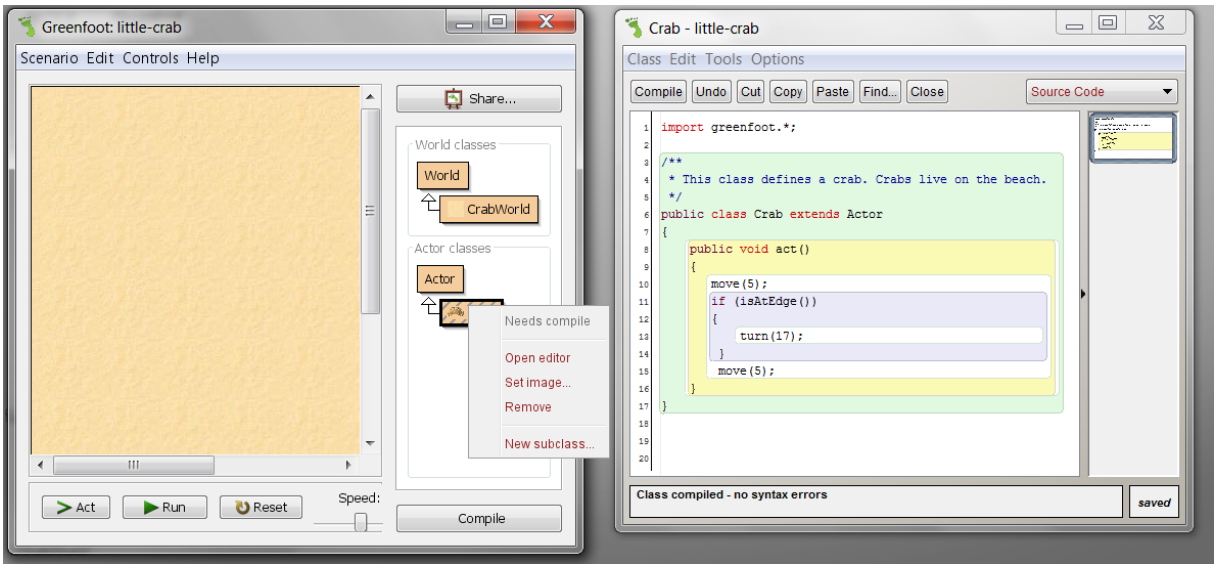


*Figure 5 Greenfoot editor*

## 2.4 Within Dutch education

As the informatics subject has programming within its curriculum, the Dutch programming (Greenfoot.org, n.d.-a)education includes a variety of the aforementioned are used. However, education does not limit itself by only using these programming environments, there are a variety of others being used. As the informatics course can be taught in a variety of ways, so does each teacher have their preference for a certain programming environment and uses these within their education. Environments like Scratch or Snap! seem to be used often as an introduction to programming but are replaced by textual coding to further learn about programming.

Programming education is not only offered through secondary school informatics education, but a lot of external parties also offer programming courses as well. These external parties can work separate from the secondary school or in collaboration. One of such companies is Lyceo. They work together with secondary schools by offering programming education called CodeLab (Lyceo, 2020). With the use of Processing, the children learn how to make an interactive game.

## 2.5 Conclusions

Not only does the Dutch government recognize that a basic understanding of technology is important, they and other parts of the world still notice that it is hard to get young secondary schoolers motivated for informatics-like courses involving programming. This can be tackled by addressing the teaching methods, orienting them more towards teaching the somewhat abstract concepts of programming by using visual programming environments like Scratch, Snap!, Processing or Greenfoot, while still being critical about these environments, and personalizing the curriculum to fit the needs of the individual pupil. The motivation for such a course can be improved by implementing gamification to shape the assignments but can also benefit from increasing self-efficacy and providing direct feedback to the pupil. Furthermore, there is only a small percentage of women currently occupying the Computer Science field, which is mainly the result of academic stereotypes. This needs to be solved by a change in image but can also be helped by shaping the taught material to appeal more easily to girls.

# Chapter 3 – Methods and techniques

This chapter of this report will discuss the methods and techniques used to end up with the final report by describing the different steps taken and their process.

## 3.1 Creative Technology design process

The Creative Technology design cycle is a way of iterative design that comes from a problem statement to a final solution for said problem. This design cycle can be seen in Figure 6. The Creative Technology design process is based on classical models of creative design that use divergence and convergence models, but are also supported with spiral models in each of the design phases (Mader & Eggink, 2014). The design questions, as well as the ideation phase, specification phase, realisation phase and final evaluation and how they are tackled with a Creative Technology design process point of view, will be explained below.

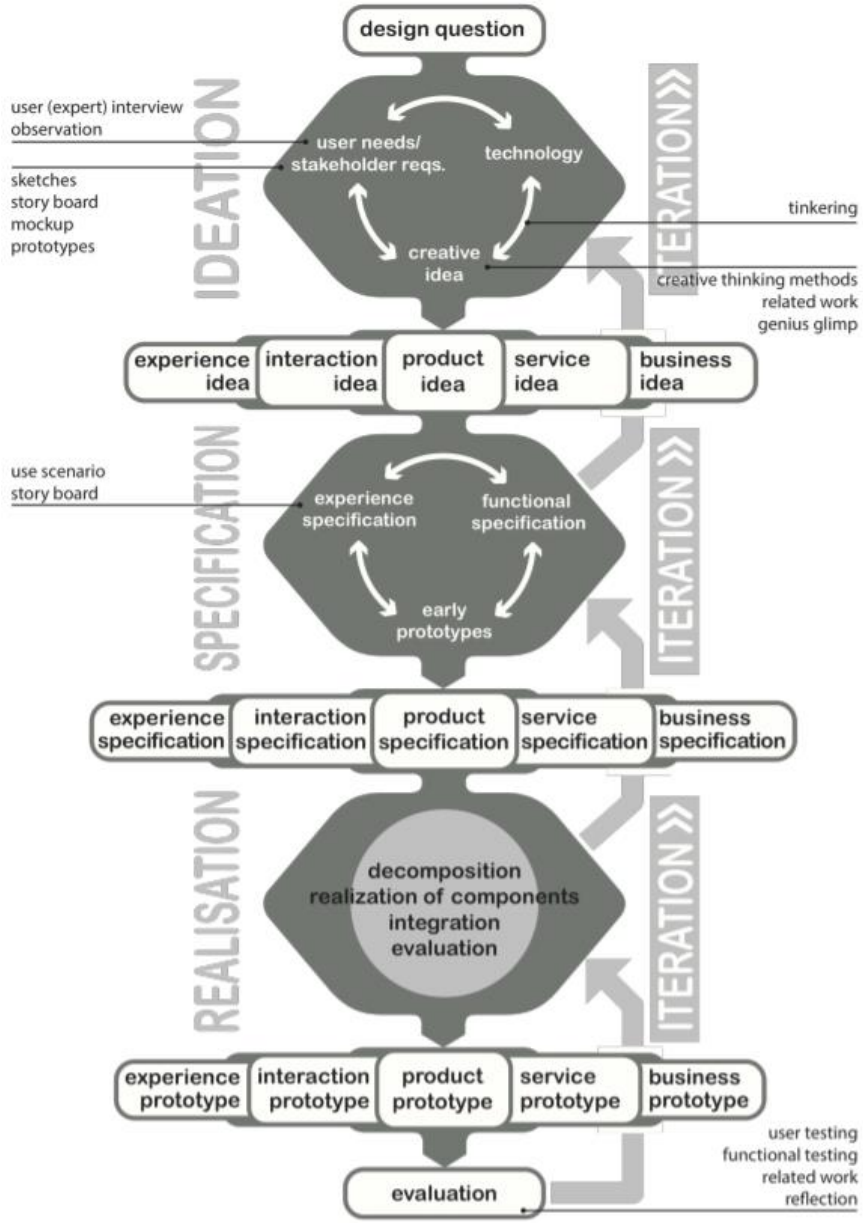


*Figure 6 Creative Technology design process*

### 3.2 Design questions

To end up with the final design for the main research problem, several design or research questions must be defined. These help to guide the design process and help structure the bigger question into sub-questions that are easier to answer. Some of these questions that relate more to the problem statement have already been discussed and potentially been answered within the introduction and State of the Art chapters of this report. Other questions that relate more to the solution will be discussed in later parts of this report.

**Research Question**

How to enthuse young secondary schoolers for informatics education?

**Sub-Questions**

1. What is the role of the informatics course?
    a. How is informatics education shaped within the Dutch educational system?
    b. Why is it important?
    c. How do pupils benefit by following this course?
2. In what ways can informatics be taught?
    a. How do secondary schools and teachers already implement informatics currently?
    b. What are the appropriate teaching methods?
        i. What programming language type is most suitable?
        ii. What teaching methods apply to what age-group?
3. What is the appropriate age of secondary school pupils to invoke interest?
    a. When do they choose the subject?
        i. What is their choice based on?
        ii. How is their choice influenced?
4. How can enthusiasm for informatics be increased?
    a. What is already done within schools to create interest for informatics?
    b. How are they motivated for informatics?
        i. How do girls view informatics?
        ii. What are the obstacles for girls to choose informatics?
5. How can a change in the view of informatics be realised?
    a. What are the challenges for presenting a changed image?
    b. What shape should the presentation of this view take?

### 3.3 Ideation

Within the ideation phase, the needs of the users and stakeholders are analysed. This is done by analysing the context the problem takes place in, the main stakeholders and the user-groups. Unlike the Creative technology design process, this is not yet done through user interviews or observations. Rather this is done by looking at literature, government reports and other sources that relate to the topic a good image of these different aspects is gathered. User interviews are implemented at a later stage. As a result of divergent brainstorming solution concepts for three of the main problems found are presented.

### 3.4 Specification

To specify the solutions the final result of this research should offer, a number of requirements are defined. These will help to shape the final result further. These requirements are based on

all the previously found literature and their conclusions from the introduction, State of the Art, and ideation chapters. Here is where user interviews are implemented in the form of online surveys with the two main user groups. This is done to confirm the requirements that are needed, but also to shed light on which requirements should be most important. By converging, these are the requirements with the main focus throughout the realisation of the final result.

### 3.5 Realisation

Within this phase, the final result is given shape as a prototype. Cyclically, the prototype is formed. Not only is this design cycle applied during the realisation of the prototype, but also the brainstorming stage of the design process. By quickly evaluation each step of its design process, reviewing it a total image, quick adjustments can be made. These adjustments are not all elaborated within this report. The design is based on the inspiration of existing solutions but differs because of the requirements it must meet to achieve the goal set out in this report. A final prototype is the result of this phase. This prototype should provide a way on how to help enthuse pupils for the informatics subject.

### 3.6 Evaluation

The evaluation phase is the final phase within this graduation project regarding the final solution. With user testing the benefits and flaws of the final prototype come to light. Evaluating these points leads to a small iteration to be made. Further iterations are suggested within the report as well.

# Chapter 4 – Ideation

Within this chapter, the initial ideation will be described. Various aspects that influence this initial ideation phase will be discussed and evaluated. The context, stakeholders and end-users will be analysed and fleshed out. Several user profiles will be created to help envision an end-user interacting with the final product or service, further shaping the ideation and requirements for the final solution.

## 4.1 Context analysis

As the focus of this research revolves around the Dutch educational system, the geographical and educational context will mostly be related to the Netherlands. However, that does not mean the concepts discussed cannot be applied to other countries as well.

### *4.1.1 Digital skills education in the Netherlands*

SLO has defined four digital literacy skills that stem from eleven 21st-century skills (see Appendix A). These 21st-century skills concern generic skills with their accompanying knowledge, insights and attitudes that are necessary to contribute to our future society (Stichting Leerplan Ontwikkeling, 2019a). The four digital-oriented skills are classified as digital literacy. These four skills are computational thinking, ICT (Information and Communication Technology) base skills, media literacy and information skills. They each cover a variety of aspects of their respective topic. A lot of these topics are also practised within the Dutch elective informatics course that is offered during secondary school. Some examples of digital literacy aspects covered by informatics are data collection and processing, algorithms, programming, abstraction, security, digital information processing and societal impact (Examenblad.nl, 2020). The factor for informatics that counteracts benefitting digital literacy amongst Dutch students is that informatics is not mandatory within the secondary school curriculum. This subject can be chosen by the pupil when they move to upper secondary school (bovenbouw in Dutch). This happens after their 3rd year in secondary school when they are around 14 years old. For the HAVO level, the upper secondary school consists of two more years, while for the VWO level this is three years. Informatics is available within any curriculum track, therefor available to any pupil. Presently, it is for the pupil to decide whether they want to follow this course within their upper secondary school curriculum. However, that might change in the future depending on the decisions made by the Dutch government.

### *4.1.2 Digital skills education implementation*

The digitization agenda of the Dutch government is meant to cover the implementation of digital literacy skills within Dutch education. The agenda states that schools are already increasingly implementing digitization within their education (Ministerie van Onderwijs, Cultuur en Wetenschap, 2019b). However, not all schools can do this as well as others. This can be due to the lack of facilities, knowledge, or teachers not being adequately digitally literate themselves. While it is a goal of the Dutch government to increase digital literacy within Dutch education, it is not yet mandatory to implement it within any curriculum, not in primary school nor secondary school (Pijpers, 2019). In other European countries however it is becoming increasingly mandatory (Lepeltak, 2019). In France for example, children are increasingly exposed to ICT in primary school. In Denmark, Poland, Israel and the United Kingdom the developments are similar. Furthermore, in France, the completion of the subject Numeric Science and Technology (Science Numérique et Technologie in French) is mandatory within the exam that gives access to university (the baccalauréat in French), which is comparable to

the VWO educational level. The overarching problem all of the European countries seem to face is the shortage of ICT trained professionals (Lepeltak, 2019). This is also very true for the Netherlands and will continue to be a problem in the future (Ministerie van Onderwijs, Cultuur en Wetenschap, 2019).

#### *4.1.3 Choosing informatics*

As mentioned before, the informatics course within secondary school is an elective. Within the first three years of HAVO and VWO, also called lower secondary school (onderbouw in Dutch), no informatics is being taught. A subject that is sometimes taught within lower secondary school is information science (informatiekunde in Dutch) and covers the very basics of digital literacy at a low level. This could provide a small introduction to the extent to which digital literacy is covered within informatics. Unfortunately, information science is not offered at many schools anymore and is disappearing from lower secondary school curricula as well (Qompas, 2019).

But how is the pupil able to decide whether informatics is for them? Because informatics seems to suffer from an image that it is a very technical subject, this can be difficult because technical subjects are not always regarded positively within society. Technical subjects can be seen as too difficult, boring, irrelevant or non-understandable, which they do not need to be. Because of a wrong representation within society but also school institutions this can also negatively affect the choice of the pupil. The challenge is to correctly inform pupils about the course. To do so, good information needs to be available. Since informatics is a very hands-on subject, a practice lesson can be beneficial to experience and understand what the subject is about and how it can be meaningful to the individual pupil. Some schools implement these practice lessons already. “We let the pupils know that the subject exists, and if they want they can join a practice lesson” says Ter Wal, an informatics teacher in Aalte, the Netherlands (Heur van, 2005). Another VWO specific secondary school, called Het Stedelijk Gymnasium van 's-Hertogenbosch, also offers a similar introductory lesson (Weert van, n.d.). Providing correct and intriguing information about the course, together with a practice lesson can enthuse the pupil about the course and encourage them to choose the subject. However, there does not seem to be a baseline in the way to show how informatics is built up and what it can offer the pupils. This is often done by the school staff themselves, by the dean or the informatics teacher themselves. However, there might be opportunities to offer an overarching introduction that is implementable by the schools.

### 4.2 Stakeholder analysis

Stakeholders are defined as anyone, any group of people or any instance that impacts, or is impacted by the envisioned product or service. They influence the product or service is implemented, but also take part in defining its criteria. They are impacted by the results of the service or product, as they might use it or undergo secondary effects of it. These stakeholders will be defined, their impact will be explored as well as how they are impacted by the product or service. The benefits and disadvantages they undergo as a result will also be discussed. Finally, this will be summarised in a stakeholder map and they will be put on a commitment scale.

### *4.2.1 Dutch government*

The Dutch government in the scope of this graduation project mainly means the Ministry of Education, Culture and Science (Ministerie van Onderwijs, Cultuur en Wetenschap in Dutch). They regulate the development of new curricula, the levels of education that need to be upheld and the implementation thereof on a national level. They make sure that education is fitting for pupils to prepare for their independence and responsibilities for their future (Rijksoverheid.nl, n.d.).

The result of this report could help the government by increasing and improving the awareness of informatics and the number of pupils that become familiar with this subject. This could however also have a negative impact, as there is a large shortage of teachers for this subject. As a result, the government could face this teacher shortage problem on an increased level than it already is if interest for informatics were to rise.

### *4.2.2 Dutch educational advisors and developers*

Educational advisors like SLO (Stichting Leerplan Ontwikkeling in Dutch) make sure that the goals of the government are checked and researched, after which plans are set up to match these goals. Learning goals are defined, and fitting study methods and materials are created to reach those goals. Quality checking these learning goals, evaluating how the educational system should be shaped to fit the envisioned goals of the government. Educational developers specifically make sure that the goals can be reached with fitting study methods and materials. By doing so they shape the way the learning goals are achieved within the curricula (SLO.nl, n.d.).

As a result of this report, a small step towards achieving the learning goals can be made. It would assist these educational parties by promoting the informatics curriculum that helps achieve a part of the learning goals set out by the government: increasing digital literacy. However, as the Dutch government experiences the lack of teachers as a problem, it can be the same for these educational parties. They must make sure they can reach the demands of the educational system and a shortage in staff could pose a problem. They also need to make sure the learning goals are reached in a correct manner that is ideally future proof as technology tends to evolve quickly.

### *4.2.3 ICT field*

The ICT (Information and Communication Technology) field is very broad and broadens even more as technology becomes more prominent. Not only everyday life but also Universities and Universities of Applied Sciences increasingly incorporate informatics in one way or the other. Also, corporate and non-corporate life is exposed to ICT in some way, some more directly related to informatics than others. In corporate life especially, ICT can be of great added value and more money is being spent on its research and development (Eurostat, 2017; Statista, 2019).

As pupils are increasingly well equipped with the knowledge they need to function within modern-day society, they can participate in it on an adequate level (Eurostat, 2016). Therefore, an increased interest in informatics and the flow of pupils that are interested to work within the field might increase. Overall, it should increase the number of people able to contribute to the field. This is beneficial for the field as it allows for a larger diversity of people contributing to it. Additionally, the field will be able to satisfy the increasing demand for ICT

trained individuals. This increase could however also cause an overflow or oversaturation of the field, which could be counter-effective.

#### *4.2.4 Secondary schools*

The secondary schools are the educational institutions that offer the informatics course and help aid in the development of young pupils. These schools are responsible for training pupils to be able to participate in and contribute to society.

By offering informatics they can make a start in contributing to the increasing demand of well-trained individuals in that field. Not only that, but they also train the pupils to live within a modern, technology overflowing, society. By offering informatics the schools can shape the educational path these pupils will be able to follow. This path can also be beneficial for the performance within other school subjects. The skills and techniques they acquire within informatics, like problem decomposition, for example, can be carried over to support their learning in other subjects. However, the shortage of informatics teachers counteracts the implementation of this subject within many school curricula. In 2017 only 49% of Dutch secondary schools were able to offer informatics (Schellevis, 2017). The schools that do offer the subject, however, might experience a shortage of informatics teachers as well.

#### *4.2.5 Educational staff*

This group of people concerns anyone working within secondary schools. Deans, teachers, mentors but also supporting staff. These people all work together to shape the pupils who follow an educational path at their secondary school. The educational staff is included as a stakeholder group because they can to contribute to the changing image of informatics. Also, they need to realize and set an example that informatics is an inclusive subject that can be interesting for everyone.

As there is a shortage of informatics teachers specifically, it might be necessary for the staff to help where they can and where it is needed. This could lift some weight from the shoulder of the informatics teacher present. One example could be in providing the information to help the pupil get a clear view of the informatics subject. This does require the staff themselves to become a bit familiar with the subjects covered in informatics. They also need to realize and possibly change their views that they have on informatics. Becoming more well-versed in technology can benefit this change in view. The result of this research could add to these factors but also benefit the overall staff team. Having pupils practice the informatics skills and techniques could benefit the lessons of other teachers.

#### *4.2.6 Informatics teachers*

This part of the staff is charged with teaching, supporting and encouraging the pupils that follow the informatics course, but also inspire pupils to incorporate informatics in their curriculum when moving to upper secondary school. Not only are these teachers responsible for explaining the various topics and concepts that are discussed within the subject, but they also need to present contemporary and inclusive views of the work field. By doing so it can encourage the pupils to see themselves within these fields. If not, it could inspire the pupils to recognize that they can implement their newfound skills and techniques anywhere (Nationaleberoepengids.nl, n.d.).

Increasing the number of pupils can bring difficulties due to a lack of personnel or facilities. However, it would allow the teacher to spread their knowledge and excitement about the subject to a wider audience. Not only do the pupils benefit from the teacher, but the teacher can also learn from their pupils. They will be presented with a larger variety of views on the taught material and receive a larger variety of questions from the pupils. These all contribute to a more well-versed teacher that can handle various situations within their teaching.

#### *4.2.7 Secondary school pupils*

The pupils are regarded as the main stakeholder of this research. They are the ones that need to be enthused about the informatics course as this will benefit them greatly within modern society. These pupils are young. Their interest levels vary greatly but also change rapidly. They come from a variety of backgrounds and cultures. At this young age, they also develop themselves at a rapid speed. Not only as they grow physically, but also as they develop themselves mentally. These pupils will, among other factors, help shape the way the informatics course is taught to them. This way they can learn the concepts in a way that is most suitable for them. As they realize the benefits of the subjects, they will be able to better influence the world around them using the learned skills and techniques.

By exploring how these children choose their subject, and how their enthusiasm about informatics can be increased, it is possible to influence this positively. By exposing them to the reality of what the course entails they can better form their opinion about it and realise how it can be valuable to them. The result of this research will hopefully show them this. Depending on the end-product and what form it will take, it will demand some of their time to explore the reality of the course.

#### *4.2.8 Parents or caregivers*

The caregivers of the pupils provide a supporting role. They are responsible, outside of secondary school, for the upbringing, social education and development of these pupils. Similar to the teachers they should be able to show their children what kind of possibilities the subject of informatics can bring. They need to set a good example. Not only to possibly encourage their children to choose the course but also to be able to understand and assist in the choosing process.

As their children might be in the process of making a decision, the parent might need to assist. Depending on the result of this research it could also demand some time from them. Furthermore, their children could become more well-versed in the aspects around informatics than them. On one hand, the children will then be able to teach their parents things about the subject, which is beneficial for the overall increase in digital literacy amongst the Dutch population. On the other hand, the parents might not be able to help their child with the informatics assignments or other questions the child might have related to the subject, maybe resulting in demotivation of the pupil.

### 4.3 User analysis

A user is someone who directly interacts with the envisioned product or service. Their actions influence the way the product or service is used. The product or service can also steer the actions of the user, nudging them towards the desired behaviour. The goals that the product or service aims to achieve need to be well incorporated within the user experience. User experience not only includes the interaction with the product or service, but also the attitudes of the user towards it, the ease of use and the efficiency of it. Within this research we identify two main

users: secondary school pupils and informatics teachers. In Appendix B a variety of user profiles can be found that summarise and illustrate these different kinds of users from the following analysis.

### *4.3.1 Secondary school pupils*

These children are the main user of the product or service. As mentioned in the stakeholder analysis these are the pupils that this research hopes to enthuse for the informatics subject, resulting in them choosing the course for their upper secondary school curriculum. The choice for informatics is made in lower secondary school (onderbouw in Dutch), which is the third year of secondary school. The research will only consider the pupils in upper secondary school to get a view on how they have made their choice to incorporate informatics in their curriculum. The age in the first three classes generally ranges from 11 to 15 years old.

These pupils have a large variety of interests, educational and cultural backgrounds, and additionally, their way of responding to teaching can be very different. The goal of the product or service is to enthuse these pupils for informatics. To do so the product or service needs to be very inclusive, approachable and not too formal. First of all, it should be fun to help create enthusiasm. By doing so it can accommodate and cater to the large variety of pupils. By making the product or service engaging can help actively involving the pupils.

### *4.3.2 Informatics teachers*

These are the people educating the pupils about the different aspects of the informatics course. They determine how they teach these pupils about the course, what sub-subjects will be incorporated within the curriculum and which of these sub-subjects are up to the pupils to decide. These teachers can, like the pupils, come from a variety of backgrounds. However, since the informatics subject has been around for a while, undergoing many iterations and changes at an attempt to fit modern times, the teachers can vary in level themselves as well. That might require them to learn new skills and techniques so that they can convey the current state of informatics correctly. Together with the shortage of teachers in this field this can lead to an increase in workload. Not being able to provide lessons for the pupils that are interested in the subject could pose a problem.

It would be very useful to incorporate their cooperation with the product or service. They know best how they teach their informatics course and are there the ones that can represent it best as ambassadors of their taught subject. As an added benefit, they know the concepts of informatics and are familiar with the skills and techniques. If these concepts, skills and techniques are incorporated in the product or service, they could assist in the conveyance of these concepts, skills and techniques.

## 4.4 Solution concepts

A solution that could solve the overall problem can be approached in different ways. The main goal of this solution is to get young secondary school pupils enthusiastic about the informatics course. Three main problems can be identified from the context analysis and the previous research. Firstly, informatics is elective and therefore not mandatory to be implemented in curricula. This leaves room for the pupil to omit the subject from their curriculum, even though it is regarded by the Dutch government as a subject that offers important skills. Secondly, there is an enormous shortage of teachers, which results in informatics being offered less. This lowers the number of schools offering informatics education, lowering the possibility for pupils to even

practice the subject. Lastly, the course and the attached work field is seen as too technical, which could lead to a negative perception of the informatics subject. As such, pupils might be discouraged to choose the subject. Additional problems like inclusivity and approachability of the course will be considered as well. The three main problems will be discussed and a concept solution for each will be presented.

### *4.4.1 Informatics is elective*

The easiest solution would be that the Dutch government makes informatics mandatory for every HAVO and VWO pupil going to upper secondary school. Or even incorporate informatics entirely throughout secondary school, and maybe even primary school. However, discussions about making informatics mandatory in upper secondary school have been going on for quite some time, compared to other European countries (Lepeltak, 2019). It seems difficult to find a suitable way of implementing informatics within all curricula. Most importantly, it does not solve the shortage of informatics teachers the Dutch educational system is facing. This shortage has been predicted to be a persisting problem for the near future as well (Ministerie van Onderwijs, Cultuur en Wetenschap, 2019).

Instead of making the whole informatics course mandatory, parts of it could be integrated within current curricula. These subjects should be those that are best approachable and that could be taught by non-informatics teachers as well, evading the teacher shortage problem while still discussing informatics topics. Examples of such topics are information searching, online communicating, ethics related to technology, data researching, problem decomposition, cybersecurity and privacy. These topics could be interwoven into other subjects. Some parts could even be implemented in the mentorship courses (mentoraat in Dutch) that help in guiding pupils through secondary school.

Another approach could be to only make parts of the informatics course mandatory. Similar to the courses in secondary school that are only mandatory for one year. Social studies (maatschappijleer in Dutch), natural sciences (algemene natuurwetenschappen in Dutch) and if still offered at school, information science (informatiekunde in Dutch) are examples of such courses. During that single year, the aim is to introduce the pupils to subjects that are valuable for their development or to increase their common knowledge. Informatics could take a similar approach, covering the very basics of topics like information searching, online communicating, ethics related to technology, problem decomposition, cybersecurity and privacy. This could help them get a feel and basic understanding of technology, enabling problem-solving in technology-rich environments. Creating a compilation of the topics and selecting them from the overall informatics curriculum can ensure that the topics are fitting and that the most important topics for young developing pupils are highlighted. By evaluating their approachability, it can be made sure that they are implementable by other teachers or instructors within their own taught course. Offering examples of current topics or discussions can act as a bridge from theory to practice.

However, all these suggested solutions all rely on decisions made or to be made by the Dutch government. As such, these lie outside of the scope of this graduation project, but the concept of making the implementation approachable will be considered for the final solution.

### *4.4.2 Teacher shortage*

This problem has already been discussed previously. Unfortunately, there is no immediate solution for this shortage. TeachforAmsterdam is trying to offer a partial solution to this matter. By inviting IT professionals to follow a part-time study-programme they hope to train them, resulting in more informatics teachers. This allows the professionals to still contribute to their current field of work and interest, but also develop the skills to be able to transmit this passion and knowledge to another generation through teaching (Hakker, 2019). This programme can be seen as an addition to the existing, full-time study, programmes geared towards educating new teachers.

However, there are already a variety of online tools available that can help pupils study informatics concepts and topics by themselves without the immediate feedback of a teacher. The variety of visual programming environments can make programming seem less daunting which is one of the more technical and difficult aspects covered in informatics. In a fun and playful way, the pupils can already discover the programming field. By doing so they already develop important skills like problem decomposition and program design. Covering the more abstract topics in informatics, like ethics and cybersecurity, could be difficult for the pupils to practice on their own as it can require discussion for further discovery on the topic.

Having the pupils practice informatics and informatics concepts could be a way to solve the teacher shortage. But what would make the pupils study and practice this on their own? A teacher or instructor is necessary to motivate the pupils, give them immediate feedback to promote their learning and aid in the learning process prescribed by the course. Their parents will not be able to stand in for a teacher for example. It would be difficult for an at-home application or course to take the place of a teacher without guidance from the school.

### *4.4.3 The image that informatics seems too technical*

The presumption that informatics is too technical is present within multiple facets of society. That could be because the computer science field of study and work can be very technical, and the image of the informatics subject might be associated with computer science. Therefore informatics must be so as well. However, informatics is a very broad subject, with technical aspects incorporated, but is also taught on a significantly simpler level than what would be experienced within the computer science fields of study and work. Informatics also focusses more on the practical aspects whereas computer science is more theory-based.

Not only do the pupils see it that way, it is also presented to them that way. Parents, teachers, educational staff and other adults might not have a clear idea of what informatics offers either. Therefore easily labelling it as too technical because that is what they have heard or what they believe informatics to be. Some subjects within the informatics curriculum are more on the technical side, that is true. Programming and algorithms, for example, dive deeper into the technical aspect of technology. Informatics, however, is not as technical or out of reach as one might think. It also offers a large variety of ethical questions or matters that deal with societal impact. It should be accessible for everyone as it trains important skills that are necessary for 21$^{st}$-century society.

As information provision or presentation on what informatics is can vary per school, the pupils might not receive an accurate view of what the subject entails. There might not be well-structured information in place that highlights the different facets of informatics. By breaking

down the topics and learning goals, presenting them in an accessible way, this presumption can be lifted. This could be done in an informative session, explaining what informatics is about. Making this information session accessible outside of schools can benefit the view of the parents and even the public as well. It will at least inform them about the contents of the subject.

Another way is by introducing an introductory lesson that shows what can be done with informatics concepts and showing that the difficult concepts can be learned by anyone in small steps. By doing so it serves as an introduction to the subject as the theory is shown in a practical application. Adding this interaction further exposes the pupils to what the subject looks and feels like. They can more effectively form a vision of what it could mean for them. Interaction by introductory lessons also enables immediate feedback, which can strengthen motivation.

### 4.5 Conclusions

The Dutch government has selected skills that they find essential in the 21st-century that aim to increase digital literacy, to increase general technology knowledge. These skills are currently slowly incorporated within Dutch education. However, the Netherlands is quite slow in incorporating these skills in the form of computer science or informatics related education. Informatics is already taught at several schools, but this amount would need to be increased to. The information provision of informatics does not seem to be streamlined across secondary schools. Not only are there stakeholders in the educational sector, but also the work sector that could benefit from this. There are three main problems identifiable: the informatics course is not mandatory, there is an enormous shortage of informatics teachers and informatics is seen as a very technical subject, therefor not appealing to a greater audience than it could. Only this last problem lies within the scope of this graduation project and will be further explored.

# Chapter 5 – Specification

In this chapter, the possibilities for a method to increase informatics enthusiasm will be specified. First looking at the literature, previous research and the ideation several requirements will be defined which a solution will try to meet. By doing so the goals of a solution are made explicit. Relevant here is that not only the functional workings of the solution are addressed, but also the intended user experience. The requirements will be further specified according to the conducted survey. The final solution will be part of the already existing information provision in place by the school and informatics teacher. As such from here on out the final solution will be referred to as the *informative session*, as it will take form as an additional session to the information provision already in place as those can differ between schools as became apparent in the context analysis. Having a functional, interesting and encompassing information provision can positively influence the pupils to choose informatics.

## 5.1 Requirements

From the ideation phase, it seems to be clear that the third concept idea about changing the image of informatics is the most realistic within the scope of this graduation project. The other problems to be tackled, making informatics mandatory and solving the teacher shortage are not solvable through this graduation project as they lie out of reach. However, parts of those problems will be considered. When looking back at the literature research, current developments, stakeholder and user analyses and the ideation, several requirements can be identified and grouped. These requirements will be elaborated on below to help shape the specifications that the informative session must meet. Some of these specifications will come forward more prominently than others within the session, depending on the outcome.

### *5.1.1. Changing the technical image of informatics*

#### 5.1.1.1. Inclusivity

When using the term inclusivity, it is meant that informatics should be for everyone regardless of gender, background, skill-level etc. As stated in the State-of-the-Art chapter of this report there seem to be strong beliefs that gender-stereotypes but also academic-stereotypes are at play. Due to these stereotypes they might believe that the subject does not fit them. Portraying an inclusive and diverse image of informatics the pupils should at least not be discouraged by any stereotype.

The gender-stereotype does not need to be approached as careful within this research as one might think. The goal is not to make informatics also interesting specifically for girls, putting the focus on them. Rather, informatics needs to be presented as interesting for every gender. It needs to be presented in a gender-neutral way. Making sure that the pupils can have a taste of the informatics experience that fits them is important. There needs to be enough freedom for them to envision the possibilities informatics can have for them as an individual, regardless of their gender.

Academic stereotypes seem to be more prevalent in the image of the work field that informatics can be associated with. Computer Science related professions, for example, are often seen as very technical and the survey confirms some of these beliefs. It may be the case that the current workforce within such fields is predominantly male and indeed it can be very technical (Centraal Bureau voor de Statistiek, 2019; Eurostat, 2019; National Girls Collaborative Project, n.d.). Informatics, however, is not yet on that level of technicality. Pupils

can also learn a lot about computers, networks and online safety in a more general sense without going too technical. That is the goal of informatics. Presenting the various aspects and possibilities within the informatics curriculum can hopefully ensure that the pupils realise that there are more facets to informatics than just the technical ones. While informatics does not need to be all that technical compared to the work fields it is associated with, it can be a first start to pique the interest of the pupils for those work field, but it certainly does not have to be.

#### 5.1.1.2. Accessibility

Accessibility in this sense is not only the physical or digital accessibility of the informative session but also the fact that it needs to be easily understandable. The pupils that are about to decide to include informatics are rather young and can be rather unexperienced with the concepts. For the pupils, it needs to be a low enough level, while remaining challenging and entertaining, as their first introduction to the subject. It also needs to be relatable to them, being close to what they would use technology for, for example. By making the session relatable and therefor accessible to each pupil it strengthens the idea that informatics is indeed and can be important for them.

The other side of accessibility stems from the informatics teacher shortage. The informative sessions could be given during other class hours like the mentorship course or partially as an at-home assignment. This would be to relieve the amount of time taken up from the informatics teacher. Therefore it must be accessible for other teachers or parents to implement and practice with the pupil.

### *5.1.2. Pupil motivation*

#### 5.1.2.1. Gamification

Working on a self-made game by students can create a passion to want to do more (Rajaravivarma, 2005). Gamification can, aid in motivating the pupils to learn and interact with the introductory informatics concepts presented. These concepts can be quite new to some pupils, so it is important that they would want to challenge themselves. By implementing game elements, it could help motivate to participate in this informative session.

#### 5.1.2.2. Personalization

By personalizing curricula, motivation can be invoked. SLO says that the informatics subject needs to be personalized in the additional topics to be chosen by the pupils. This can help informatics appeal to a wider audience (Stichting Leerplan Ontwikkeling, n.d.). The informative session would benefit from presenting some of these personalization aspects. If the pupil can personalize the session to where it would be most relatable to them and their situation it can help them see how informatics could relate to them. Personalization can help them realise how they could use informatics to benefit them and their interests. Different categories of informatics, like gaming or social media, for example, can be introduced in the informative session to cater to the different interests the pupils might have.

#### 5.1.2.3. Performance evaluation

By giving the pupils feedback on their performance it can further increase their motivation. It can also partially show them how their informatics course would be taught. However, this performance evaluation is somewhat dependent on the knowledge on the informatics subject of the teacher or parent assisting the informative session. Immediate feedback would be ideal to

increase this motivation (Mannila et al., 2006; Powers et al., 2006; Skinner, 1969). Ideally, this would be done by the informatics teacher themselves.

### *5.1.3. Effective teaching methods for computer science and programming education*

#### 5.1.3.1. Gamification

Gamification has been proven to increase the motivation for and effectiveness of learning (Kiryakova et al., 2014). It can be used to introduce the pupils to the informatics subjects in a fun and interactive way. By doing so attention for the information provided about informatics will hopefully be remembered better compared to when the information would be presented to them in a more formal way like a booklet or presentation. This can hopefully lead to a positive attitude towards the subject.

#### 5.1.3.2. Reduce complexity

As one of the more technical aspects of informatics revolves around programming it should be incorporated a simple and easily understandable manner within the informative session. If a form of programming or the concept of it were to be implemented it should be explaining the basics of what programming is. Possibly explaining the different styles of programming environments much like the environments explored in the State-of-the-Art chapter. Core concepts of visual programming, like combining blocks to perform an action, for example, can be built upon and used for the informative session. The information session should not be too complex in general as it might discourage the pupils. It does however still need to be representable of the informatics course.

#### 5.1.3.3. Performance evaluation

Performance evaluation in the form of immediate feedback not only increases pupil motivation, but it is also a good way to increase learning. By giving feedback and explaining any difficult parts of the informative session it can give a feeling of what informatics as a subject can be like. The performance of the pupil can also be evaluated by their classmates. Discussions could arise about their answers and these discussions can be talked about with the whole class. That way, different viewpoints on certain problems or aspects of informatics can be brought to light. Learning from their fellow pupils and the teamwork by doing so can help in the learning process in secondary school.

#### 5.1.3.4. Top-down learning approach

Top-down learning can be defined as learning by practice (Tindle, 2018). By immersing the pupil in the context of informatics they can experience the subject from their current perspective. This does not require the pupil to know the informatics theory that would be taught in the subject, but rather let the pupil think for themselves and let them draw conclusions from what they know already. By adding just a few pieces of information or teaching them very basic principles, they should be able to piece together the information. This ties in even further that the informative session needs to be relatable to them personally.

With just a few pieces of information, together with their knowledge about the concepts, they could break down some abstract concepts, like the internet for example. Or get a basic grasp of how it is supposed to work. This further strengthens that informatics does not need to be a technical and complex subject and can be tackled by anyone.

### *5.1.4. External requirements*

#### 5.1.4.1. Teacher shortage

As mentioned before, this is not a problem solvable within the scope of this research. However, it needs to be considered, nonetheless. An increase in interest for the subject will put more strain on the informatics teacher present at the school. Potential solutions for this are covered in point 5.1.1.2.

#### 5.1.4.2. Time

The informative session would ideally be implemented during one of the class hours or during the time allocated for informatics information provision. If the informative session is implemented during a class hour it needs to be usable within one or a maximum of two class hours. This would mean that it would take between 30 and 60 minutes. This number is an estimate and based on the fact that Dutch class hours are usually 50 minutes long. Some of that time is deducted to fit the ways the secondary schools handle their class hours, like walking time for example. Explanation time and other factors that distract the class are also considered in this estimated time.

#### 5.1.4.3. Addition to current information provision

The interactive informative session must be implementable as an addition to the information provision that is already in place by the teacher or school. The informatics teacher working at the secondary school needs to have some part in the informative session, that is required. They need to explain the way their course is taught, what subjects are being covered and what the pupils can expect from their course. They are the main responsibles for the course, so some information provision needs to be done by them. However, the informative session can be an extension of the information provided by the teacher.

#### 5.1.4.4. Independence

As defined in some of the previous requirement, the informative session needs to be able to stand alone. It needs to be executable separately from the specific educational content taught by the teacher within their informatics course. It also needs to be able to be implementable or practicable outside of school if necessary.

## 5.2 User-group exploratory surveys

Two different surveys were conducted to find out if the views on informatics found in literature, and the view expected by this research, match that of the actual two main stakeholders, the user groups discussed within the ideation chapter of this report, secondary school pupils and informatics teachers. The conducted surveys can be found in Appendix C. These surveys were spread around through the I&I newsletter, mainly to generate responses for the teacher survey (I&I, 2020a). To reach secondary school pupils contact was made with informatics teachers through email, social media and professional contacts, asking them to spread the survey around at their secondary school. Informatics teachers were asked specifically because the survey needed to be spread amongst pupils that attend a secondary school where informatics is taught. That way their views on the subject can be measured. The analysing process, as well as the most important results from each respective survey, will be discussed.

### *5.3.1 Analysing process*

The surveys were conducted through Google Forms, a free online survey tool offered by Google. Once the surveys did not generate any new responses, which was around three weeks

after they were spread around, a copy of the responses was made. That way the original responses would still be available in case were something to go wrong with the further response processing. The copied results were processed for analysis. As the surveys were conducted in Dutch to match the native language of the user group the survey in Appendix C is also Dutch. There could be slight discrepancies while translating the results to present in this report. These discrepancies should only be minor and will not change the results in meaningful ways.

The first step in the analysing process is removing the null responses, the responses that do not provide meaningful data. Test responses left blank or with randomly answers were deleted. These responses were most likely used by potential users to see what the questionnaire looks like. Responses that did not agree with the terms and privacy measures of the survey were also not considered, as those do not generate a meaningful response.

The results were analysed in sections similar to how the surveys were structured. For example, the pupil survey is structured in three different sections: the pupils that have chosen informatics, the pupils that have not chosen informatics and the pupils that still need to make a choice. These different options led to different, yet similar sections in the questions that followed. The different section asked different information that was desired from that particular sub-group. These sections will be analysed in a similar method as to how the surveys are structured.

### *5.3.2 Results pupil survey*

The survey has been spread around amongst secondary school pupils with a total of 62 responses to see how a variety of these pupils are motivated for informatics, how they regard the subject and how they experience informatics and its information provision within their school environment. This survey was divided into three distinct groups of pupils that were according to their relation with informatics. These groups were divided if the pupil had chosen informatics, had not chosen informatics, or still had to choose the subject.

#### 5.3.2.1 General questions

After filtering the total of 62 responses, 55 meaningful responses were left. Of these responses, 32 of the pupils were boys, with an average age of 15 years old. This group of boys was split about 40% over the HAVO and 60% over the VWO study level. There were 22 girls, also with an average age of 15 years old. This group of girls was also split about 40% over the HAVO and 60% over the VWO study level. One response would rather not disclose their gender and was also 15 years old. This division can also be seen in Figure 7.

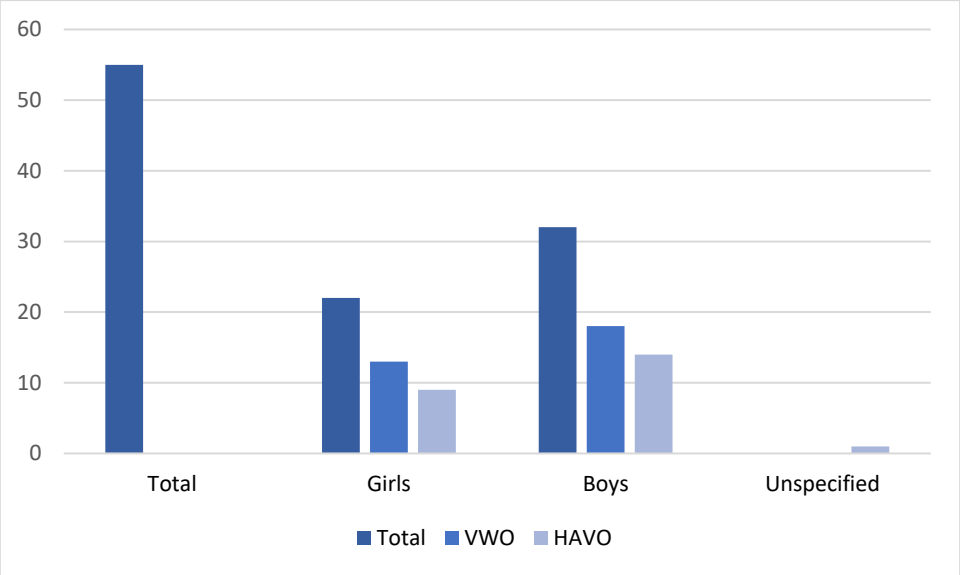


*Figure 7 Pupil gender and study level distribution*

Almost all of these pupils say that they spend a lot of time on social media. Additionally, most pupils say that they also spend a lot of time on the computer in general and that they like to spend their time gaming. Two pupils said that they do not interact with technology much. Surprisingly, one of them did choose informatics, while the other did not.

The largest group of pupils, 80%, was in their fourth year of secondary school. Other respondents came from the first, third, fifth and sixth years of secondary school. The respondent from the first year of secondary school seems out of place, but this respondent still must make the decision for informatics, so it makes sense. These pupils are spread out over 6 different schools, the spread of these pupils can be seen in Figure 8.

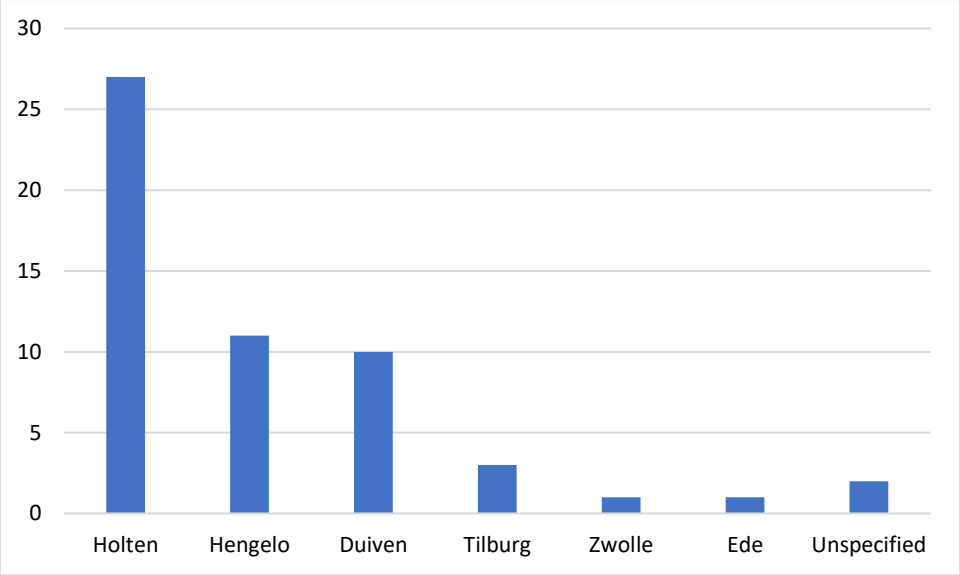


*Figure 8 Pupil distribution amongst school locations in the Netherlands*

How the pupils view informatics has an interesting division and can be seen in Figure 9. Most of the pupils, 47,3% see informatics as a subject fit for people that find computers interesting. The second largest part, 36,4% sees informatics as a technical subject. Both groups

recognise view informatics as a more technical oriented subject. This confirms the theory that informatics is indeed viewed as a technical subject of study. More interestingly, 10,9% of the pupils do view informatics as a subject fit for everybody. That is ultimately the desired view that is aimed to be represented through this graduation project.

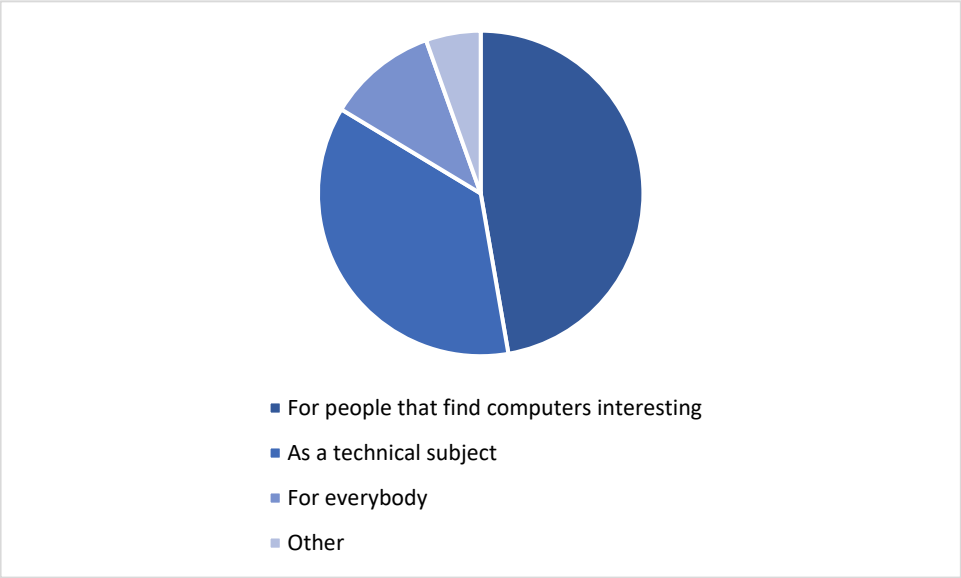


*Figure 9 Pupil view of the informatics subject*

When asked the question of how informatics could be useful for them, various answers were given. The largest amount of answers, about a third of the responses, related to the fact that informatics provides a deeper understanding of computers in general. This is seen as important by the pupils, especially in our modern society. The second-largest amount of responses, also about a third of the responses, relate to the future of the pupil in some way. This was described related to more possibilities for a job, potential study or their future in general. For their job, some say that it does not even have to be an ICT focussed job, but that informatics could prove useful in any kind of job. The third-largest amount of answers, about a fifth of the responses, relate to increasing the understanding of programming, coding and programs used by the pupils. Other responses related that informatics could provide a good basis for a variety of skills. A few of the pupils even said that they could imagine that informatics can help practice creativity. Creativity in the sense of creating original programs or code, but also creativity in finding solutions for problems. Interestingly, the pupils that view informatics as a subject for everybody did not present different expectations of the subject. They mainly saw informatics as a good way to learn about computers as well.

To conclude on the variety of pupils that filled in the survey. On average the group of respondents represent a 15-year-old pupil in their fourth year of secondary school. There is a good mix between boys and girls and a balance between both study levels. There is enough spread amongst different secondary schools. Therefore, there is enough variety in the views of informatics, as different schools can present a different way of informatics education.

The following sections will discuss each of the different sections of the survey. As can be seen in Figure 10 there was adequate variety in the division between pupils that have and have not chosen informatics. Out of the 55 meaningful responses, 76,4% did choose informatics. About 21,8% of the pupils did not choose informatics. Unfortunately, there was

only one respondent, so 1,8% that still must decide to incorporate the subject or not. Having more of this kind of respondents would have possibly given more insight on what that group would like to see concerning informatics information provision.

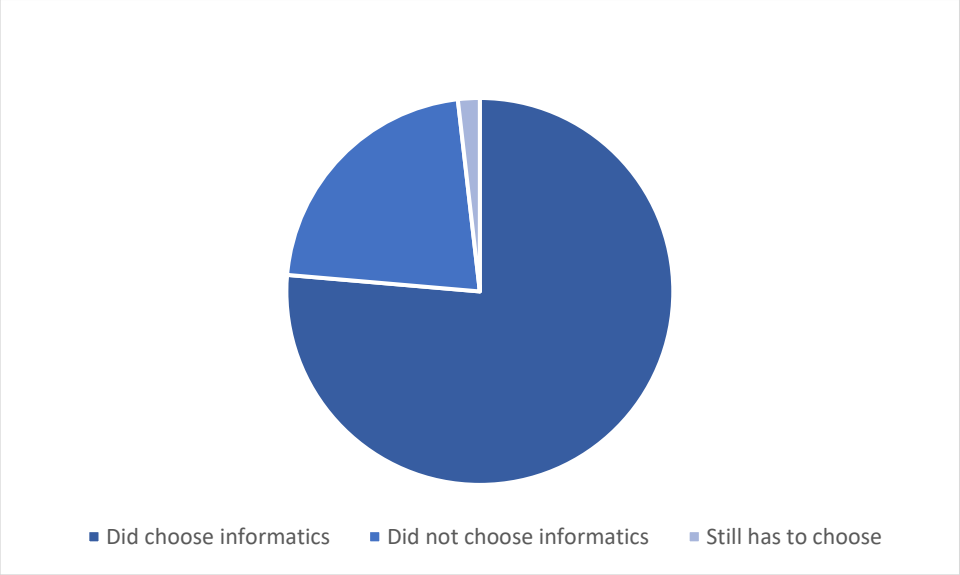


*Figure 10 Inclusion of informatics within pupil curricula*

#### 5.3.2.2 Informatics has been chosen

Out of all the 55 meaningful responses, 42 had chosen informatics within their curriculum. Four of these respondents indicated that their school does not provide any information about the informatics subject. Informatics information provision is lacking. The schools of the remaining 38 respondents do provide this information.

The most prominent kind of information that is provided through the schools that do offer it is with a planned information provision moment. A presentation given by the teacher for example. The vast majority of responses had this as their main source of information about informatics. Additionally, some schools offered the option to join a practice lesson or provided the pupils with informative material to review at home. Giving out information in one form or the other proves to be appreciated. About two-thirds of the respondents expressed that they found this information useful for their choice. Almost all these responses expressed that the information provided by the school gave them a better idea of what the subject would entail. They got more information about the subject itself, but also how the exercises, classes and the way of learning would be structured. It also showed them that there are various ways to approach the subject by combining theory and practice through different projects and working on the level that is most suited for the individual. One of the responses stood out saying: “You get a better image of what the subject is about other than the presumptions you already have about it”. Combating these presumptions is one of the bigger requirements within this graduation project. The other third expressed that this information was not useful to them. This was due to not providing enough information. Not presenting a clear and accurate image of what the pupil could expect from the subject and what they will learn and practice within it was lacking as well. “Little new information, only presenting what we as pupils already expected to learn about: computers” says one of the respondents.

Having this information provision helped the pupils solidify their choice for the subject. They were already contemplating choosing the subject, but just needed a clearer image of its contents. The information provision by the school was for some the decisive moment. Others mentioned that after having received the information, attending a practice lesson and discussing it with friends, family and teachers it solidified their choice even more. This shows that providing accurate information can help shape the image these pupils have of the course, helping them decide if it is right for them or not. On average, the pupils felt like they knew enough about the subject before making their choice. An average score of 3,3 out of 5 was given on their confidence in knowing enough about the subject before making the decision.

The reasons why these pupils have incorporated the informatics subject within the curriculum mostly lie in line with the expectations they have of the subject. Most of them think that it would be interesting to learn about computers and programming. A few of these people also think the subject would be fun. Some say that they think it would be useful later on, for their study, job or just in general. Some chose the subject because they did not like the other options they had for their elective course.

In Figure 11 a division of what these pupils like and dislike about the subject can be seen. They had the option to give multiple answers. As can be seen, programming is seen as the aspect that is most fun about informatics. Learning about computers is second and learning how the internet works is third in what the pupils like most about the subject. When looking at the dislikes the teacher and the way of teaching is disliked the most. Learning about how computers work is tied with learning about how social media work as the second most disliked aspect.

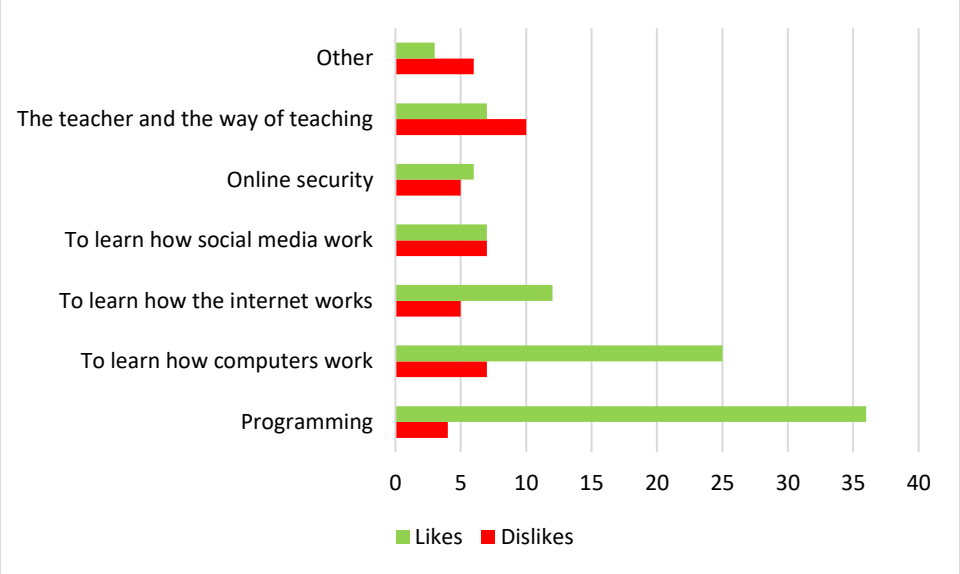


*Figure 11 Pupil likes and dislikes within informatics that did choose the subject*

To conclude this section of the survey: pupils that chose informatics found that the information provision from their school was sufficient and helpful. By a teacher giving a presentation about what the subject entails the pupils imagined that they would mainly be learning about computers and programming. However, the presentation of a clear and inclusive image of informatics can still be improved.

#### 5.3.2.3 Informatics has not been chosen

Out of all the 55 meaningful responses, 12 had not chosen informatics within their curriculum. All these respondents indicated that their school does provide information about the informatics subject.

The most prominent kind of information that is provided through the school is also with a planned information provision moment for these pupils. Most responses had this as their main source of information about informatics. Additionally, some schools offered the option to join a practice lesson or provided the pupils with informative material to review at home.

Giving out information in one form or the other proves to be appreciated by some of these pupils. About half of the respondents expressed that they found this information useful for their choice because this gave them a better idea of what the subject would entail and what they could expect from is. About one-third of the respondents did not find the information provision useful. They felt like it did not give them a clear image of the subject. One pupil even said that the lack of info provided made it hard to make the decision. One response said: “It was presented in a boring way, hardly any effort was put into making it sound appealing or interesting”. Making sure that, even though the subject might not be chosen by the pupil, the presentation of the subject is interesting is important. That way it can be ensured that the pupil can make an informed choice.

Having this information provision helped the pupils solidify their choice for the subject. By either participating in a practice lesson, talking with friends that already chose the subject and family who do something in a similar feel helped them make the decision. Ultimately, most pupils expressed that the subject did not pique their interest, that they see it as a fit for them or that they would rather do something else. On average, the pupils felt like they knew enough about the subject before making their choice, but just barely. An average score of 2,9 out of 5 was given on their confidence in knowing enough about the subject before making the decision. Speculation about the low score could be due to their early disinterest in the subject, making them not seek more information about the subject.

Even though they did not choose the subject, they still expressed there were aspects that they liked and disliked about the subject. A division of this can be seen in Figure 12. They had the option to give multiple answers. As can be seen, learning about the workings of social media is seen as the aspect that interests them the most about informatics. Learning about how computers work is second. When looking at the dislikes, learning about programming and how the internet works are tied for the most disliked aspect.

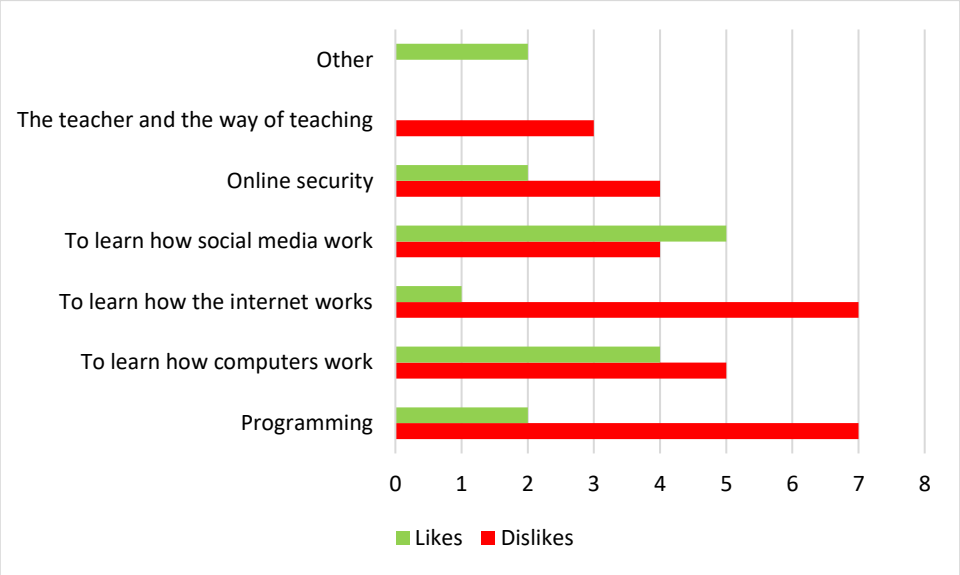


*Figure 12 Pupil likes and dislikes within informatics that did not choose the subject*

To conclude this section of the survey: pupils that did not choose chose informatics found that the information provision from their school was sufficient and helpful for their choice but could be improved. Some pupils could still not form a clear image of the subject and what it entails. Social media and the inner workings of the computer seems like the aspects that these pupils would have found most interesting about the subject, despite not choosing it. Showing them the fun sides of informatics could potentially motivate them enough to choose the subject. However, informatics does not need to be liked by everyone. To some people, it is just not in line with their interests and that cannot be forced.

#### 5.3.2.4 The choice still needs to be made

Out of all the 55 meaningful responses, only one still has to make the decision to incorporate informatics within their curriculum or not. The school of this pupil does provide information about the subject. This is done through information provided by a teacher. Although the choice does not yet need to be made, this pupil feels like they know enough about the subject. They give a score of 3 out of 5 on their confidence in knowing enough about the subject before making the decision.

What they think is most interesting would be programming. Learning about how the internet works seems less interesting. To convince this pupil to choose informatics would be to solidify the enthusiasm for programming, but also to show how learning about the workings of the internet can still be interesting.

#### 5.3.2.5 Informatics improvements

The pupils had to indicate what they already appreciated about the informatics subject. Not only on the subject itself, but also on the way that it is taught at their school. A lot of different answers were given, but most revolved around the same sort of answer.

A lot of pupils mentioned that informatics is a good subject because you do not learn about only one aspect of informatics, but various parts are covered. Within these different parts they also get the freedom in what kind of program or website you are allowed to create. At a young age knowledge about computers and how computers think and operate is also something

that the pupils found important. People learn to better understand the technology they are using, and they see this as especially important regarding online security. Learning about technology and programming specifically can also help later on in their studies or jobs. As there is a shortage of ICT trained professionals this can be beneficial.

Most of the pupils also mention that they really like the way of teaching. The teacher makes them think about the answer without giving too many clues. That way they have to Figure it out for themselves. Clear explanations and making sure everybody can participate in the class with their questions and their answers is important. Encouraging individual progress by checking their homework and having the pupils work in teams encourages motivation and productivity.

Some improvements that could be made however are mostly concerning the teaching material or the way of teaching. As for most of the pupils, the theory is rather new. Slowing down on some of the topics could benefit the pupils. Spreading the theory over a longer period of time and repeating difficult topics can help the pupils understand is better. Repetition can ensure that the pupils do understand the material properly. Customizing the assignments to better fit each pupil, although may be difficult to execute in practice, could help some they say. Some of the teaching material could explain more of the theory and delve deeper into some topics, but also the practice so that it is understandable for everyone. Explaining more why code does or does not work is also desired. However, part of knowing why your code does not work, where the problem lies and how this can be resolved is all part of the programming process which needs to be learned.

The pupils would also like to see more practical applications of the subject. Not only would they like to see more of the theory explained with examples, but they would also like to see the practical applications of informatics in real life. Explaining how informatics could benefit them in the future or visiting a company that shows them how they put informatics into practice would be interesting, according to some of the responses. This could also encourage the feeling that informatics is for everyone and “not only for nerds” is what one of the respondents said. Covering topics that apply to almost everyone, like social media for examples, could also help eliminate this stereotype and make the subject more accessible to a wider variety of pupils.

### *5.2.3 Results teacher survey*

Informatics teachers, on the other hand, are mainly asked about how they bring the subject to the attention of the pupils within their school. Unfortunately, only 4 teachers filled in the survey, therefore these results cannot be considered significant and cannot serve as a generalisation of the user group. Nevertheless, will the results be presented and some conclusions will be drawn from them.

#### 5.2.3.1 General questions

As mentioned, four informatics teachers with full qualifications filled in this survey, three of which were male, and one was female. Their average age is 53 years old. They have been teaching informatics for several years. One has been teaching between four and five years while the other three have been teaching for over five years. All the teachers teach both the HAVO as well as the VWO level and state that, on average, their pupils have a 6,25 rating out of 10 in

terms of prior familiarity with technology. On average these pupils also have a rating of 4 out of 10 when it comes to familiarity with the informatics subject when they start.

Interestingly, two of the teachers use fully self-developed teaching material to teach their subject, while the other two use a combination of self-developed and existing material provided by a publisher. The main criteria for also implementing self-developed material is to make sure it appeals to the pupils. That way it applies better to the pupils and gets them more actively working with the material. A variety of programming languages is used to practice this material, of which HTML, Python and PHP are the top three.

Only one of the three teachers admits that they do not see informatics as a technical subject. However, they do present it as a beta subject that can apply to all different study tracks that the pupils can choose within their secondary school career. This feeling of inclusivity, that it can apply to anyone, is confirmed by one of the other teachers as well. The other two teachers see informatics as a subject that is interesting for people that are curious about computers. While those opinions differ slightly, all of them do state that they find informatics indispensable for the future of the pupils, within society and later for their profession. However, the subject needs to be appealing to the students that choose is, as not all pupils are interested in it, says one of the teachers.

Two of the four teachers confirm that the main limitation of offering the informatics subject is the teacher shortage. These two teachers are both the only informatics teachers at their school. One of the other teachers mentions that they only offer informatics in the more technical oriented study tracks the pupils can follow. This is due to teacher shortage as they are the only teacher at their school.

One of the schools offers the pupils with a mandatory practice lesson in informatics. This is to help the pupils make the decision for informatics. According to two of the responses, incorporating some experience with the informatics classes, be it within lower secondary school or by following some classes, would be beneficial for the choosing process of the pupils. The main factors that help the pupils make their choice are the image of the subject, experiences from older pupils and the information provision provided by the school.

#### 5.2.3.2 Informatics information provision is offered

Three out of the four schools do offer information provision to its pupils, where at two of these schools following the information provision is mandatory. All three schools offer information through a presentation for example. Furthermore, two of the schools offer the option of attending practice lessons. That way pupils can see what the subject is like. The other school provides additional information on a more personalised basis through personal meetings.

All three teachers try to present the actual image of what informatics entails. One teacher explicitly mentions that they try to find out what stereotypes or prejudices the pupils might have and present the actuality of the subject and how it is taught at their school.

The totality of the information provision does help the pupils make an informed choice whether they would like to include informatics into their curriculum, according to these three teachers. This is because the pupils have a more general, one-sided view of the topic, which is more technical. “They do not realise what the subject can entail” says one of the teachers.

The teachers give the influence of informatics information provision when considering the choice of the pupil, a score of 4 out of 5. This means that the teachers think that providing the pupils with accurate information, that fits the situation at their school, helps them decide whether the pupil wants to include informatics in their curriculum or not.

#### 5.2.3.3 Informatics information provision is not offered

The school that only offers informatics within the more technical oriented tracks of upper secondary school only has one informatics teacher. Because they are the only one, this teacher is not able to easily offer information provision of the subject to the pupils of their school. However, they would be interested in providing this information. They also think that it could maybe help the pupils in making an informed choice about whether the informatics subject is for them.

#### 5.2.3.4 Pupil interest and motivation

To get an indication of how the teachers experience the appeal of the subject for their students, questions about the interest and motivation of pupils were asked. The term interest is interpreted as the level of interest pupils show in the subject and how enthralling they find it to be. The term motivation is interpreted as how much the pupils like to work on the subject and tackle its different aspects. On interest, the teachers gave an average rating of 7,25 out of 10. On motivation, the teachers gave an average rating of 6,75. This low score in motivation, according to the teachers, is because of various external factors that are not related to the informatics subject necessarily. One teacher, however, says that the pupils do not realise the benefits of the subject.

When discussing motivation, the teachers were asked if they saw a difference in the motivation when it comes to the gender of the pupil. Two of the teachers says that gender does not make a difference for motivation, the other two say that boys are more motivated for the subject. The teachers mentioned that overall, it depends on the different subjects within the course and that gender is not necessarily the sole cause for the lack of motivation. However, they also mention that girls might have the feeling that they are unable to do informatics, while some girls are very interested in the subject. This feeling of being incapable regarding informatics makes a dent in their motivation.

Overall, there seems to be no large difference between study levels. HAVO pupils seem to need more positive encouragement and successes regularly during more concrete tasks they need to perform. VWO seems to be more theoretically interested in the subject whereas HAVO seems to be less so. Incorporating a lot of practical assignments seems beneficial for both study levels in making the subject more interesting to them.

#### 5.2.3.5 Informatics improvements

The main improvement that the teachers mention is that the quality of teaching methods for informatics is insufficient. The teaching material always seems to be behind on the actuality. The reason for this could be that computer-related subjects are still rapidly changing, so this is understandable. However, an effort to incorporate subjects that better fit present times and are up to modern standards are desired, according to the teachers. They would also like to see a more diverse array of topics being covered like music and programming, programming of drones and exploring business life in an informatics context.

To make it more interesting for girls specifically, they suggest incorporating more practical assignments within the curriculum. To add to the wider array of topics mentioned above, more focus could also be spent on design-related applications of informatics. Making an ICT-module mandatory within lower secondary school could also help to pique the interest of girls, says one of the teachers. By familiarising them earlier with the subject interest might be invoked earlier on.

### 5.3 Conclusions

To conclude the specifications chapter of this report, the survey results confirmed most of the expectations and predictions previously mentioned. The informative session envisioned as the final result of this graduation project needs to present an inclusive environment that allows everybody to get introduced to the practice of informatics. It needs to defy the image that informatics is just a technical subject and that it is only for people who have an interest in computers as was confirmed from the pupil survey. One out of the four teachers mentioned to already try to do this within their information provision. Clarifying what the subject is about can help solidify their choice for the subject as mentioned in the survey results. To do so, different possibilities that informatics can offer each pupil need to be presented. By presenting practical applications and examples, which was desired by several pupils, this can be done further. Their motivation for the course can be increased by presenting the session in the form of a game that can match the interest of individual pupils. Teaching requirements that apply to the informatics course itself also apply here. If the informative session can be implemented by the informatics teacher, that would be an added benefit as a lot of pupils like the way of teaching from their informatics teacher. It needs to be simple enough to understand quickly, yet still cover some of the concepts of informatics. This can be done using a top-down learning approach enabling the students to break down bigger, more technical problems, into parts that are more easily understandable. Lastly, external requirements are to be considered, the duration of a class as a time constraint especially.

# Chapter 6 – Realisation

Within this realisation phase, the ideation and specification chapters are combined with brainstorming to come up, create and realise the informative session. This envisioned session aims to aid in the choice for informatics, providing a clearer view of the informatics subject and its various topics to the pupils and motivating them for its concepts. As Dutch is the native language, the final product for the informative session will be in Dutch. However, the contents of the session that will be discussed in the following chapters will be presented in English.

## 6.1 Forefront requirements

Each of the requirements from chapter 5 presents important factors the solution must try to meet. From these, the most important ones are selected that will be at the forefront of the informative session.

Inclusivity is very important. Inclusivity allows to present and include a wider audience within the field of informatics and technology. Rather than gearing the informative session to a specific group of pupils, whether it be interest, background, gender etc. it is kept very general. By making the session general it allows each pupil to be able to relate themselves to the informative session or to be able to find the aspects of informatics they are most interested in. This feeling of relatability can increase the motivation of the pupil. Including a variety of topics of informatics can make sure this is reached.

Further increase in motivation is helped by gamification. The informative session will be a game with a more top-down approach. As this session is supposed to be fun, the game will be focussed around the pupils playing and interacting with each other. That way, they can also learn from each other and share other insights they might have about the subject.

Showing the pupils that seemingly difficult informatics concepts can be broken down in smaller, more understandable parts is important. It shows that although informatics can seem very technical and daunting, it does not have to be. Everyone can learn about informatics and there are various aspects to it. Making the informatics simple and more approachable at the start can facilitate easier understanding.

In the end, it needs to be implementable realistically within school hours, ideally within one 30-minute session. That is a short timeframe, but as it is the goal to only present an introduction of topics covered in informatics, a short time frame should be possible. The informative session should not try to explain how the informatics course is built up or how it is taught, as that can vary between schools and is up to them to explain. Therefore, it needs to be independently implementable as an addition to already existing information provision. Only relating to informatics by covering, for the pupils relatable, topics and teaching them the very basics of those concepts.

## 6.2 Brainstorming

By combining the initial ideation concept and the forefront requirements a few options will be discussed an evaluate. By keeping the user profiles in mind, a situation of how the end-users will use the informative session. Through this design process, the best option for the informative session is to be found.

### *6.2.1 Game brainstorming*


*Figure 13 Game of the goose*

Game of the goose (Ganzenbord in Dutch), seen in Figure 13[6], is a game that lets the player walk along a path until they reach the end. Most pupils are already familiar with the rules of this simple. Depending on which square they land on they must execute different tasks. These tasks could relate to different informatics topics, making the pupil explain a certain concept to the other players, giving the pupil more information or having them make a small exercise for example. The game and its gameboard could take up a specific theme. For example, the whole game could take the player on a journey through the web. An example of such already exists, but relates mostly to being offline (Nationale Academie voor Media & Maatschappij, n.d.). Making the whole board according to a theme would limit the variety of topics covered. This being only an introductory session would need to show the pupils the larger variety of topics that can be covered within informatics.

*Figure 14 Ludo game*

Ludo (Mens-erger-je-niet in Dutch), seen in Figure 14[7], is a game known by many and is similar to game of the goose in the sense that it lets the player walk along a path until they reach the end. This needs to be repeated multiple times until all of their pawns are parked in their colour. Similar to game of the goose an element of assignments could be added. For example, before a player can park their pawn, they have to answer a simple question related to an informatics topic. If answered correctly they can park their pawn. If answered incorrectly, an explanation for the correct answer can be presented, teacher the player something about that informatics topic. However, making sure these questions are simple enough to be able to answer correctly, while still providing a challenge can be difficult.

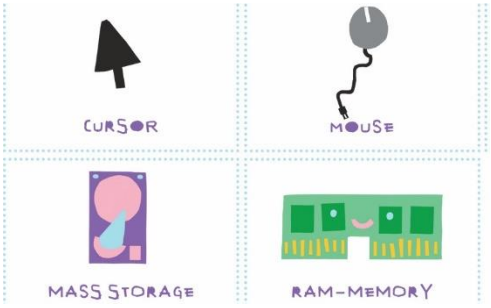


*Figure 15 Memory icon examples*

Memory is one of the easiest games to play. When matching up different face-down cards related to informatics topics the player would be presented with a small piece of text explaining that topic. Examples of icons that could be used can be seen in Figure 15[8]. The challenge with this game is that it is difficult to categorise different cards under the same topic, as is done within the informatics curriculum guidelines set out by the Dutch government.

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[6] https://nl.wikipedia.org/wiki/Ganzenbord
[7] https://www.bol.com/nl/p/longfield-games-ludo-opklapbaar/1004004007096195/?Referrer=ADVNLGOO002027-G-58409000156-S-490629531986-1004004007096195&gclid=EAIaIQobChMI8bjp8IvU6gIVDLDtCh0Apgf7EAQYASABEgLBnPD_BwE
[8] https://www.helloruby.com/play

Quartets or Go Fish (kwartet in Dutch), originated during the 1960s (Ultimate Top Trumps, 2013) and is a well-known, easy to play Dutch card game. The goal of this game is to gather sets of four cards that relate to the same category. An example of these categories and a few of its members can be seen in Figure 16[9]. This example, in particular, revolves around different kinds of social media. There do not seem to be any other quartets games in existence that relate to informatics in any way. The categories for the informative session could be based on the informatics guidelines and topics set out by the Dutch government. Each member of this category will cover some part of its hierarchy for example when talking about networks or cover some example of that category like different programming languages for example. When a player has successfully collected a card from an opponent, they need to read the informative text on the card to their other players. This ensures that all people and not only the collector of that card learn a bit of that category.

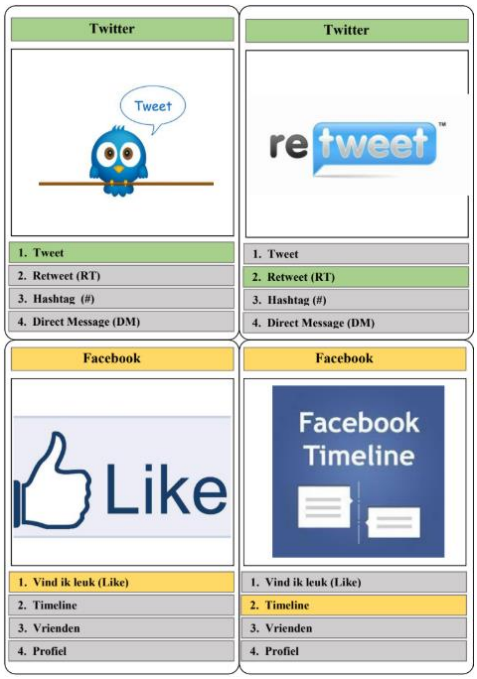



*Figure 16 Quartets card game*

Two of the forefront requirements are to make the informative session a game that is easily understandable and also playable in a short time. Making the game based on an existing game that the pupils are familiar with eliminates the explanation of the basic rules. Quartets seems to be the most fitting out of the above-mentioned games. It also allows for clear categorisation of various informatics topics, presenting elements of each of those topics.

### 6.3 Quartets categories and members

Each quartets category contains four cards. Usually, quartets includes eight categories but can be as big as one wants. That makes it expandable for additional categories if desired. This can even be adjusted to each secondary school specifically, depending on the way they shape their curriculum.

The eight categories will be based on the different interests of the user groups but will be mainly based on the topics defined by SLO and the government (College voor Toetsen en Examens, 2019; Woldhuis, 2020). The order these categories are discussed in is not in order of importance as they are not numbered in the final product. Each category will be given four members. These will be based on online material, examples that are often used for informatics and ICT education for children, but also the material discussed in previous parts of this report. The Dutch version of this text can be found in Appendix D.

The main challenge of writing these members is the limited amount of text that can be used. As this is meant to be put on a playing card alongside the category name, a list of its members and an image leaves little room for the explanatory text. The text might be adjusted

[9] http://ict-idee.blogspot.com/2015/02/210-kwartetspel-social-media.html

slightly to better fit the final product. Each member of the category also needs to be able to stand on its own in terms of the information it provides. It should not need to rely on the information provided in the information of other members. Still, when all members come together, they need to provide a cohesive whole.

#### *6.2.2.1 Streaming*

**Services -** Streaming is offered through streaming services. Spotify, Netflix, YouTube and Twitch are all well-known services that all offer something different. A subscription offers more features or is just necessary for using the service.

**Media -** Streaming can give access to various kinds of media. With Spotify, you can listen to music while Netflix gives you access to an enormous amount of movies and tv shows. In a similar way, the new Google Stadia even lets you stream games to play.

**Resolution -** Resolution means the sharpness of the image. The height of the resolution is indicated in the amount of horizontal pixels. The more pixels, the sharper the image and the more detail can be seen. Displays with an 8K resolution as such have 8000 horizontal pixels (Samsung, n.d.).

**Buffering -** Before music or video starts playing a portion of it is downloaded. Because of this you can listen or watch without any interruptions, even if there are some slowdowns in the internet signal while you listen or watch (PCMag, n.d.).

#### *6.2.2.2 Programming*

**Syntax -** Syntax is the rules that structure the programming language. This can be seen as the grammar of that specific programming language (Oxford English Dictionary, n.d.-h). You will get errors when mistakes are made in the syntax of the code.

**Commands -** These are specific assignments that are executed in the code. This can, for example, make sure that a line of code is repeated several times or that a line of code is only executed when certain criteria are met.

**Textual Programming -** Here the programming language is built up of text and punctuation marks that are typed under each other in lines to make up the code. Programming happens this way in general. The most well-known programming languages are Python, Java and C (Goel, 2020).

**Visual Programming -** Here the code is built up of visual blocks that are snapped into each other. Programming languages like Scratch and Snap! use this form of programming. This is an easy way to practice with programming.

#### *6.2.2.3 Applications*

**Google -** In 1997, Google was meant to make structuring and finding information on the internet easier (Google, n.d.). Up to now, it is still the most well-known search engine in the world. Google nowadays has a lot of different services like Google Maps, Google Drive and Gmail.

**Internet of Things -** Abbreviated as IoT is a well-used term within the ICT-world. It means that a lot more everyday objects are connected to the internet (Oxford English Dictionary, n.d.-c). Examples of these are smart home application, like Philips Hue and Google Home.

**Logistics -** ICT is also more applied within logistical systems. Digitally keeping track and automatically processing of shipments, but also being able to easily manage your stock is made a lot easier and more organized.

**Healthcare -** Technology is also more applied in healthcare. This can help deliver quality, safety and can make healthcare more affordable and easier for the patient and the caregiver (ZonMw.nl, n.d.).

#### *6.2.2.4 Gaming*

**Input -** Input is how you communicate the control over the game. This can be done via a joystick, keyboard or controller (Build-Your-Own-Computer.net, n.d.). There are different ways of giving input: via buttons, a touchscreen or with motion like with the Wii.

**Output -** Output is what the game communicates to you. Of course, this is what you see happen on screen, but can also be the light effects or vibrations of the controller.

**Graphics -** What you see on the monitor is what we call graphics. These can be in 2D, like many of the Mario games, but can also be in 3D like we mostly see nowadays. Often a lot of calculations are being made to show these graphics.

**Frame Rate -** Also known as FPS which stands for Frames Per Second. This is about the number of frames that are shown per second. One frame is one image on your screen, the more images per second, the smoother the image.

#### *6.2.2.5 Networks*

To describe the workings of a network, the diagram seen in Figure 17[10] was used, describing the main components within a network.

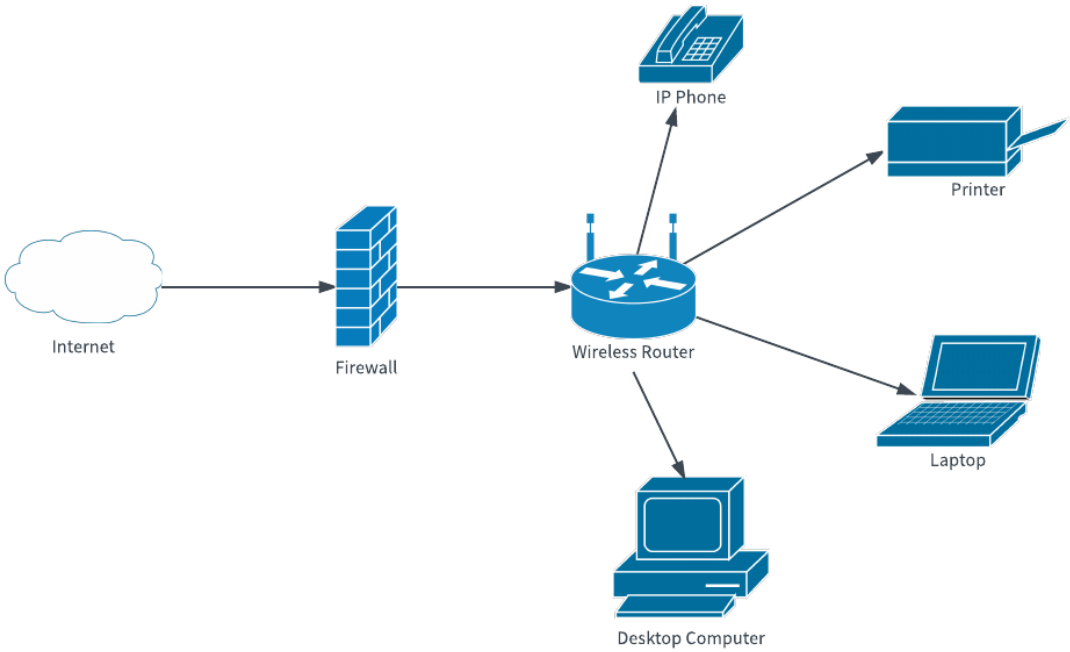



*Figure 17 Network components diagram*

[10] https://www.lucidchart.com/pages/templates/network-diagram/home-network-diagram-template

**Internet -** This is the abbreviation of *internetwork*: interconnected networks. The internet is a large network that makes sure that information and communication can be exchanged amongst systems. The internet gives access to the World Wide Web (Oxford English Dictionary, n.d.-d).

**Firewall -** A firewall protects the network against misuse from outside. It scans all incoming network traffic and decides whether or not it is dangerous (Kaspersky.nl, n.d.; Oxford English Dictionary, n.d.-b).

**Router -** This device connects multiple networks. It makes sure that groupings of information are communicated to the correct place within the network (Oxford English Dictionary, n.d.-f). This is also known as the device that manages all WiFi signals within your home (Het Klokhuis, 2019).

**Nodes -** These are all the devices that are connected within a network like your computer, laptop and smartphone (Beach, 2004). A printer or security camera can also, for example, be part of a network.

#### *6.2.2.6 Privacy*

**GDPR -** The General Data Protection Regulation is the privacy law within the European Union and is also known in Dutch as the AVG. This law makes sure that other parties must handle your data carefully (Autoriteit Persoonsgegevens, n.d.).

**Cookies -** Cookies are small files that are saved to your computer when you visit a website (VeiligInternetten.nl, n.d.). These files record information about your preference settings, how you use a website, but also what kind of advertisements would fit you best.

**Personal Data -** The combination of all this data shapes an image of you as a person (Autoriteit Persoonsgegevens, n.d.). This can be your date of birth, bank details or address, but also the route you take to cycle to school says something about you.

**Hacking -** The act where something or someone gathers information from a person or an instance without permission. This can be done through a virus, but also by misleading someone to fill out their personal data (Malwarebytes.com, n.d.).

#### *6.2.2.7 Social Media*

**Platforms -** The social media platform is where the contact takes place. YouTube, Instagram, TikTok and Snapchat focus more on sharing media. Facebook, LinkedIn and WhatsApp are more about maintaining contact with others.

**User Profile -** This is the information with which you present yourself to others. This information about yourself can vary a lot. Luckily, you can also decide who can see your profile and what they can see.

**Advertisement -** Because a lot of time is spent on social media it is the ideal medium for companies to show advertisements. The advertisements are adjusted to fit you as a person best according to the data they have collected of you. That makes the advertisements as appealing as possible.

**Influencer -** Social media make it a lot easier to connect with an audience from all over the world. A social media influencer can make use of their connections to make advertisements for companies, but can also use it to ensue action, for a better environment for example.

#### *6.2.2.8 Smartphones*

**Operating System -** Abbreviated as OS. This is the system that makes sure your smartphone functions properly by addressing its software and hardware (Oxford English Dictionary, n.d.-e). The most well-known OS are Android and iOS.

**Sensors -** There are a lot of sensors in your smartphone that measure physical properties or changes (Oxford English Dictionary, n.d.-g). The biggest sensor would be the touchscreen that makes controlling your smartphone possible. Other sensors are the camera, microphone and GPS for example.

**Screen -** The screen is not only a touchscreen to be used as input but is also an output in the form of an LCD-screen. This allows you to see all your messages, apps, pictures en videos.

**App -** This is an abbreviation for *application*: software developed with a specific purpose in mind (Oxford English Dictionary, n.d.-a). Apps on a smartphone can be games, social media or Magister, but your alarm clock is also managed through an app.

## 6.4 Design inspiration and concept

For the design of the cards, a few different factors need to be kept in mind. As the design might require commercial printing it is important to already design in a printable size. Therefore the cards will be sized 9,9cm x 7,5cm as this is the size used by KwartetCadeau, an online printing service for personalized quartets games (KwartetCadeau.nl, n.d.-a). This bigger size compared to regular playing cards also offers the space needed to display the pieces of text that accompany each card.

For the general layout of the cards themselves, a mood board was created which can be seen below.

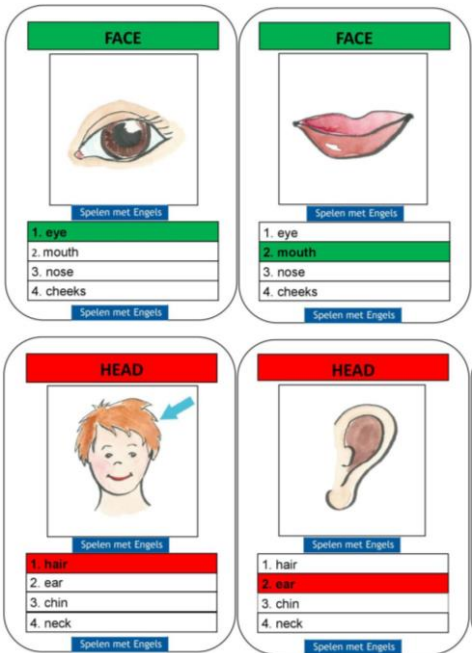



*Figure 18 Quartets presentation inspiration*


*Figure 19 Quartets icon inspiration*


*Figure 20 Quartets layout inspiration*

From Figure 18[11] we can see a way of presenting the categories and their four members in a clear way. However, listing the members all one under the other takes up a lot of space. That space is needed for the explanatory pieces of text. Presenting the category and its members within the same category colour helps distinct the different parts of the cards clearly.

Figure 19[12] shows a way of presenting its different categories or game elements with the use of icons. Icons are a clear representation of a particular concept and can easily convey what that concept needs to look like. As this game deals with 32 different elements it might be hard to find a cohesive set of icons that covers all these elements. Some elements might also be hard to convey through icons.

For the general layout Figure 20[13] will be referenced as the main inspiration. The differently coloured borders to distinct the different categories are put at the top and bottom of the card. This defines clear areas for the name of the category at the top and its various members at the bottom. Sectioning off the cards into its different elements and making those sections distinct is important for clarity.

The elements that the cards will contain are:

1. The category name
2. Member icon
3. Member explanatory text
4. Members list

[11] https://spelenmetengels.nl/product/kwartet-my-body/
[12] https://kwartetwinkel.nl/2019/01/tientijdvakkenkwartet/
[13] https://grabagift.nl/product/kwartetspellen-full-colour-bedrukken/

### 6.5 Quartets game final design – Informati-Kwartet

The final design of all the cards can be found in Appendix E. As said before the cards are completely in Dutch to match the native language of the user-group.

The name of the quartets game is Informati-Kwartet (Informati-Quartets in English). This is an obvious play on the words “Informatica” and “Kwartet”, which are the Dutch words for informatics and quartets.

Below, in Figure 21, examples of the fronts of one category can be seen. A list of all the icons used can be found in Appendix F with their corresponding copyright credits.

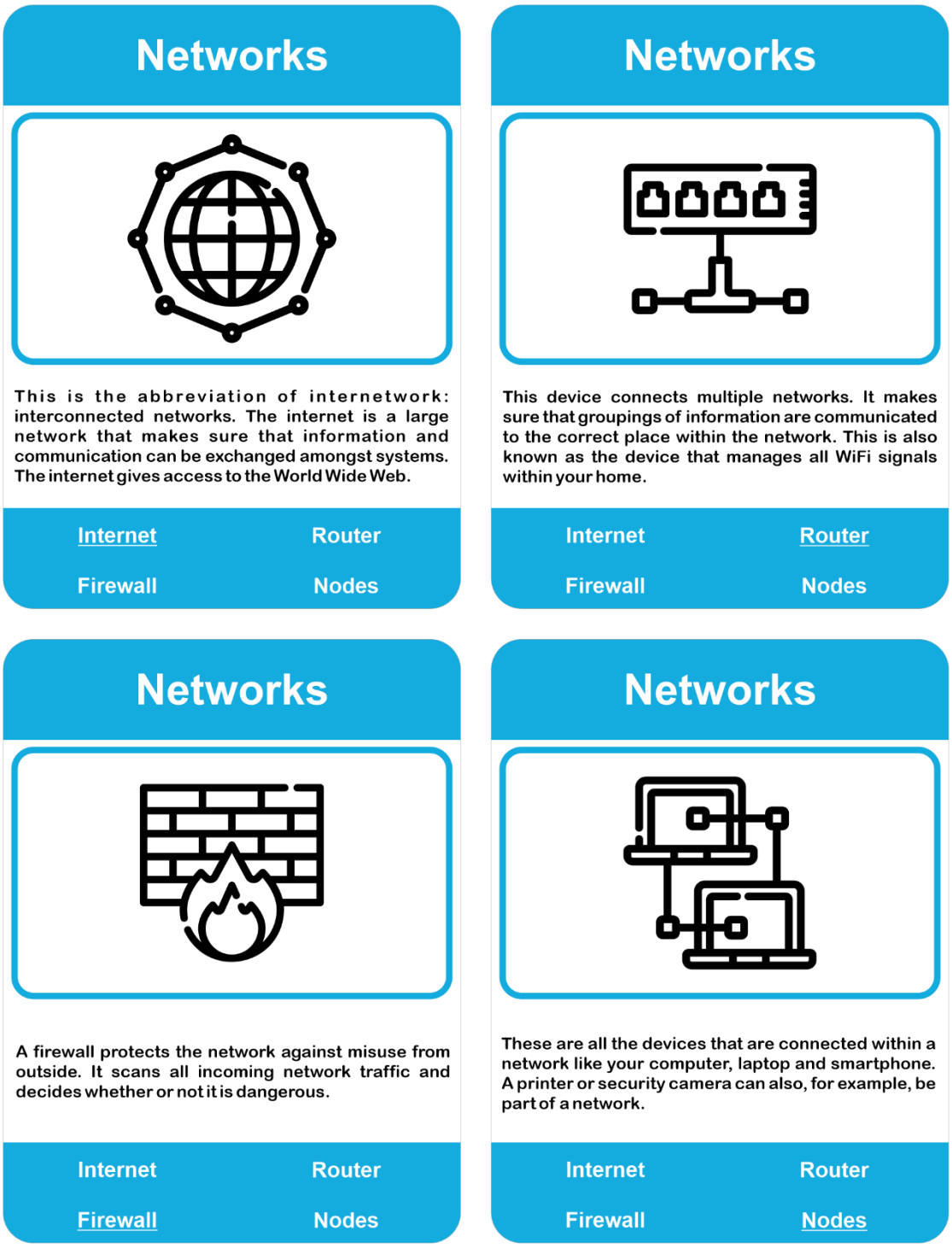



*Figure 21 Informati-Kwartet network card-set example*


*Figure 22 Final prototype Informati-Kwartet card back*


*Figure 23 Final prototype Informati-Kwartet overview*

### 6.6 Game rules

The rules of the game are adjusted from already existing quartets rules (KwartetCadeau.nl, n.d.-b; Spelregels.eu, n.d.; Ultimate Top Trumps, n.d.). Specific rules and changes are made to encourage the learning aspects of the card game. The Dutch version of these rules can be found in Appendix G.

Number of players: 2 – 8

Game time: 15 – 30 min.

Age: 12+

**Goal**

Informati-Quartets is made up of 8 categories, each with 4 cards that belong to the category, the quartet. The goal is to collect as many quartets as possible.

The intention of this quartets game is so you learn a bit what subjects you can encounter in informatics and what those mean.

**Preparation**

Mix up the cards well and distribute them among the players. Each player gets 4 cards. The remaining cards are put in a pile. You can look at your own cards.

**The game**

One player starts and asks one of their fellow players for a card they would like to have. By doing so you have to name the category on the top of the card and the name of one of the cards you would like to have. If your fellow player has that card, they must give it to them. Out loud you read the category, underlined name and the piece of text of the card. That way everybody learns a bit about that card.

The player can continue asking fellow players for cards until one of those players does not have the card that is being asked for. When that happens a card from the pile must be drawn by the person who was asking for the card. You play clockwise, it’s the next player’s turn. You continue playing until all quartets are collected.

When you get a quartet, you say: “quartet” and put the cards face-up on the table. The player with the most quartets at the end of the game wins!

# Chapter 7 – Evaluation

This chapter goes over the evaluation process of the final prototype of the informative session: the Informati-Kwartet quartets game. User tests were performed with the final prototype. A total of 13 meaningful responses were gathered through these user tests.

## 7.1 User testing limitations

The prototype was made as a physical prototype of the card game to be tested by potential users. Due to the results of the COVID-19 pandemic, this user-testing could unfortunately not be performed with the two main user-groups, the pupils and informatics teachers. Because of the effects of the COVID-19 virus, the timing of this graduation project was delayed, and testing had to be performed in July. Dutch secondary schools by that time have their summer holiday, so pupils and teachers are not as available. As mentioned before, an attempt was made to incorporate the pupils that filled in the pupil survey into the testing. Sadly, none of the 55 respondents indicated they wanted to or were available to help during their summer holiday. Instead, University of Twente students were gathered to participate in the user testing.

As the quartets game revolves largely around interaction with the other player or players, it was important to physically test the prototype. That way, the effect of the interaction could be seen. Also, as this informative session would be implemented within a physical classroom, under normal circumstances, it was important to see if the physical game would work as well. Unfortunately, due to the virus safety measures testing could only be performed one-on-one. By doing so the group interaction that the game would normally take place in was also not testable.

Not being able to perform the user testing with the two main user groups makes it difficult to evaluate the effectiveness of the final prototype. The effectiveness of how the pupils react to the quartets game in particular. However, due to the situation, there was no better alternative possible. The pure functioning of the game-mechanics, the clarity of the rules and the look and feel of the cards can be judged, however. The user testing mainly focussed on these criteria. Users that tested the final prototype were also asked if they could imagine this card game being used by the pupils and if they thought it would be effective. So, there is some speculation to be made about the effectiveness but cannot be confirmed for certain.

## 7.2 User testing process

In total 12 user tests have been performed using the process described below. Of these 12 users, seven were male and five were female with an average age of 20 years old. Their prior knowledge of informatics can be seen in Figure 24. Most of the concepts covered by the informative text on the cards was already somewhat familiar to them.

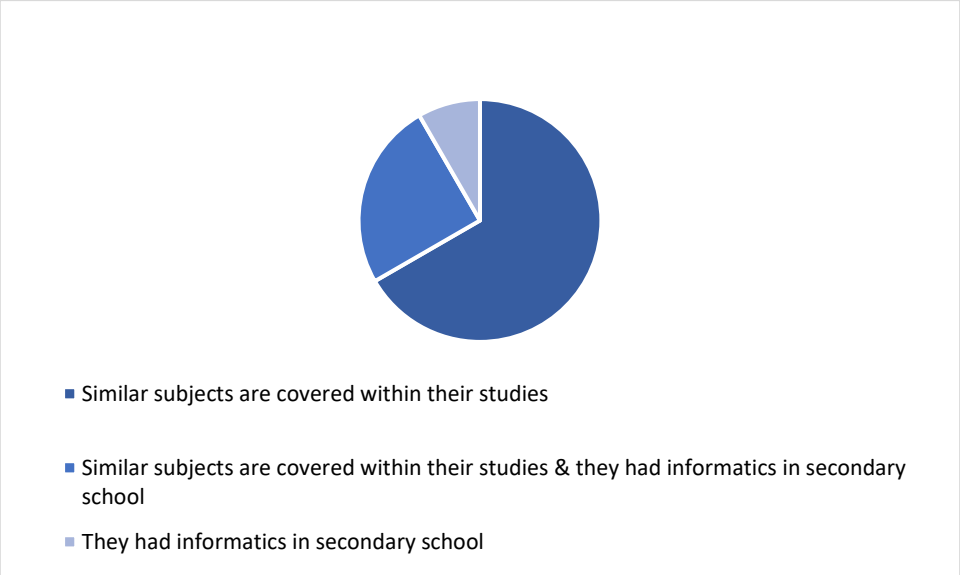



*Figure 24 User testing prior informatics experience*

At the start of the testing, the user was asked to carefully read the information about this graduation project and its research topic, as well as the consent information, after which the game would be played. The user was told to read the card with the game rules before starting the game. A timer of 15 minutes was set to make sure there was enough time left to fill out the remainder of the survey. All the games played with the users were finished before these 15 minutes had passed.

The game was played between the user and the researcher. In Figure 25 a diagram can be seen of the setup. Both players were sitting across from each other with the pile of cards in the middle. The laptop on the right was used for filling in the survey.

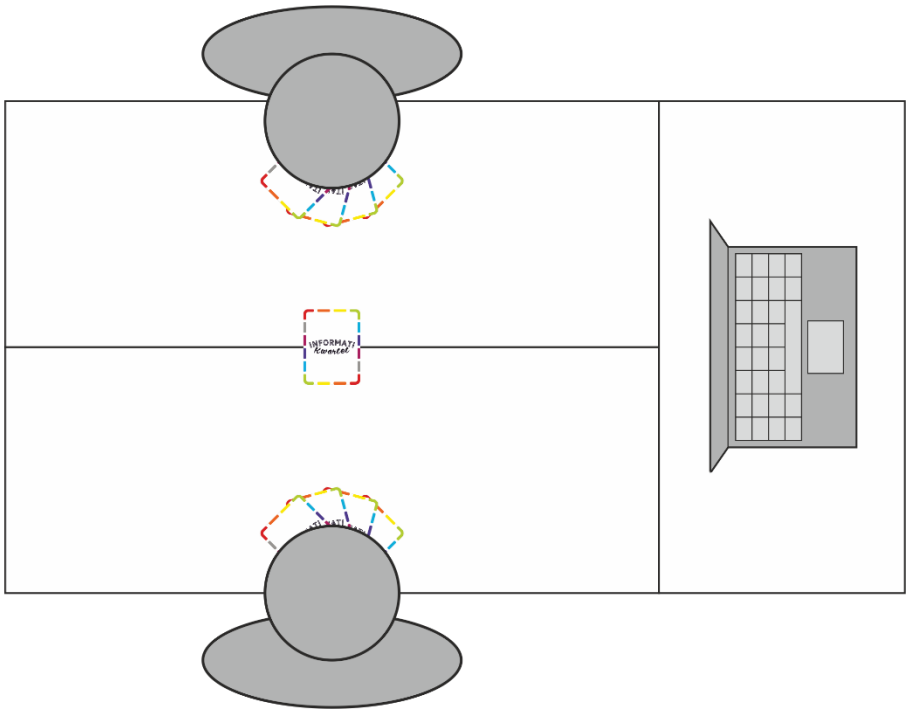


*Figure 25 User testing setup*

After the game was finished, the user was asked to fill in the remainder of the survey. This survey was also conducted through Google Forms and processed similarly to the pupil and teacher surveys previously discussed within this report. The original Dutch version of the survey can be found in Appendix H. Again, there could be slight discrepancies while translating the results to present in this report. These discrepancies should only be minor and will not change the results in meaningful ways.

## 7.3 Game evaluation

By playing the game, some minor mistakes in the cards were found. These were mostly alignment mistakes and minor spelling errors. These have already been adjusted in the final prototype in Appendix E and the Dutch informative pieces of text found in Appendix D. There was one small suggestion made by one of the users about the Smartphone category and the "screen" card in particular. The fact that not all smartphone screens are LCD-screens. This has been adjusted in the card accordingly, removing "LCD", generalizing it to screens. Another factor is that Google was not founded in 1997, but in 1998. In 1997 is when the domain name of Google was registered. The company was actually incorporated in 1998. This has also been changed in the prototype of the cards and the Dutch text of the cards.

Overall, the users found the game fun to play. On a scale of one to 10, they gave the enjoyment of playing the game a 7,75 score. What made the game fun according to them was that the cards looked nice and that quartets, in general, is a fun game. The information that was presented was very easy to understand, accessible and relatable to many people. Learning about informatics related topics was interesting to one of the users, even though those subjects are covered within their studies.

However, "having to read the informative text out loud removed me from the flow of the game and is easily forgotten" is what one user said. Two other users also did not see the appeal of having to read the cards out loud, it lowered the tempo of the game. "Playing the game multiple times would make reading the cards out loud tedious" says one user. Unfortunately, without the informative text, the pupils would not be able to be exposed to the various aspects of informatics and knowing what those can entail. There also seemed to be not enough categories to play an interactive game according to three users. Most of the time the categories were assembled by drawing from the pile. This is most likely because the games were played one-on-one. Having a minimum of three players could resolve this issue but playing with only two people was necessary in this case and did not seem like a problem to the other nine users.

### *7.3.1 Game rules evaluation*

Out of the 12 responses five mentioned that they were already familiar with the general rules of quartets because it is such an easy game and played by many people in the Netherlands. Additionally, they mentioned that the rules were clear and well explained. Combined with their already existing knowledge of the game and the game rules card it was easy enough to play.

However, some adjustments needed to be made to the card with the game rules. First of all, an indication that there was a backside to the game rules card as desired by one user. Adding an arrow to the side with PTO, meaning Please Turn Over (z.o.z., zie ommezijde in Dutch) was added.

The game rules, in general, seemed clear, but while playing some unclarities about specific rules came to light and the game needed some additional rules added to make sure they were complete. As a player, you should only be allowed to ask for a card from a category that you have in your hand. This is a standard rule within quartets but was not incorporated in the prototype. In practice, this was not a problem, but it was best to add it either way. When successfully asking for a card from a fellow player and receiving it, only the card description needs to be read. Reading the category and the card name once more when it has been said just before seemed redundant. Furthermore, the description needs to be only read out loud once during the game. This prevents time from being taken up by re-reading descriptions when a card is passed around the group multiple times. When unsuccessfully asking for a card from a fellow player, therefor not receiving any card results in having to draw a card from the pile. If this drawn card results in a quartet, you should immediately be able to put it on the table face-up as a completed set. When all cards from their hand have been combined into sets by one player, or they are left with no cards in general, they should just draw a card from the pile. This allows the game to continue. One of the respondents mentioned that the game rules were presented in text that was too long, which resulted in confusion about the rules by not having read them carefully. Having these additional rules would prolong this text further, unfortunately. However, these additional rules seem to be necessary as during multiple of the user tests the same unclarities occurred.

One interesting aspect was that only three out of the 12 respondents made sure to read the informative text out loud each time they received a card from the other player, in the case of this user testing that was the researcher. The other ten players either only read the text of the first few cards they received and then stopped or did not read any out loud at all. All while the researcher did keep reading the texts out loud of the cards they received. This rule is the only way to make reading the informative text mandatory. It is important to show the contents of what informatics as a subject is about, which is the goal of this game. To make sure this rule stands out within the game rules card, it has been made bold. Additionally, one user said that it would be beneficial to read all unread cards out loud as well once a quartet has been gathered before laid out on the table. This rule was also added. A suggestion that was made in this regard was to possibly only read all the cards when a quartet was gathered. “As that is a more natural pausing time of the game, it might make more sense to do that way instead of interrupting the game” mentioned one of the users. That could be a possibility and could be tested in further iterations of the prototype to see whether that method is more suited compared to reading the cards out loud each time a player receives one from another player.

Some of the respondents mentioned that it would have been nice to have an overview of all the categories that will be presented within the game. That way they could have had an idea of what would be included in the game. An additional card showing all eight categories has been made. This would also be beneficial if the number of categories would be expanded or customized. This customization could be to better fit the way the informatics subject is taught at the different secondary schools, as there seems to be some variation between schools in terms of the teaching method and the contents covered.

All these changes combined resulted in the following game rules. The new card with the adjusted game rules and the category overview card has also been adjusted in Appendix E. The Dutch version of these improved rules can be found in Appendix I.

#### 7.3.1.1 Improved game rules

Number of players: 2 – 8

Game time: 15 – 30 min.

Age: 12+

**Goal**

Informati-Quartets is made up of 8 categories, each with 4 cards that belong to the category, the quartet. The goal is to collect as many quartets as possible.

The intention of this quartets game is so you learn a bit what subjects you can encounter in informatics and what those mean.

**Preparation**

Mix up the cards well and distribute them among the players. Each player gets 4 cards. The remaining cards are put in a pile. You can look at your own cards.

**The game**

One player starts and asks one of their fellow players for a card they would like to have. By doing so you have to name the category on the top of the card and the name of one of the cards you would like to have. If your fellow player has that card, they must give it to them. **Out loud you read the piece of text of the card.** That way everybody learns a bit about that card. If that same card is asked by someone else during the game, it doesn't have to be read out loud again.

The player can continue asking fellow players for cards until one of those players does not have the card that is being asked for. When that happens a card from the pile must be. If this results in the player having a quartet it can immediately be laid face-up on the table. If there are no more cards in the pile, nothing happens. You play clockwise, it's the next player's turn. You continue playing until all quartets are collected.

When you get a quartet, you say: "quartet" and put the cards on the table. Make sure to read the cards out loud that haven't been read yet! The player with the most quartets at the end of the game wins!

### *7.3.2 Cards aesthetics evaluation*

The design and look of the cards were well appreciated by all users. On average the aesthetics received an 8,67 out of 10. What stood out to the users were the clear images or icons used to depict each card. Although the symbols were not always clearly indicating at first glance what the card was about, which required reading the name of the card to understand the symbol, was pointed out by one user. The cohesive design of the cards and the symbols also helped make it feel like a professional game. Having different colours for each of the categories allowed the cards to be easily distinguishable.

However, many of the users expressed their dislike for the small text. It often seemed like there was also too much text, making the user not eager to read it. Having a lot of small text seemed too cumbersome. Also, the underscore to indicate the name of the cards were sometimes hard to read. Especially with the Applications (Toepassingen in Dutch) cards which

have white text on a yellow background, this is difficult to read. A suggestion was to add a box around the name of the card instead of the underscore to make it more prominent.

The problems of the text being too small and some of the cards being difficult to read could be because of the printing situation. Due to added printer margins, the cards turned out to be about one centimetre short on each side compared to the envisioned size of 9,9cm x 7,5cm. The size of the printed cards ended up being 8,7 x 6,6 cm. This size difference could be resolved by professionally printing the cards on the correct size, making the text larger and increasing the print quality resulting in more legible text.

### *7.3.3 Cards contents evaluation*

The categories were experienced as being clear. However, some users expressed their concern with the choice of categories. If they did not know the subject it could feel a bit overwhelming. Not knowing why some of the categories were picked had some users a little confused. For the end-users, mainly being the pupils, this could be the case. However, this quartets game is meant to be played alongside the existing information provision of the teacher. The subjects should make more sense after hearing the explanation of the subject from the teacher. The Networks (Netwerken in Dutch) category could be expanded a bit more according to one user. “It’s a complex subject, so a bit more content might be desirable”.

Overall, the members of each category were clear as well. The accompanying informative text helped to clarify these even further. However not every member was the best fit for that category according to one user. “Input and Output is not necessarily gaming and would fit better under a category relating to computer architecture” was the example given. Categories were chosen first within this project. Gaming was one of the categories alongside Social Media and Streaming to cater to different interests of the pupils. Finding fitting members that were not too specific but related to the category in a more general sense was how these members came to be. Input and output are very much so related to gaming, and the informative text explained these two concerning gaming as well. That is not to say that input and output only belong to gaming but within this prototype and its categories that ended up being the case.

The pieces of informative text were perceived as being clear. In terms of the quality of explanation of the card, the text was good. Two users expressed that they found the pieces of text too long. Another user also said that the structure of each text was sometimes not optimal, making it difficult to read out loud. In further iterations of this prototype, more specific attention could be given to the textual structure of the informative pieces of text.

The contents of the informative text offered little new information to the users overall because most of these concepts are already covered within their studies at university. Four of the 12 respondents did mention that they learned something from playing this game. The informative text served as a good refresher of knowledge for most of them, better explaining what some of the concepts mean than they initially thought. Some of the more technical concepts like pixels, nodes and textual programming were new to some of the users.

### *7.3.4 Target group effectiveness evaluation*

Nine out of the 12 users indicated that they thought this quartets game fits the target group of the pupils. Two users thought that it would not, and one user did not answer the question.

The reason why the users thought it would fit the pupil target group is that most of the pupils are already familiar with a few concepts presented through the cards, especially the internet, but not all of them. The users thought the pupils would still be young enough to enjoy quartets. The aesthetics of the cards are also fit for children, but the more serious topic helps to make the game feel more serious and not so much childish, one user expressed. The cards can give a simple and clear explanation of these concepts. The vocabulary and choice of words were also fitting.

However, the two participants that thought that quartets would not be fitting mentioned that this was mainly because it was a quartets game. Quartets could be considered a childish game, which would make it that the pupils think they are not taken seriously. Causing them to not play the game seriously either. One user mentioned “I don’t think the game matches up to the expectations of what you will actually be doing in informatics. People mostly expect to be programming”. Expecting programming as the main topic of discussion within the subject is exactly the prejudice that the informative session tries to eradicate as informatics is about more topics than just programming. As this game could be implemented alongside information provided by the teacher, the game serves as an extended example of that information provision. As it is an extended example, it is allowed to be perceived as less serious and more like fun. However, the game must be played properly to be effectively exposed to the information presented, which is mentioned in the game rules as the goal of the game. That would need to be emphasized by the teacher as well.

When asked if this game could potentially help the pupils with their decision to choose informatics or not seven respondents thought it would while five respondents thought it would not. The way it could help with the decision that was mentioned was that programming is already a well-known topic covered within informatics. This game, however, presents the vaster array of topics that will be covered within the subject. The game shows that informatics is more than just programming and about computers, but that it is also related to more social aspects for example. It can especially further increase the enthusiasm of pupils that were already interested in the subject.

However, the users that thought that this game would not help with the decision said that the game cannot spark interest if it is not already there. The game will more so appeal to pupils that are already interested in the subject. “Informatics is interesting to you or it is not” is what one user said. There are a lot of concepts covered, some of which are above the basic level which could discourage. While playing the game there is more emphasis on the concepts and what they mean, but not really what is specifically covered within the informatics subject. The game does not explain or explicitly show why informatics is a fun subject that the pupils must incorporate within their curriculum was mentioned by some users. The goal of the game, to show the topics that can be covered within the subject might also be easily forgotten.

### 7.4 Conclusions

In total 12 users tested the final prototype. Unfortunately, due to timing constraints as a result of the COVID-19 pandemic, it was not possible to test with secondary school pupils or informatics teachers, who would be the end-users of this product. The mechanics and clarity of the game, however, was testable. The effectiveness of the game on the choice of the pupils can only be speculated on.

The game is perceived as fun and easy to play thanks to the look of the cards and the already familiar rules of quartets. Some additions to the rules have been made to make them complete. The contents of the cards portrayed the diversity of the informatics subject well according to the students. By presenting the different categories and its members this diversity is shown. The informative pieces of text were clear, but a bit long. The way these pieces of text are incorporated within the game rules is not yet optimal and would require further testing.

Overall, the game is imagined to be fitting for the target audience. The bright colours, simple explanations and the easy game would be fitting for young pupils. There are some worries that the game would not be taken seriously. It is also questionable if the game would be able to spark interest at all for informatics. It would however further enthuse pupils that already have an interest in informatics. While the goal of the game might be forgotten while playing, it would be a good addition to information provision that is already in place at the secondary schools. Playing the game does not take up a lot of time and could be easily adjusted to fit the specific topics offered by each secondary school.

## Chapter 8 – Conclusion

The final result of this graduation project, being the Informati-Kwartet prototype was a success and was perceived to be a good addition to the information provision already in place at the secondary school. Unfortunately, changing the Dutch educational system revolving around informatics education is not possible within the scope of this graduation project. What has been confirmed is that informatics is regarded by pupils as a subject on the more technical side and mainly for people that have an interest in computers. Regardless of whether these pupils have incorporated informatics within their curriculum, this opinion is shared. Some of the pupils do agree that it is important for everybody to experience a basic understanding of the concepts covered in the informatics subject. By breaking the informatics subject down in eight topics with four distinct parts it can present a more graspable image of what the informatics subject can entail. The collection of effective teaching methods helped shape the final prototype of Informati-Kwartet through the requirements it had to meet. The final prototype still requires testing with pupils and needs to find the optimal way to present the informative pieces of text. However, a basis has been made to break down the vast contents informatics can cover and present it in a fun, attractive and interactive way that could already be by secondary schools implemented as is. This simplified and more tangible presentation of the subject, albeit limited, can be a good basis for further developments or researches surrounding informatic information provision.

## Chapter 9 – Future Work

As a result of this graduation project, the groundwork for the card game has been made. However, as informatics related education is most likely going to change in the near future in terms of what is required and mandatory to be implemented throughout Dutch education, it is not certain how long this will remain a valuable addition to the information provision sessions. If informatics were to become mandatory in the future, for example, there would possibly be no more need for the information provisions that are in place currently. In such a situation this card game could be implemented within the education of the informatics subject, by introducing the subject to new pupils in one of the first classes.

First of all, the final prototype should be tested in the size it was designed for with the target groups, the secondary school pupils and the informatics teachers. The base functioning of the card game has been tested and evaluated, but it was not possible to perform user testing with the groups, unfortunately. Seeing how those groups react to and interact with the card game could confirm the effectiveness of the card game or provide new opportunities for improvements to be made. Implementing it within a real setting as an addition to an information provision session can further test this.

Whether the card game would retain its value within information provision or be implemented within early informatics education, there are still improvements to be made. The way the informative text is presented to all the players of the game seemed to need some revisions. Reading it out loud after receiving a card seemed to pause the game, which was not ideal for some of the user testers. A few solutions for this have been discussed within the evaluation chapter of this report, like presenting less information and making the text more legible for example. Testing these different options with the targets group could help find the optimal way to present the information about the informatics concepts.

Adding a larger variety of categories could also be a good addition to the card set. Finding out the differences in informatics education for different secondary school can serve as a basis for these added categories. Personalizing the quartets sets to better fit the informatics education at specific secondary school might also affect the enthusing of the pupils, as it can present a more accurate representation of the subject and how it is taught at their school.

After all, these factors have been re-evaluated in their correct setting and the best fitting information provision format the game could potentially be digitalized. Some expansion in the form of inclusion of actual technology could provide a more realistic feel for the concepts that are being presented. By moving or combining the game with a digital format could help explain the concepts more easily. By showing examples or have the pupils practice with the concepts could give the pupils an even better grasp of these concepts. This implementation, however, might go outside of the scope of the information provision session and might be more suited for implementation within early informatics education.

## Appendix A – 21st-century skills

Skills, knowledge, insights and attitudes that the Dutch government deems very important for anyone participating in modern society. Four of these skills are part of the digital domain, collectively called digital literacy (Stichting Leerplan Ontwikkeling, 2019b).


These translate to Computational thinking, Information skills, ICT base skills, Media literacy, Communicating, Collaborating, Social & cultural skills, Self-regulating, Critical thinking, Creative thinking and Problem-solving.


These translate to Computational thinking, ICT base skills, Media literacy and Information skills.

## Appendix B – User profiles

The following pages contain user profiles. These are meant to illustrate the core users of the product or service. As a representation of the user group, they help define the requirements for the product or service. They also aid in imagining in what context and by whom the product or service will be used. The product or service needs to be able to cater to a variety of people who have different interests, skills, backgrounds, cultural heritage etc. Therefore, the users are also represented as a varied group of people. These user profiles are based mainly on the stakeholder analysis and the user analysis. These profiles were also adjusted according to the results of the surveys spread amongst informatics teachers and secondary school pupils, to better represent the final user-group.

# ERIK VERSTEEG

51, Rotterdam, NL

INFORMATICS TEACHER

- STATUS: MARRIED
- CHARACTER: EXTROVERT

## PERSONALITY

- Enthusiastic
- Innovator
- Tinkerer
- Studious
- Energetic

## BIO

Erik studied computer science and has just recently finished a master degree to become an informatics teacher and has been a full-time teacher for three years now. He was always excited about technology, building and tinkering with electronics from a young age. He wants to share his enthusiasm with the pupils he teaches, but he realizes that technology is not interesting in the same ways for everybody as it is for him. However, he wants to encourage the pupils to put their own spin on the technology they are using. In his free time, he likes to play soccer with his team and does swimming on his own. He enjoys cooking and working in the garden. He is a very social person.

## Motivations

| | | | |
|---|---|---|---|
| TECH-PROFICIENCY | | PRACTICAL | |
| TECH-INTEREST | | THEORETICAL | |

## Goals

- Teach pupils the fun of technology and informatics
- Bringing his knowledge and enthusiasm about the subject in creative ways
- Practicing technology by tinkering

## Frustrations

- His enthusiasm can overshadow his authority
- Too eager to teach the pupils too many different things at once
- Finding a balance between his work life and private life

> "Creatively incorporating technology in my life is exciting!"

## Time-division

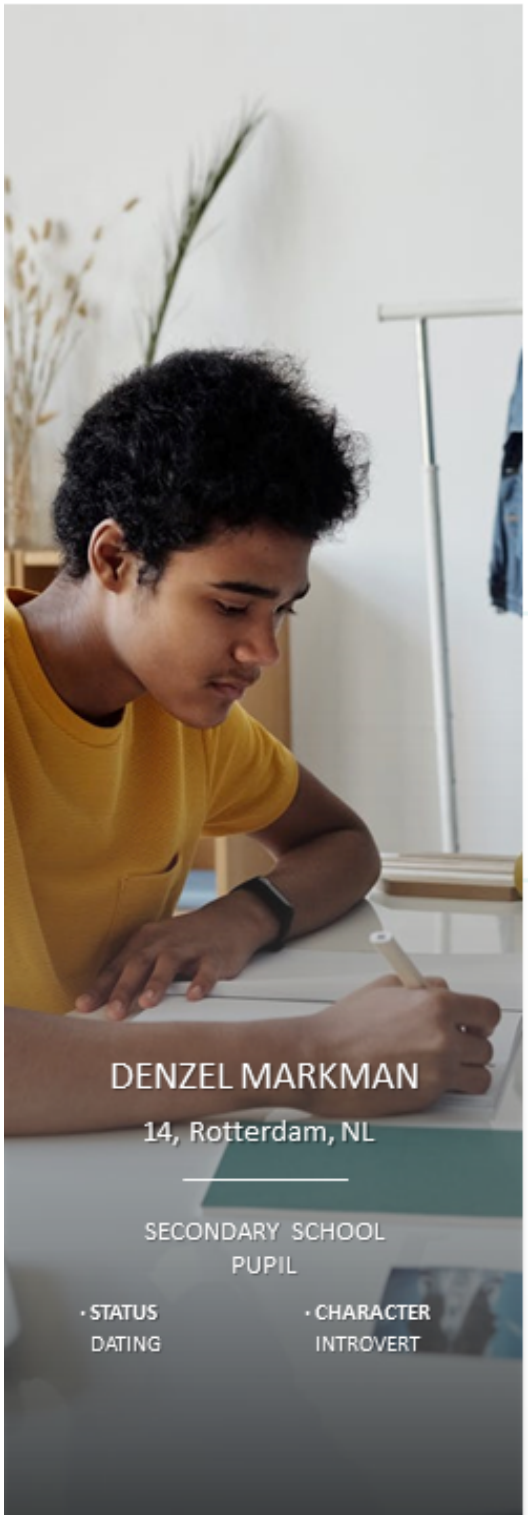
- Schoolwork
- Social media
- Social interactions
- Family life
- Hobbies

## Influenced by

- COLLEAGUES
- TECHNOLOGY
- TEACHERS' UNION
- SOCIETY
- PUPILS
- BLOGS/FORUMS

## Frequently used apps

- Magister
- Google Calendar
- Trello



# DENZEL MARKMAN

14, Rotterdam, NL

SECONDARY SCHOOL PUPIL

- STATUS DATING
- CHARACTER INTROVERT

## PERSONALITY

- Creative
- Quiet
- Studious
- Eager
- Hardworking

## BIO

Denzel is in his third year of secondary school. He finds it difficult which curriculum track to follow. Does he choose the beta-track or alfa-track. He is also unsure about whether or not to choose informatics. He does not see himself as a gamer or an avid tech user, so is it useful for him? Instead, he likes drawing and product design. He spends the majority of his time doing that while researching and discussing possibilities on online forums.

He does enjoy gaming from time to time together with his friends. He also plays baseball at the local baseball club and with his dad.

Erik Versteeg is the mentor of Denzel. Mr Versteeg his enthusiasm about informatics does intrigue Denzel.

## Motivations

TECH-PROFICIENCY

TECH-INTEREST

PRACTICAL

THEORETICAL

## Goals

- Having fun in school with friends, trying to become more extroverted
- Practicing and implementing his design interest within school subjects
- Trying to make the right choices for his curriculum with an eye on the future

## Frustrations

- Has difficulties with social interactions sometimes
- Does not realise the relation between design and technology
- Cannot find much support from his parents for schoolwork

> "I want to design to improve the lives of people"

## Time-division

- Schoolwork
- Social media
- Social interactions
- Family life
- Hobbies

## Influenced by

- FRIENDS
- TEACHERS
- ROLE MODELS
- INFLUENCERS
- SOCIAL MEDIA
- BLOGS/FORUMS

## Frequently used apps

Magister

YouTube

Nonogram

# PATRICIA GONZALES

42, Almere, NL

INFORMATICS & SOCIAL STUDIES TEACHER

- STATUS MARRIED
- CHARACTER LOVINGLY

## PERSONALITY

- Calm
- Empathic
- Patient
- Direct
- Eye for detail

## BIO

Patricia studied law before becoming a teacher. She specialized in online law, focussing on the rights of individuals on social media and how online businesses can make sure their rights are well taken into account. Through her studies she came to realize that there are so many aspects of technology that influence us, but that hardly anybody has an extensive understanding of it. That is why she decided to become an informatics teacher. To teach students how they should treat technology in ethical ways, but also inspire students to see how technology can benefit individuals and society.
She is happily married and has two children. Together with her family she likes to cycle and do activities.

## Motivations

TECH-PROFICIENCY

TECH-INTEREST

PRACTICAL

THEORETICAL

## Goals

- Show that you do not need to be an expert in technology to be able to use it as a valuable tool
- Give the pupils the opportunity to understand the principles of informatics well
- Explore the social and societal impact of technology

## Frustrations

- Has a hard time keeping up with the rapid technology developments
- Sees herself not as an informatics-expert and is still finding her way
- Tries to be patient with rude and uninterested children but that is hard

> "I want students to see the possibilities technology can offer"

## Time-division

- Schoolwork
- Social media
- Social interactions
- Family life
- Hobbies

## Influenced by

- COLLEAGUES
- FAMILY
- TEACHERS' UNION
- SOCIETY
- PUPILS
- SOCIAL MEDIA

## Frequently used apps

Magister

Google Calendar

Facebook


## PERSONALITY

- Energetic
- Social
- Impulsive
- Eager
- Distracted

## BIO

Erika is in her third year of secondary school. She has a hard time focusing and does not like studying too much. That is why she is retaking the third year. She spends a lot of time on social media and likes hanging out a lot with her friends. She finds it interesting how technology can influence the social contacts and interaction of people. She would like to see how informatics can help her understand how these influences come to be. Patricia Gonzales is her social studies teacher. Thanks to misses Gonzales, Erika realised the societal aspect of informatics. She likes to do baking with her friends and making TikTok videos. Reading is also something she likes to do.

## Motivations

| | | | |
|---|---|---|---|
| TECH-PROFICIENCY | | PRACTICAL | |
| TECH-INTEREST | | THEORETICAL | |

## Goals

- Understand how technology influences society
- Get better at studying by choosing subjects and teachers that motivate her
- Improve on her science related subjects as they interest her but she finds them very hard

## Frustrations

- Struggles to motivate herself to study
- Her parents want her to overachieve, which causes her to rebel against that
- Spends a lot of time on social media

> "I love spending time with my friends and expressing that on social media!"

## Time-division

- Schoolwork
- Social media
- Social interactions
- Family life
- Hobbies

## Influenced by

- FRIENDS
- TEACHERS
- PARENTS
- INFLUENCERS
- SOCIAL MEDIA
- TRENDS

## Frequently used apps

Magister · Instagram · TikTok

## Appendix C – User-group exploratory surveys

The two surveys that were conducted can be found below. These were spread among the two main stakeholders of this research, the secondary school pupils and the informatics teachers. These two stakeholders will also be the main users of the final solution. As both user groups have Dutch as their native language, these surveys are in Dutch as well.

### Appendix C.1 Pupil survey

This survey was spread amongst six different secondary schools and generated 55 meaningful responses. Through contact with informatics teachers and them spreading it around within their schools made this possible.

# Leerlingen Vragenlijst - Informatica keuze en interesse

Hallo, mijn naam is Philippe Tuinman en ik ben aan het afstuderen voor mijn Bachelor studie Creative Technology aan de Universiteit Twente.

Voor mijn onderzoek ben ik aan het kijken hoe scholieren op middelbare scholen enthousiast(er) gemaakt kunnen worden voor het vak informatica. De overheid vindt het belangrijk dat men de dingen leert die bij informatica aan bod komen. Zo kan men beter omgaan met onze moderne samenleving. Ik denk ook dat dit belangrijk is. Daarom wil ik kijken hoe de keuze voor het vak informatica aangemoedigd kan worden.

Daar heb ik jouw hulp bij nodig!
Omdat ik zelf geen docent informatica ben en het vak zelf nooit gehad heb kan ik moeilijk deze vragen beantwoorden. Zeker nu ik ook niet meer op scholen langs kan komen door de coronacrisis is dit erg lastig.
Daarnaast kunnen er per school en per scholier veel verschillen zijn.
Graag zou ik je daarom willen vragen om de volgende vragenlijst in te vullen, zodat ik een beter beeld krijg over jouw keuze voor het vak bij jou op school.
Het zijn een flink aantal vragen, maar het beantwoorden zou niet langer dan 15 minuten moeten duren.

Ik zal kijken hoe jullie de keuze voor het vak maken en hoe dat is voor allerlei middelbare scholieren (van verschillende leeftijd, geslacht, afkomst etc.). Ligt het aan het beeld wat je hebt van het vak? Lijkt het vak te technisch? Heb je wel genoeg juiste informatie om een goed idee te hebben waar het vak over gaat? Maar ook de vragen als: Wat is belangrijk als het vak gegeven wordt? En welke manieren kunnen een goede introductie zijn voor het vak?
Dit zijn een aantal vragen die ik probeer te beantwoorden met deze vragenlijst.
*Vereist

Toestemmingsinformatie

## Naamloze titel

Door middel van deze informatie wil ik je extra inzicht geven over het doel van mijn onderzoek en hoe je daar aan kan bijdragen.
Volgens de overheid is de beheersing van digitale vaardigheden nodig om beter te kunnen functioneren in onze moderne maatschappij. Gebruik van technologieën zoals smartphones, tablets en laptops is een basis, maar niet genoeg. Om een goede mening te kunnen vormen over de functies, de invloeden en gevolgen deze technologieën op de maatschappij en jouzelf zijn vaardigheden die dieper gaan dan "alleen het weten te gebruiken van" nodig.
Ik sluit me persoonlijk aan bij het beeld van de overheid. Vanuit mijn studie heb ik ook geleerd dat er meer aan technologie te pas komt dan alleen maar de functionaliteit. Het heeft veel invloeden, meer dan men soms denkt, op ons als mens en hoe wij met onze medemens en omgeving omgaan.

De overheid ziet het vak informatica als een goede stap voor leerlingen om technologie beter te begrijpen. Daarom wil ik kijken hoe informatica onder de aandacht wordt gebracht bij de leerlingen en wat de mogelijkheden zijn om die keuze aan te moedigen bij de leerlingen. Niet door ze te forceren informatica te kiezen, maar om ze goed kennis te laten maken met het vak dat laat zien dat het ook voor hen belangrijk is, allemaal op een motiverende en interactieve manier.
Alleen moet ik eerst een goed beeld krijgen van het vak, de situatie op school, ervaringen op school en hoe de voorlichting over het vak op dit moment gebeurd.

Daarom vraag ik je mijn vragenlijst in te vullen om deze vragen te beantwoorden.
De vragenlijst is erg uitgebreid maar zou niet meer dan 15 – 20 minuten moeten duren om te beantwoorden.
Na afronding van het onderzoek mag je natuurlijk de resultaten van dit onderzoek opvragen. Hiervoor kun je aan het eind van de vragenlijst je e-mailadres invullen.

Ik wil je vragen voordat je de vragenlijst invult deze toestemmingsinformatie goed door te lezen en te ondertekenen als je hiermee akkoord gaat.
Ook is het belangrijk dat een van je ouders of verzorgers deze informatie goed doorleest en ook toestemming geeft.
Het is aan te raden dat je deze vragenlijst met je ouder of verzorger naast je invult, zodat zij kunnen zien wat voor soort vragen het zijn en je misschien kunnen helpen.

Als deelnemer van deze vragenlijst:
Zal je gevraagd worden een vragenlijst in te vullen. Deze vragenlijst gaat over:
- Jezelf als persoon
- Je ervaringen met het vak informatica en een eventuele voorlichting daarvan
- Je tips voor verbeteringen van het vak en de voorlichting

Deelnemen aan dit onderzoek is vrijwillig. Je hoeft geen vragen te beantwoorden die je niet wil beantwoorden. De antwoorden worden opgeslagen op een veilige plek; alleen de onderzoeker heeft toegang. Deze antwoorden zullen anoniem gemaakt worden, verwerkt en gepresenteerd worden in het onderzoeksverslag. Anonieme quotes of fragmenten kunnen eruit worden gehaald om toe te voegen aan het afstudeerverslag. Op elk moment kun je je toestemming innemen en zal je deelname direct worden stopgezet waarbij de gegevens ook correct zullen worden verwijderd. Je bent vrij om op elk moment voor welke reden dan ook je deelname aan het onderzoek te stoppen. Om dit stopzetten goed te kunnen doen vraag ik je om een bijnaam op te geven. Op deze manier kan ik je antwoorden koppelen aan de door jou gegeven bijnaam om je aanvraag voor stopzetting te verwerken. Voor vragen kun je bij mij terecht, of bij mijn begeleider (Angelika Mader), de contactgegevens zijn onderaan te vinden.

Wil je graag onafhankelijk advies over meedoen aan dit onderzoek, of een klacht indienen? Dan kun je terecht bij Petri de Willigen, secretaris van de Ethische Commissie (tel. 053-489 2085, ethics-comm-ewi@utwente.nl). Deze commissie bestaat uit onafhankelijke deskundigen van de Universiteit Twente en is beschikbaar voor vragen en klachten rondom het onderzoek.

Met vriendelijke groeten,
Philippe Tuinman
p.tuinman@student.utwente.nl
06-57077926

Begeleider: Angelika Mader
a.h.mader@utwente.nl

1. Welke unieke bijnaam wil je gebruiken om anoniem te blijven? *

_____

2. Ik heb de informatie op dit formulier gelezen, heb hier geen vragen meer over en ga hiermee akkoord. *

*Markeer slechts één ovaal.*

- ◯ Ik ga akkoord *Ga naar vraag 4*
- ◯ Ik ga niet akkoord *Ga naar vraag 49*

3. Ik, de verzorger van de leerling, heb de bovenstaande informatie gelezen, heb hier geen vragen meer over en ga hiermee akkoord. *

*Markeer slechts één ovaal.*

- ◯ Ik ga akkoord *Ga naar vraag 4*
- ◯ Ik ga niet akkoord *Ga naar vraag 49*

## Demografisch

Deze vragen zijn om mij een beeld te geven over jou als scholier.

4. Geslacht

*Markeer slechts één ovaal.*

- ◯ Jongen
- ◯ Meisje
- ◯ Zeg ik liever niet
- ◯ Anders: _____

5. Hoe oud ben je?

_____

6. Doe je HAVO of VWO?

*Markeer slechts één ovaal.*

- HAVO
- VWO

7. Welke klas zit je?

*Markeer slechts één ovaal.*

- Klas 1
- Klas 2
- Klas 3
- Klas 4
- Klas 5
- Klas 6

8. Waar zit je op school? Plaatsnaam en schoolnaam (schoolnaam is optioneel)

_____

9. Doe je zelf al veel met technologie?

*Vink alle toepasselijke opties aan.*

- [ ] Ik zit veel achter de computer
- [ ] Ik game graag
- [ ] Ik zit veel op social media
- [ ] Ik doe zelf niet veel met technologie

Anders: [ ] _____

10. Hoe zie jij het vak informatica?

*Markeer slechts één ovaal.*

- ◯ Als een technisch vak
- ◯ Voor mensen die computers interessant vinden
- ◯ Voor iedereen
- ◯ Anders: _____

11. Hoe denk je dat informatica nuttig voor jou kan zijn?

_____

_____

_____

_____

_____

12. Heb je informatica gekozen?

*Markeer slechts één ovaal.*

- ◯ Ik heb informatica WEL gekozen *Ga naar vraag 13*
- ◯ Ik heb informatica NIET gekozen *Ga naar vraag 25*
- ◯ Ik moet nog kiezen *Ga naar vraag 35*

*Ga naar vraag 13*

## Informatica wel gekozen

Deze vragen zijn om te kijken waarom jij informatica wel hebt gekozen.

13. Wordt er op jou school voorlichting gegeven over het vak informatica?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee

14. Hoe wordt voorlichting gegeven?

*Vink alle toepasselijke opties aan.*

- [ ] Voorlichtings moment (bijvoorbeeld door een presentatie van de docent)
- [ ] Proefles(sen)
- [ ] Materiaal (zoals flyers of boekjes) dat je thuis kunt bekijken
- [ ] Er wordt geen voorlichting over informatica gegeven bij mij op school
- [ ] Anders: _____

15. Vond je de voorlichting nuttig? Als er geen voorlichting gegeven wordt vul dan "Geen voorlichting" in.

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee

16. Waarom vond je de voorlichting wel of niet nuttig? Als er geen voorlichting gegeven wordt vul dan "Geen voorlichting" in.

_____

_____

_____

_____

_____

17. Wat heb je geleerd van de voorlichting? Als er geen voorlichting gegeven wordt vul dan "Geen voorlichting" in.

_____

_____

_____

_____

_____

18. Hoe heb jij de keuze gemaakt om informatica te kiezen? Heb je bijvoorbeeld met mensen gepraat, zelf informatie gezocht of iets heel anders?

19. Wist je genoeg over informatica en wat je daar allemaal mee kan leren voordat je de keuze maakte?

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Ik wist te weinig | ◯ | ◯ | ◯ | ◯ | ◯ | Ik wist genoeg |

20. Was er iets wat jouw keuze voor het vak lastig maakte?

21. Wanneer wist je dat je informatica wilde kiezen?

22. Waarom heb je informatica gekozen?

23. Wat vind je leuk aan informatica?

*Vink alle toepasselijke opties aan.*

- [ ] Programmeren
- [ ] Leren hoe computers werken
- [ ] Leren hoe het internet werkt
- [ ] Hoe social media in elkaar zit
- [ ] Online veiligheid
- [ ] De docent en hoe er les wordt gegeven
- [ ] Anders: _____

24. Wat vind je niet leuk aan informatica?

*Vink alle toepasselijke opties aan.*

- [ ] Programmeren
- [ ] Leren hoe computers werken
- [ ] Leren hoe het internet werkt
- [ ] Hoe social media in elkaar zit
- [ ] Online veiligheid
- [ ] De docent en hoe er les wordt gegeven
- [ ] Anders: _____

*Ga naar vraag 45*

## Informatica niet gekozen

Deze vragen zijn om te kijken waarom jij informatica niet hebt gekozen.

25. Wordt er op jou school voorlichting gegeven over het vak informatica?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee

26. Hoe werd de voorlichting gegeven?

*Vink alle toepasselijke opties aan.*

- ☐ Voorlichtings moment (bijvoorbeeld door een presentatie van de docent)
- ☐ Proefles(sen)
- ☐ Materiaal (zoals flyers of boekjes) dat je thuis kon bekijken
- ☐ Er wordt geen voorlichting over informatica gegeven bij mij op school
- Anders: ☐ _____

27. Vond je de voorlichting nuttig? Wat heb je geleerd van de voorlichting? Als er geen voorlichting gegeven wordt vul dan "Geen voorlichting" in.

_____

_____

_____

_____

_____

28. Hoe heb jij de keuze gemaakt om informatica niet te kiezen? Heb je bijvoorbeeld met mensen gepraat, zelf informatie gezocht of iets heel anders?

_____

_____

_____

_____

_____

29. Wist je genoeg over informatica en wat je daar allemaal mee kan leren voordat je de keuze maakte?

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Ik wist te weinig | ◯ | ◯ | ◯ | ◯ | ◯ | Ik wist genoeg |

30. Was er iets wat jou keuze voor het vak lastig maakte?

31. Wanneer wist je dat je informatica niet wilde kiezen?

32. Waarom heb je informatica niet gekozen?

33. Wat leek jou wel leuk aan informatica?

*Vink alle toepasselijke opties aan.*

- [ ] Programmeren
- [ ] Leren hoe computers werken
- [ ] Leren hoe het internet werkt
- [ ] Hoe social media in elkaar zit
- [ ] Online veiligheid
- [ ] De docent en hoe er les wordt gegeven
- [ ] Anders: _____

34. Wat leek jou niet leuk aan informatica?

*Vink alle toepasselijke opties aan.*

- [ ] Programmeren
- [ ] Leren hoe computers werken
- [ ] Leren hoe het internet werkt
- [ ] Hoe social media in elkaar zit
- [ ] Online veiligheid
- [ ] De docent en hoe er les wordt gegeven
- [ ] Anders: _____

*Ga naar vraag 45*

Moet nog kiezen

Deze vragen zijn om te kijken hoe jij gaat beslissen of je informatica wel of niet gaat kiezen.

35. Wordt er op jou school voorlichting gegeven over het vak informatica?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee
- ◯ Weet ik niet

36. Hoe wordt voorlichting gegeven?

*Vink alle toepasselijke opties aan.*

- [ ] Voorlichtings moment (bijvoorbeeld door een presentatie van de docent)
- [ ] Proefles(sen)
- [ ] Materiaal (zoals flyers of boekjes) dat je thuis kon bekijken
- [ ] Er wordt geen voorlichting over informatica gegeven bij mij op school

Anders: ☐ _____

37. Vond je de voorlichting nuttig? Wat heb je geleerd van de voorlichting? Als er geen voorlichting gegeven wordt of je hebt die nog niet gehad vul dan "Geen voorlichting" in.

_____

_____

_____

_____

_____

38. Hoe ga je de keuze maken om informatica wel of niet te kiezen? Ga je bijvoorbeeld met mensen praten, zelf informatie zoeken of iets heel anders?

_____

_____

_____

_____

_____

39. Weet je genoeg over informatica en wat je daar allemaal mee kan leren voordat je de keuze maakt?

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Ik weet te weinig | ◯ | ◯ | ◯ | ◯ | ◯ | Ik weet genoeg |

40. Is er iets wat jou keuze voor het vak lastig maakt?

41. Wanneer denk je dat je weet of je informatica wil kiezen of niet?

42. Ga je informatica kiezen denk je?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee
- ◯ Ik weet het nog niet

43. Wat lijkt jou leuk aan informatica?

*Vink alle toepasselijke opties aan.*

- ☐ Programmeren
- ☐ Leren hoe computers werken
- ☐ Leren hoe het internet werkt
- ☐ Hoe social media in elkaar zit
- ☐ Online veiligheid
- ☐ De docent en hoe er les wordt gegeven

Anders: ☐

44. Wat lijkt jou niet leuk aan informatica?

*Vink alle toepasselijke opties aan.*

- [ ] Programmeren
- [ ] Leren hoe computers werken
- [ ] Leren hoe het internet werkt
- [ ] Hoe social media in elkaar zit
- [ ] Online veiligheid
- [ ] De docent en hoe er les wordt gegeven

Anders: [ ] _____

*Ga naar vraag 45*

## Verbeteringen van het Informatica-onderwijs

Tot slot vraag ik je hoe je informatica als vak beter zou willen maken.

45. Wat vind je goed aan informatica, het vak zelf maar ook hoe het bij jou op school gegeven wordt?

_____

_____

_____

_____

_____

46. Wat vind je slecht aan informatica, het vak zelf maar ook hoe het bij jou op school gegeven wordt?

_____

_____

_____

_____

_____

47. Hoe kan informatica als vak nog meer verbeteren denk je?

48. Hoe denk je dat het informatica onderwijs verbeterd kan worden om het nog interessanter en leuker te maken voor iedereen?

*Ga naar vraag 49*

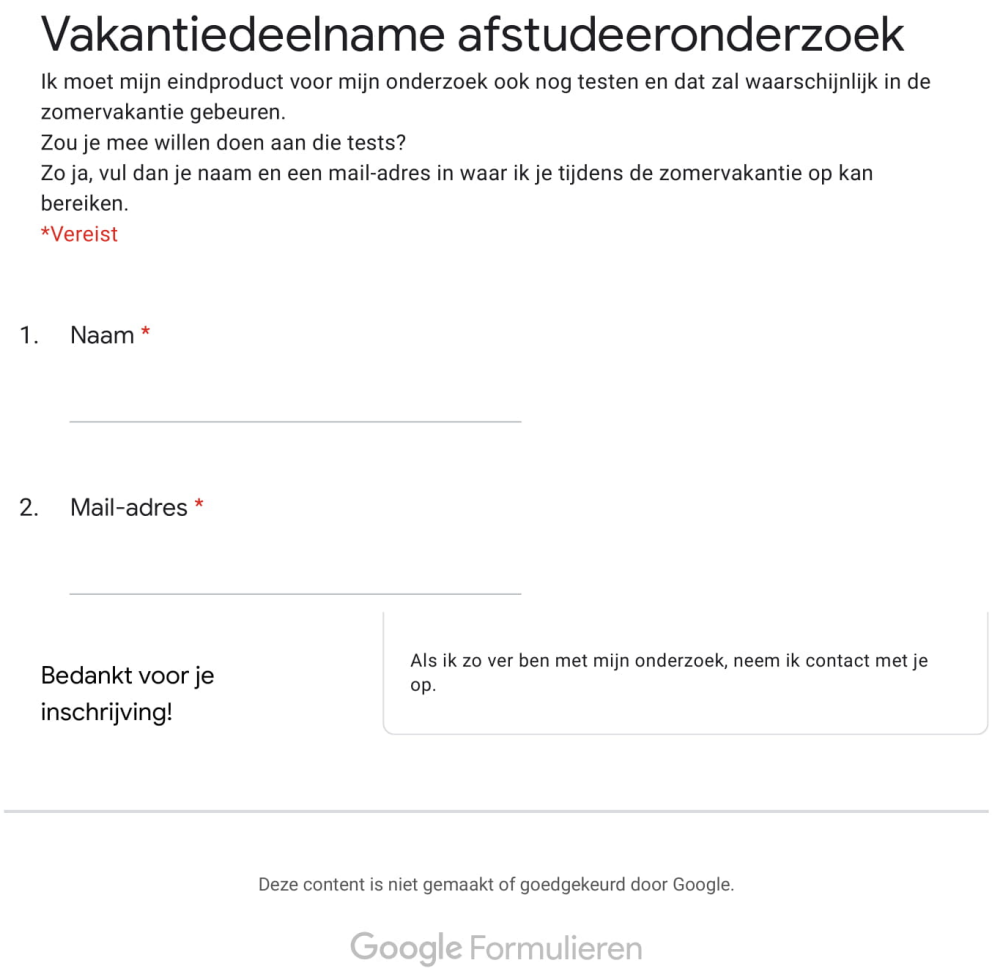
Bedankt voor je hulp!

49. Heb je nog opmerkingen, suggesties of tips?

**Als je op de hoogte gehouden wilt worden over dit onderzoek en het eindresultaat kun je altijd contact met mij opnemenen via de mail. p.tuinman@student.utwente.nl**

**Appendix C.2 Pupil vacation test participation**

After filling in the pupil survey, the pupils were presented with a link that led to this small survey. The purpose of this survey was to potentially gather pupils who would be willing to participate in testing during their summer vacation. Unfortunately, no responses were gathered.



Vakantiedeelname afstudeeronderzoek

Ik moet mijn eindproduct voor mijn onderzoek ook nog testen en dat zal waarschijnlijk in de zomervakantie gebeuren.
Zou je mee willen doen aan die tests?
Zo ja, vul dan je naam en een mail-adres in waar ik je tijdens de zomervakantie op kan bereiken.
*Vereist

1. Naam *

2. Mail-adres *

Bedankt voor je inschrijving!

Als ik zo ver ben met mijn onderzoek, neem ik contact met je op.

Deze content is niet gemaakt of goedgekeurd door Google.

Google Formulieren

## Appendix C.3 Teacher survey

This survey was spread around to the teachers through the newsletter of the trade union of informatics teachers I&I. A total of four meaningful responses were generated.

# Docenten Vragenlijst - Informatica keuze en motivatie

Hallo, mijn naam is Philippe Tuinman en ik ben momenteel bezig met mijn afstudeerscriptie binnen de Bachelor Creative Technology aan de Universiteit Twente.

Voor mijn onderzoek ben ik aan het kijken hoe leerlingen op middelbare scholen enthousiast(er) gemaakt kunnen worden voor het vak informatica. Ik denk dat het heel belangrijk is voor leerlingen om beter bekend te zijn met technologie dan het alleen te gebruiken. Dan kunnen ze er onder andere ook hun eigen mening over vormen. Vandaar dat ik wil kijken hoe de keuze voor het vak informatica aangemoedigd kan worden.

Daarbij heb ik uw hulp nodig!
Omdat ik zelf weinig tot geen ervaring heb met het geven van informatica-lessen op een middelbare school kan ik moeilijk de situatie inschatten. Zeker nu ik ook geen observaties op locatie meer kan doen door de coronacrisis is dit erg lastig.
Daarnaast verschilt de situatie ook nog eens per school.
Graag zou ik u daarom willen vragen om de volgende vragenlijst in te vullen, zodat ik een beter beeld krijg over de situatie bij u op school en binnen uw vak.
Het zijn een flink aantal vragen, maar het beantwoorden zou niet langer dan 15 – 20 minuten moeten duren.

Ik zal kijken waar het maken van de keuze op gebaseerd wordt voor allerlei middelbare scholieren (van verschillende leeftijd, geslacht, afkomst etc.) en hoe die keuze op een positieve manier beïnvloed kan worden. Ligt het aan het beeld wat de scholieren hebben van het vak? Lijkt het ze te technisch? Hebben ze wel genoeg en de juiste informatie om een goed beeld te kunnen vormen? Hoe is enthousiasme voor een vak überhaupt te wekken? Maar ook de vragen als: Wat is belangrijk bij het onderwijzen van een vak informatica? En welke manieren kunnen een goede introductie bieden voor het vak?
Dit zijn een aantal vragen die ik probeer te beantwoorden door middel van deze vragenlijst.
*Vereist

Toestemmingsinformatie

Door middel van deze informatie wil ik u extra inzage geven over het doel van mijn onderzoek en hoe u daar aan kunt bijdragen. Volgens de overheid is de beheersing van digitale vaardigheden vereist om beter te kunnen functioneren in onze moderne maatschappij. Gebruik van technologieën zoals smartphones, tablets en laptops is een basis, maar niet genoeg. Om een goede mening te kunnen vormen over de functionaliteit, de invloeden en gevolgen deze technologieën op de maatschappij en het individu zijn vaardigheden die dieper gaan dan "alleen het weten te gebruiken van" vereist.
Ik sluit me persoonlijk aan bij het beeld van de overheid. Vanuit mijn studie heb ik ook geleerd dat er meer aan technologie te pas komt dan alleen maar de functionaliteit. Het heeft veel invloeden, meer dan men soms denkt, op ons als mens en hoe wij met onze medemens en omgeving omgaan.

De overheid ziet het vak informatica als een goede stap voor leerlingen om technologie beter te begrijpen. Daarom wil ik kijken hoe informatica onder de aandacht wordt gebracht bij de leerlingen en wat de mogelijkheden zijn om die keuze aan te moedigen bij de leerlingen. Niet door ze te forceren informatica te kiezen, maar om ze goed kennis te laten maken met het vak door ook te laten zien dat het ook voor hen belangrijk is. Dit alles op een motiverende en interactieve manier.
Alleen moet ik eerst een goed beeld krijgen van het vak, de situatie op school, ervaringen op school en hoe de voorlichting over het vak op dit moment plaatsvindt.

Om die reden presenteer ik u een vragenlijst om deze vragen te beantwoorden.
De vragenlijst is erg uitgebreid maar zou niet meer dan 15 – 20 minuten moeten duren om te beantwoorden.
Na afronding van het onderzoek mag u natuurlijk de resultaten van dit onderzoek opvragen. Hiervoor kunt u aan het eind van de vragenlijst uw e-mailadres invullen.

Ik wil u vragen voorafgaand de vragenlijst deze toestemmingsinformatie goed door te lezen en te ondertekenen als u hiermee akkoord gaat.

Als deelnemer van deze vragenlijst:
Zal u gevraagd worden een vragenlijst in te vullen. Deze vragenlijst gaat over:
- Uzelf als persoon
- Uw ervaringen met het vak informatica en een eventuele voorlichting daarvan
- Uw aanbevelingen voor verbeteringen voor het vak en de voorlichting

Deelname aan dit onderzoek is geheel vrijwillig. U hoeft geen vragen te beantwoorden die u niet wilt beantwoorden. De antwoorden worden opgeslagen op een veilige plek; alleen de onderzoeker heeft toegang. Deze antwoorden zullen geanonimiseerd, verwerkt en gepresenteerd worden in het onderzoeksverslag. Anonieme citaten of fragmenten kunnen eruit worden gehaald om toe te voegen aan het afstudeerverslag. Op elk moment kan u uw toestemming terug trekken en zal de deelname per direct worden stopgezet waarbij de gegevens ook correct zullen worden verwijderd. U bent vrij om op elk moment om welke reden dan ook uw deelname aan het onderzoek te stoppen. Om dit stopzetten te kunnen faciliteren vraag ik u om een bijnaam op te geven. Op deze manier kan ik uw antwoorden koppelen aan de door u gegeven bijnaam om uw aanvraag voor stopzetting te verwerken. Voor vragen kunt u bij mij terecht, of bij mijn begeleider (Angelika Mader), de contactgegevens zijn onderaan te vinden.

Wilt u graag onafhankelijk advies over meedoen aan dit onderzoek, of een klacht indienen? Dan kunt u terecht bij Petri de Willigen, secretaris van de Ethische Commissie (tel. 053-489 2085, ethics-comm-ewi@utwente.nl). Deze commissie bestaat uit onafhankelijke deskundigen van de Universiteit Twente en is beschikbaar voor vragen en klachten rondom het onderzoek.

Met vriendelijke groeten,
Philippe Tuinman
p.tuinman@student.utwente.nl
06-57077926

Begeleider: Angelika Mader
a.h.mader@utwente.nl

1. Welke unieke bijnaam wilt u gebruiken om anoniem te blijven? *

2. Ik heb de bovenstaande informatie gelezen, heb hier geen vragen meer over en ga hiermee akkoord. *

   *Markeer slechts één ovaal.*

   ◯ Ik ga akkoord *Ga naar vraag 3*
   ◯ Ik ga niet akkoord *Ga naar vraag 47*

## Demografisch

Deze vragen zijn om mij een beeld te geven over uzelf als informatica-docent.

3. Geslacht

*Markeer slechts één ovaal.*

- ◯ Man
- ◯ Vrouw
- ◯ Zeg ik liever niet
- ◯ Anders: _____

4. Leeftijd

_____

5. Functie

*Markeer slechts één ovaal.*

- ◯ Docent informatica middelbare school
- ◯ Student informatica-lerarenopleiding
- ◯ Anders: _____

6. Hoe lang werkt u al binnen het informatica-onderwijs?

*Markeer slechts één ovaal.*

- ◯ Minder dan 1 jaar
- ◯ Tussen 1 en 2 jaar
- ◯ Tussen 2 en 3 jaar
- ◯ Tussen 3 en 4 jaar
- ◯ Tussen 4 en 5 jaar
- ◯ Meer dan 5 jaar

7. Aan welke niveaus geeft u informatica les?

*Vink alle toepasselijke opties aan.*

- ☐ HAVO
- ☐ VWO

8. Gebruikt u een lesmethode of door uzelf ontwikkeld materiaal?

*Markeer slechts één ovaal.*

- ◯ Lesmethode
- ◯ Zelf ontwikkeld materiaal
- ◯ Combinatie van een lesmethode en eigen materiaal
- ◯ Anders: _____

9. Wat zijn uw belangrijkste criteria voor het kiezen van dit lesmateriaal of een combinatie van lesmateriaal en eigen materiaal?

_____

_____

_____

_____

_____

10. Welke programmeertaal hanteert u voornamelijk binnen uw lessen?

*Vink alle toepasselijke opties aan.*

- ☐ Java
- ☐ Python
- ☐ HTML
- ☐ PHP
- ☐ Processing
- ☐ Arduino
- ☐ Scratch

Anders: ☐ _____

11. Informatica wordt vaak gezien als een technisch vak. Ziet u informatica ook zo?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee
- ◯ Misschien

12. Hoe presenteert u of de school het vak?

*Markeer slechts één ovaal.*

- ◯ Een typisch bètavak
- ◯ Voor degene die interesse heeft in computers
- ◯ Voor iedereen
- ◯ Anders: _____

13. Vindt u het belangrijk dat leerlingen informatica volgen? Waarom wel / niet?

_____

_____

_____

_____

_____

14. Is het voor de school wenselijk dat meer leerlingen voor het vak kiezen?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee
- ◯ Weet ik niet

15. Zijn er voor de school ook nog limitaties als meer leerlingen het vak kiezen? Zo ja, hoe zien die er uit?(bijvoorbeeld tekort aan docenten of computerlokalen)

_____

_____

_____

_____

_____

16. Worden er naast het vak informatica bij u op school ook nog op andere manieren informatica-achtige onderwerpen aangeboden? Zo ja, welke? (bijvoorbeeld thema-weken, hackathon etc.)

_____

_____

_____

_____

_____

*Ga naar vraag 17*

## Keuze voor het vak

Dit deel van de vragenlijst is bedoeld om inzicht te krijgen in de manieren waarop het vak informatica onder de aandacht van de scholieren wordt gebracht.

17. Waarop baseren leerlingen naar uw mening hun keuze voor het vak informatica vooral?

*Vink alle toepasselijke opties aan.*

- [ ] Beeld van het vak
- [ ] Ervaringen van oudere leerlingen
- [ ] Informatie gegeven door de school
- [ ] Ouders
- Anders: [ ] _____

18. Wat zou volgens u naast de factoren die in de vorige vraag zijn genoemd de leerlingen verder nog helpen om een goed gefundeerde keuze te maken voor het vak?

_____

_____

_____

_____

_____

19. Wordt er bij u op school voorlichting gegeven over het informatica vak?

*Markeer slechts één ovaal.*

- ◯ Ja *Ga naar vraag 24*
- ◯ Nee *Ga naar vraag 20*

## Voorlichting wordt niet gegeven

Deze vragen gaan iets dieper in op het feit dat er geen voorlichting gegeven wordt.

20. Waarom wordt er geen voorlichting gegeven?

_____

_____

_____

_____

_____

21. Zou u wel voorlichtingen willen aanbieden? Waarom wel of niet?

22. Zou een voorlichting volgens u helpen de leerling een gefundeerde keuze te laten maken?

*Markeer slechts één ovaal.*

- Ja
- Nee
- Misschien

23. Waarom zou dit helpen volgens u? Als u nee heeft ingevuld vul dan "Helpt niet" in.

*Ga naar vraag 34*

## Voorlichting wordt gegeven

Deze vragen gaan iets dieper in op uw manier van voorlichten en de effecten daar van.

24. Op welke manier biedt u voorlichting over het vak?

*Vink alle toepasselijke opties aan.*

- [ ] Voorlichtings moment (door middel van een presentatie bijvoorbeeld)
- [ ] Proefles(sen)
- [ ] Materiaal wat door de scholier thuis bestudeerd kan worden
- [ ] Anders: _____

25. Wat vindt u het belangrijkste om aan de scholieren mee te geven in uw voorlichting?

26. Helpt de voorlichting volgens u de leerling een gefundeerde keuze te maken?

*Markeer slechts één ovaal.*

- Ja
- Nee
- Misschien

27. Waarom helpt dit volgens u? Als u nee heeft ingevuld waarom helpt dat niet volgens u?

28. Wat in uw voorlichting helpt de scholieren het meest bij het maken van hun keuze?

29. Is de voorlichting verplicht?

*Markeer slechts één ovaal.*

- Ja
- Nee

30. Ziet u een verschil in het keuzeproces tussen scholieren die de voorlichting wel volgen tegenover de scholieren die dat niet doen?

*Markeer slechts één ovaal.*

- Ja
- Nee
- Misschien

31. Waarin ziet u dat verschil? Als u geen verschil ziet vul dan in "Geen verschil".

32. Hoeveel invloed denkt u dat uw voorlichting heeft op de keuze van de scholier?

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | |
|---|---|---|---|---|---|---|
| Geen invloed | | | | | | Veel invloed |

33. Hoe zouden de voorlichtingen verbeterd kunnen worden? Wat zouden goede toevoegingen zijn?

*Ga naar vraag 34*

## Motivatie Scholieren

Deze vragen gaan om de motivatie van de scholieren zelf en hoe u deze meemaakt/observeert.

34. Hoe geïnteresseerd zijn uw scholieren gemiddeld? (onder interesse versta ik dat de scholieren het vak boeiend vinden)

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Niet geïnteresseerd | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Erg geïnteresseerd |

35. Hoe gemotiveerd zijn uw scholieren gemiddeld? (onder motivatie versta ik dat de scholieren het vak graag aangrijpen om mee aan de slag te gaan)

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Niet gemotiveerd | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Erg gemotiveerd |

36. Ziet u een verschil tussen de interesse en motivatie van uw leerlingen? Zo ja, waar kan dat volgens u aan liggen? Zo nee, vul "Nee" in.

37. Welke scholieren lijken het meest geïnteresseerd en gemotiveerd?

*Markeer slechts één ovaal.*

- ◯ Jongens
- ◯ Meisjes
- ◯ Maakt geen verschil

38. Als u een verschil ziet betreffende de interesse en motivatie tussen jongens en meisjes, waar kan dat aan liggen volgens u? Als u geen verschil ziet, vul "Geen verschil" in.

39. In hoeverre verschilt de interesse en motivatie tussen HAVO en VWO leerlingen? Als u geen verschil ervaart vul dan "Geen verschil" in.

_____

40. In hoeverre zijn uw scholieren (gemiddeld) al bekend met technologie in het algemeen?

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Erg onbekend | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Erg bekend |

41. In hoeverre zijn uw scholieren (gemiddeld) al bekend met de stof die ze bij u leren?

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Erg onbekend | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Erg bekend |

42. Heeft u speciale manieren om de informatica lessen interessant te maken voor leerlingen? Zo ja, hoe doet u dat? Zo nee, vul "Nee" in.

_____

_____

_____

_____

_____

43. Evalueert u uw eigen manier van lesgeven om de interesse en motivatie van de scholieren te verhogen? Zo ja, hoe doet u dat? Zo nee, vul "Ik evauleer niet" in.

_____

_____

_____

_____

_____

*Ga naar vraag 44*

## Verbeteringen binnen het Informatica-onderwijs

Tot slot vraag ik u om uw inzichten over de verbetering van het informatica-onderwijs.

44. Hoe denkt u dat het informatica onderwijs verbeterd kan worden om het nog interessanter en leuker te maken voor de scholieren in het algemeen?

45. Hoe denkt u dat het informatica onderwijs verbeterd kan worden om het nog interessanter en leuker te maken voor meisjes?

46. Hoe zou u het beeld van informatica willen veranderen / presenteren? Als u het beeld niet wilt veranderen, vul "Geen verandering" in.

*Ga naar vraag 47*

Hartelijk dank voor uw hulp!

47. Heeft u nog opmerkingen, suggesties of tips?

48. Als u op de hoogte gehouden wilt worden over dit onderzoek en het eindresultaat kunt hier uw mail-adres invullen.

## Appendix D – Dutch version of the quartets text

### Appendix D.1 Streaming

**Diensten -** Streaming wordt aangeboden via streamingdiensten. Spotify, Netflix, YouTube en Twitch zijn welbekende diensten die allemaal iets anders aanbieden. Een abonnement geeft meer mogelijkheden of is überhaupt nodig om de dienst te gebruiken.

**Media -** Streaming kan toegang geven tot verschillende soorten media. Met Spotify kun je naar muziek luisteren en Netflix geeft toegang tot een enorme hoeveelheid films en series. Het nieuwe Google Stadia laat je op een soortgelijke manier zelfs games streamen zodat je ze kunt spelen.

**Resolutie -** Resolutie betekend de scherpte van het beeld. De hoogte van resolutie wordt aangegeven in het aantal horizontale pixels. Hoe meer pixels hoe scherper het beeld en hoe meer detail te zien is. Beeldschermen met een 8K resolutie hebben dus 8000 pixels horizontaal.

**Bufferen -** Voordat het afspelen van muziek of video begint wordt er al een deel gedownload. Hierdoor kan je zonder onderbrekingen luisteren of kijken, zelfs als er tussendoor wat vertragingen zijn in het internetsignaal.

### Appendix D.2 Programmeren

**Syntax -** De syntax zijn de regels die de code van een programmeertaal structureert. Dit kan je zien als de grammatica van die specifieke programmeertaal. Als er fouten worden gemaakt in de syntax van het programma krijg je errors.

**Commands -** Dit is een specifieke opdracht die wordt uitgevoerd in de code. Dit kan er bijvoorbeeld voor zorgen dat een regel code een bepaald aantal keer wordt herhaald of dat een regel code alleen wordt uitgevoerd als bepaalde eisen voldoen.

**Tekstueel Programmeren -** Hierbij is de programmeertaal opgebouwd uit tekst en leestekens die in regels onder elkaar worden getypt om het programma te maken. Over het algemeen gebeurd programmeren op deze manier. De meest bekende programmeertalen zijn Python, Java en C.

**Visueel Programmeren -** Hierbij wordt het programma opgebouwd uit visuele blokjes die in elkaar worden geklikt om. Programmeertalen zoals Scratch en Snap! gebruiken deze vorm van programmeren. Dit is een makkelijke manier om te oefenen met programmeren.

### Appendix D.3 Toepassingen

**Google -** Google was in 1998 bedoeld om het structureren en vinden van informatie op het internet makkelijker te maken. Het is nog steeds de bekendste zoekmachine ter wereld. Tegenwoordig heeft Google veel verschillende diensten zoals Google Maps, Google Drive en Gmail.

**Internet of Things -** Afgekort IoT is een veelgebruikte term in de ICT-wereld. Hiermee wordt bedoeld dat steeds meer dagelijkse voorwerpen worden verbonden aan het internet. Een voorbeeld hiervan zijn smart home toepassingen, zoals Philips Hue en Google Home.

**Logistiek -** ICT wordt ook steeds meer gebruikt binnen logistieke systemen. Het digitaal bijhouden en automatisch doorvoeren van vrachten, maar ook het makkelijker bij kunnen houden van je voorraad wordt een stuk makkelijker en overzichtelijker.

**Zorg -** Binnen de zorg wordt technologie steeds meer toegepast. Dit kan helpen bij het leveren van kwaliteit, veiligheid en kan zorg betaalbaarder en makkelijker maken voor de patiënt en verzorger.

**Appendix D.4 Gaming**

**Input -** Input is hoe jij het besturen van de game communiceert. Dit kan via een joystick, toetsenbord of controller zijn. Op verschillende manieren is input te geven: via knoppen, een touchscreen of met bewegingen zoals bij de Wii.

**Output -** Output is wat de game naar jou communiceert. Dit is natuurlijk wat je op het scherm ziet gebeuren, maar kunnen ook lichteffecten zijn op je controller of de vibraties ervan.

**Graphics -** Wat je ziet op het beeldscherm noemen we graphics. Deze kunnen in 2D zijn, zoals veel Mario spellen, maar ze kunnen ook in 3D zijn zoals je nu over het algemeen ziet. Vaak worden er veel berekeningen gedaan om deze graphics te laten zien.

**Frame Rate -** Ook wel bekend als FPS wat staat voor Frames Per Second. Dit gaat over het aantal frames dat je te zien krijgt per seconde. Een frame is één afbeelding op je scherm, hoe meer afbeeldingen per seconde, hoe vloeiender het beeld.

**Appendix D.5 Netwerken**

**Internet -** Dit is een afkorting van *internetwork*: onderling verbonden netwerken. Het internet is een groot netwerk wat ervoor zorgt dat informatie en communicatie uitgewisseld kan worden. Hierdoor kun je op het World Wide Web.

**Firewall -** Een firewall beschermt het netwerk tegen misbruik van buitenaf. Het scant al het binnenkomende netwerkverkeer en bepaalt of het gevaarlijk is of niet.

**Router -** Dit apparaat verbindt meerdere netwerken met elkaar. Het zorgt ervoor dat groepen informatie naar de juiste plek worden gecommuniceerd binnen het netwerk. Dit staat ook wel bekend als het apparaat wat alle WiFi signalen in je huis regelt.

**Nodes** - Dit zijn alle apparaten die aangesloten binnen een netwerk zoals je computer, laptop en smartphone. Een printer of beveiligingscamera kunnen bijvoorbeeld ook onderdeel zijn van een netwerk.

**Appendix D.6 Privacy**

**AVG -** De Algemene Verordening Gegevensbescherming is de privacywetgeving binnen de EU en staat ook wel bekend onder de Engelse afkorting GDPR. Deze wet zorgt ervoor dat er door andere partijen zorgvuldig met jou gegevens moet worden omgegaan.

**Cookies -** Cookies zijn kleine bestanden die op je computer worden opgeslagen als je een website bezoekt. Deze bestanden slaan informatie op over bijvoorbeeld je voorkeursinstellingen, hoe je een website gebruikt, maar ook wat voor soort advertenties het beste bij jou passen.

**Persoonsgegevens -** De combinatie van al deze gegevens en informatie geeft een beeld van jou als persoon. Dit kan bijvoorbeeld je geboortedatum, bankrekening of adres zijn, maar ook de route die je naar school fietst zegt iets over jou.

**Hacken -** De actie waarbij iets of iemand zonder toestemming informatie verkrijgt van een persoon of instantie. Dit kan gebeuren door een virus, maar kan ook door iemand te misleiden om persoonsgegevens in te vullen.

**Appendix D.7 Social Media**

**Platforms -** Het social media platform is waar het contact plaatsvindt. YouTube, Instagram, TikTok en Snapchat richten zich meer op het delen van media. Facebook, LinkedIn en WhatsApp gaan meer over het onderhouden van contact met anderen.

**Gebruikers Profiel -** Dit zijn de gegevens waarmee jij jezelf presenteert naar anderen. Dit kan met veel verschillende informatie over jezelf. Gelukkig kun je ook bepalen wie jouw profiel kan bekijken en wat zij kunnen zien.

**Reclame -** Omdat er veel tijd wordt doorgebracht op social media is het de ideale plek voor bedrijven om reclame aan te bieden. De reclames worden aan de hand van de data die ze over jou verzamelen zo goed mogelijk op jou aangepast. Dat maakt de reclames zo aantrekkelijk mogelijk.

**Influencer -** Social media maken het een stuk makkelijker om met een publiek over de hele wereld in contact te komen. Een social media influencer kan gebruik maken van hun contacten om reclame te maken voor een bedrijf, maar ook om op te roepen tot actie, bijvoorbeeld voor een beter milieu.

**Appendix D.8 Smartphones**

**Operating System -** Ook wel afgekort naar OS. Dit is het besturingssysteem van je telefoon en zorgt ervoor dat je smartphone functioneert door de software en de hardware aan te sturen. De meest bekende zijn Android en iOS.

**Sensoren -** In je smartphone zitten heel veel sensoren die fysieke eigenschappen of veranderingen meten. De grootste sensor is je touchscreen wat de besturing van je telefoon mogelijk maakt. Andere sensoren zijn de camera, microfoon en GPS bijvoorbeeld.

**Scherm -** Je scherm is niet alleen maar een touchscreen wat te gebruiken is als input, het is ook een output in de vorm van een scherm. Hierdoor kan je al je berichten, apps, foto’s en filmpjes zien.

**Apps -** Dit is de afkorting voor *application*: software ontwikkeld met een specifieke functie in gedachten. Apps op een smartphone kunnen spelletjes, social media of Magister zijn, maar je wekker wordt ook geregeld door een app.

**Appendix E – Final quartets prototype – Informati-Kwartet**

Fonts used: Arial, Arial Rounded MT Bold, LIBRARY 3AM (soft) by Igor Kosinky[14] and Anthem Nasney by cove703[15].





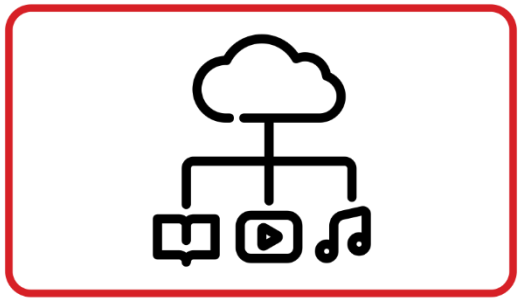
[14] https://www.fontspace.com/library-3-am-font-f30355
[15] https://www.fontspace.com/anthem-nasney-font-f32271

## Streaming

Diensten | Resolutie

Media | Buffering

## Streaming



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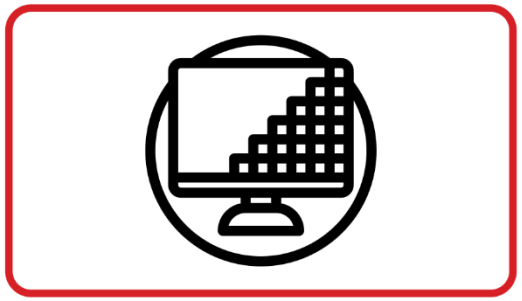
Diensten | Resolutie

Media | Buffering

## Streaming



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Diensten | Resolutie

Media | Buffering

INFORMATI Kwartet

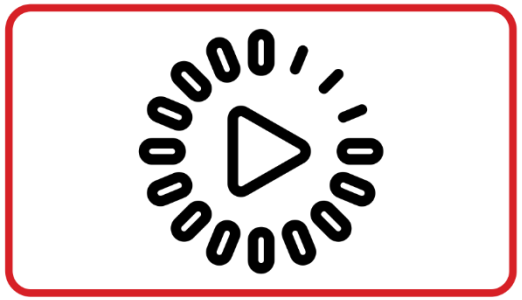
## Streaming

Streaming kan toegang geven tot verschillende soorten media. Met Spotify kun je naar muziek luisteren en Netflix geeft toegang tot een enorme hoeveelheid films en series. Het nieuwe Google Stadia laat je op een soortgelijke manier zelfs games streamen zodat je ze kunt spelen.

Diensten | Resolutie

Media | Buffering

## Streaming



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Diensten | Resolutie

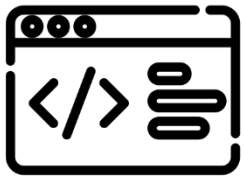
Media | Buffering

## Programmeren

Syntax | Visueel Programmeren

Commands | Textueel Programmeren

## Programmeren



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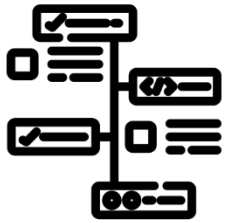
Syntax | Visueel Programmeren

Commands | Textueel Programmeren

## Programmeren



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Syntax | Tekstueel Programmeren

Commands | Visueel Programmeren

INFORMATI
Kwartet

## Programmeren

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Syntax | Visueel Programmeren

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Syntax | Tekstueel Programmeren

Commands | Visueel Programmeren

## Toepassingen

Google

Logistiek

Internet of Things

Zorg

## Toepassingen

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Google

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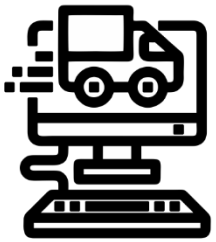

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Google

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Internet of Things

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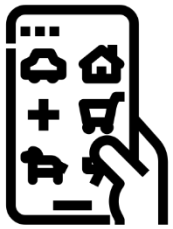
INFORMATI

Kwartet

## Toepassingen



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Google

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Google

Logistiek

Internet of Things

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## Gaming

Input | Graphics
Output | Frame Rate

## Gaming

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Input | Graphics
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Input | Graphics
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INFORMATI
Kwartet

## Gaming

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Input | Graphics
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Input | Graphics
Output | Frame Rate

## Netwerken

Internet | Router

Firewall | Nodes

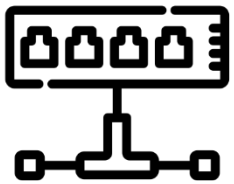
## Netwerken

Dit is een afkorting van internetwork: onderling verbonden netwerken. Het internet is een groot netwerk wat ervoor zorgt dat informatie en communicatie uitgewisseld kan worden. Hierdoor kun je op het World Wide Web.

Internet | Router

Firewall | Nodes

## Netwerken



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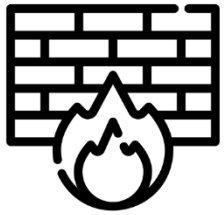
Internet | Router

Firewall | Nodes

INFORMATI
Kwartet

## Netwerken



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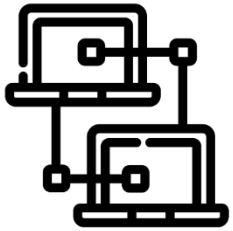
Internet | Router

Firewall | Nodes

## Netwerken



Dit zijn alle apparaten die aangesloten zijn binnen een netwerk zoals je computer, laptop en smartphone. Een printer of beveiligingscamera kunnen bijvoorbeeld ook onderdeel zijn van een netwerk.

Internet | Router

Firewall | Nodes

## Privacy

AVG | Persoonsgegevens
Cookies | Hacken

## Privacy

De Algemene Verordening Gegevensbescherming is de privacywetgeving binnen de EU en staat ook wel bekend onder de Engelse afkorting GDPR. Deze wet zorgt ervoor dat er door andere partijen zorgvuldig met jouw gegevens moet worden omgegaan.

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AVG | Persoonsgegevens
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INFORMATI
Kwartet

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AVG | Persoonsgegevens
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## Privacy

De actie waarbij iets of iemand zonder toestemming informatie verkrijgt van een persoon of instantie. Dit kan gebeuren door een virus, maar kan ook door iemand te misleiden om persoonsgegevens in te vullen.

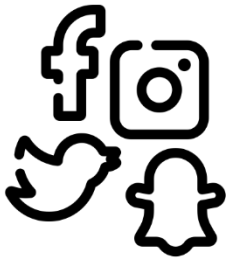
AVG | Persoonsgegevens
Cookies | Hacken

## Social Media

Platforms | Reclame

Gebruikers Profiel | Influencer

## Social Media



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Platforms | Reclame

Gebruikers Profiel | Influencer

## Social Media

Omdat er veel tijd wordt doorgebracht op social media is het de ideale plek voor bedrijven om reclame aan te bieden. De reclames worden aan de hand van de data die ze over jou verzamelen zo goed mogelijk op jou aangepast. Dat maakt de reclames zo aantrekkelijk mogelijk.

Platforms | Reclame

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INFORMATI
Kwartet

## Social Media

Dit zijn de gegevens waarmee jij jezelf presenteert naar anderen. Dit kan met veel verschillende informatie over jezelf. Gelukkig kun je ook bepalen wie jouw profiel kan bekijken en wat zij kunnen zien.

Platforms | Reclame

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Social media maken het een stuk makkelijker om met een publiek over de hele wereld in contact te komen. Een social media influencer kan gebruik maken van hun contacten om reclame te maken voor een bedrijf, maar ook om op te roepen tot actie, bijvoorbeeld voor een beter milieu.

Platforms | Reclame

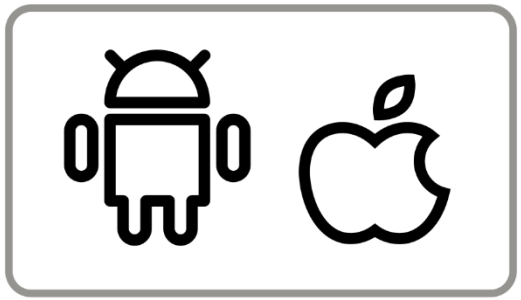
Gebruikers Profiel | Influencer

## Smartphones

Operating System | Scherm

Sensoren | Apps

## Smartphones



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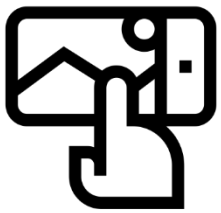
Operating System | Scherm

Sensoren | Apps

## Smartphones



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Operating System | Scherm

Sensoren | Apps

INFORMATI Kwartet

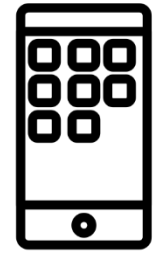
## Smartphones

In je smartphone zitten heel veel sensoren die fysieke eigenschappen of veranderingen meten. De grootste sensor is je touchscreen wat de besturing van je telefoon mogelijk maakt. Andere sensoren zijn de camera, microfoon en GPS bijvoorbeeld.

Operating System | Scherm

Sensoren | Apps

## Smartphones



Dit is de afkorting voor application: software ontwikkeld met een specifieke functie in gedachten. Apps op een smartphone kunnen spelletjes, social media of Magister zijn, maar je wekker wordt ook geregeld door een app.

Operating System | Scherm

Sensoren | Apps

## Appendix F – List of icons used

| | |
|---|---|
| **Networks** | |
| Internet | https://www.flaticon.com/free-icon/internet_3076390 |
| Firewall | https://www.flaticon.com/free-icon/firewall_3067922 |
| Router | https://www.flaticon.com/free-icon/network_3176012 |
| Nodes | https://www.flaticon.com/free-icon/cloud_3175986 |
| **Smartphones** | |
| Operating System | https://www.flaticon.com/free-icon/android_546059<br>https://www.flaticon.com/free-icon/apple_1216880 |
| Sensors | https://www.flaticon.com/free-icon/sensor_2540142 |
| Screen | https://www.flaticon.com/free-icon/smartphone_3039010 |
| Apps | https://www.flaticon.com/free-icon/iphone_915687 |
| **Privacy** | |
| GDPR | https://www.flaticon.com/free-icon/file_3143414 |
| Cookies | https://www.flaticon.com/free-icon/cookie_1035040 |
| Personal Data | https://www.flaticon.com/free-icon/personal-information_3076343 |
| Hacking | https://www.flaticon.com/free-icon/shield_3067856v |
| **Programming** | |
| Syntax | https://www.flaticon.com/free-icon/code_2920242 |
| Commands | https://www.flaticon.com/free-icon/algorithm_910083 |
| Textual Programming | https://www.flaticon.com/free-icon/algorithm_997720 |
| Visual Programming | https://www.flaticon.com/free-icon/puzzle_1408791 |
| **Applications** | |
| Google | https://www.flaticon.com/free-icon/google_2991163 |
| Internet of Things | https://www.flaticon.com/free-icon/applications_3063632 |
| Logistics | https://www.flaticon.com/free-icon/truck_2687398 |
| Healthcare | https://www.flaticon.com/free-icon/computer_2941399 |

| | |
|---|---|
| **Social media** | |
| Platforms | https://www.flaticon.com/free-icon/facebook_2920043 |
| User Profile | https://www.flaticon.com/free-icon/profile_3135776 |
| Advertisement | https://www.flaticon.com/free-icon/shopping-online_1260103 |
| Influencer | https://www.flaticon.com/free-icon/influencer_1728501 |
| **Gaming** | |
| Input | https://www.flaticon.com/free-icon/input_338025 |
| Output | https://www.flaticon.com/free-icon/output_338026 |
| Graphics | https://www.flaticon.com/free-icon/video-game_1006881 |
| Frame Rate | https://www.flaticon.com/free-icon/framerate_964050 |
| **Streaming** | |
| Services | https://www.flaticon.com/free-icon/cloud-storage_1553815 |
| Media | https://www.flaticon.com/free-icon/multimedia_1014802 |
| Resolution | https://www.flaticon.com/free-icon/resolution_832312 |
| Buffering | https://www.flaticon.com/free-icon/buffer_2009920 |
| **Other** | |
| Players | https://www.flaticon.com/free-icon/meeting-with-a-friend_82983 |
| Time | https://www.flaticon.com/free-icon/clock_2088617 |
| Age | https://www.flaticon.com/free-icon/user_1077063 |

## Appendix G – Dutch version of the game rules

Aantal spelers: 2 – 8

Tijdsduur: 15 – 30 min.

Leeftijd: 12+

**Doel**

Informati-Kwartet bestaat uit 8 categorieën met elk 4 kaarten die bij die categorie horen, het kwartet. Het doel is om zo veel mogelijk kwartetten te verzamelen.

De bedoeling van dit kwartetspel is dat je een beetje leert welke onderwerpen voorbij kunnen komen bij informatica en wat die betekenen.

**Voorbereiding**

Schud de kaarten goed en deel de kaarten uit. Elke speler krijgt 4 kaarten. De overgebleven kaarten gaan in de pot. Je eigen kaarten mag je bekijken.

**Het spel**

Eén speler begint en vraagt een medespeler om een kaart die hij of zij wil hebben. Hierbij noem je de categorie die boven aan de kaart staat en de naam van één van de 4 kaarten die je wilt hebben. Als diegene de kaart heeft moet hij die kaart aan jou geven. Je leest de categorie, onderstreepte naam en het stukje tekst van de kaart op. Zo leert iedereen een beetje over die kaart.

De speler mag bij de medespelers doorvragen totdat een speler de gevraagde kaart niet heeft. Als dat gebeurt moet een kaart uit de pot gepakt worden door degene die om de kaart vroeg. Als er geen kaarten meer in de pot zijn gebeurt er niks. Je gaat met de klok mee, de volgende speler is aan de beurt. Je gaat door totdat alle kwartetten zijn gevonden.

Als je een kwartet hebt zeg je: “kwartet” en leg je de set met de plaatjes omhoog op tafel. De speler met de meeste kwartetten aan het eind van het spel wint!

## Appendix H – User testing survey

This survey was presented to all the participants of the user testing. A total of 12 meaningful responses were generated.

# User Testing Informati-Kwartet

Hallo, mijn naam is Philippe Tuinman en ik ben momenteel bezig met mijn afstudeerscriptie binnen de Bachelor Creative Technology aan de Universiteit Twente.

Voor mijn onderzoek ben ik aan het kijken hoe leerlingen op middelbare scholen enthousiast(er) gemaakt kunnen worden voor het vak informatica. Ik denk dat het heel belangrijk is voor leerlingen om beter bekend te zijn met technologie dan het alleen te gebruiken. Dan kunnen ze er onder andere ook hun eigen mening over vormen. Vandaar dat ik wil kijken hoe de keuze voor het vak informatica aangemoedigd kan worden.
*Vereist

Toestemmingsinformatie

Door middel van deze informatie wil ik u extra inzage geven over het doel van mijn onderzoek en hoe u daar aan kunt bijdragen.
Volgens de overheid is de beheersing van digitale vaardigheden vereist om beter te kunnen functioneren in onze moderne maatschappij. Gebruik van technologieën zoals smartphones, tablets en laptops is een basis, maar niet genoeg. Om een goede mening te kunnen vormen over de functionaliteit, de invloeden en gevolgen deze technologieën op de maatschappij en het individu zijn vaardigheden die dieper gaan dan “alleen het weten te gebruiken van” vereist.
Ik sluit me persoonlijk aan bij het beeld van de overheid. Vanuit mijn studie heb ik ook geleerd dat er meer aan technologie te pas komt dan alleen maar de functionaliteit. Het heeft veel invloeden, meer dan men soms denkt, op ons als mens en hoe wij met onze medemens en omgeving omgaan.

De overheid ziet het vak informatica als een goede stap voor leerlingen om technologie beter te begrijpen. Daarom wil ik kijken hoe informatica onder de aandacht wordt gebracht bij de leerlingen en wat de mogelijkheden zijn om die keuze aan te moedigen. Niet door ze te forceren informatica te kiezen, maar om ze goed kennis te laten maken met het vak door ook te laten zien dat het ook voor hen belangrijk is. Dit alles op een motiverende en interactieve manier.
De introductie van informatica concepten is daarbij een goede eerste stap!

Daarbij heb ik het kwartetspel Informati-Kwartet gemaakt. Het kwartetspel introduceert verschillende concepten en onderwerpen die bij informatica behandeld kunnen worden.

Na afronding van het onderzoek mag u natuurlijk de resultaten van dit onderzoek opvragen. Hiervoor kunt u aan het eind van de vragenlijst uw e-mailadres invullen.

Ik wil u vragen voorafgaand de vragenlijst deze toestemmingsinformatie goed door te lezen en te ondertekenen als u hiermee akkoord gaat.

Als deelnemer van deze user testing:
- Zal u een potje van het kwartetspel spelen
- Zal u een simpele vragenlijst invullen over uw ervaringen met het spel
- Zal u gevraagd worden om uw aanbevelingen voor verbeteringen van het kwartetspel te geven

Deelname aan dit onderzoek is geheel vrijwillig. U kunt stoppen met de user testing wanneer u wilt en daar hoeft u geen reden toe te geven. Ook hoeft u geen vragen te beantwoorden die u niet wilt beantwoorden. De antwoorden worden opgeslagen op een veilige plek; alleen de onderzoeker heeft toegang. Deze antwoorden zullen geanonimiseerd, verwerkt en gepresenteerd worden in het onderzoeksverslag. Anonieme citaten of fragmenten kunnen eruit worden gehaald om toe te voegen aan het afstudeerverslag. Op elk moment kan u uw toestemming terug trekken en zal de deelname per direct worden stopgezet waarbij de gegevens ook correct zullen worden verwijderd. U bent vrij om op elk moment om welke reden dan ook uw deelname aan het onderzoek te stoppen. Om dit stopzetten te kunnen faciliteren vraag ik u om een bijnaam op te geven. Op deze manier kan ik uw antwoorden koppelen aan de door u gegeven bijnaam om uw aanvraag voor stopzetting te verwerken. Voor vragen kunt u bij mij terecht, of bij mijn begeleider (Angelika Mader), de contactgegevens zijn onderaan te vinden.

Wilt u graag onafhankelijk advies over meedoen aan dit onderzoek, of een klacht indienen? Dan kunt u terecht bij Petri de Willigen, secretaris van de Ethische Commissie (tel. 053-489 2085, ethics-comm-ewi@utwente.nl). Deze commissie bestaat uit onafhankelijke deskundigen van de Universiteit Twente en is beschikbaar voor vragen en klachten rondom het onderzoek.

Met vriendelijke groeten,
Philippe Tuinman
p.tuinman@student.utwente.nl
06-57077926

Begeleider: Angelika Mader
a.h.mader@utwente.nl

1. Welke unieke bijnaam wilt u gebruiken om anoniem te blijven? *

2. Ik heb de bovenstaande informatie gelezen, heb hier geen vragen meer over en ga hiermee akkoord. *

*Markeer slechts één ovaal.*

- ◯ Ik ga akkoord *Ga naar vraag 3*
- ◯ Ik ga niet akkoord *Ga naar vraag 30*

## Demografisch

Deze vragen zijn om mij een beeld te geven over uzelf als informatica-docent.

3. Geslacht

*Markeer slechts één ovaal.*

- ◯ Man
- ◯ Vrouw
- ◯ Zeg ik liever niet
- ◯ Anders: _____

4. Leeftijd

_____

5. Bezigheid

*Markeer slechts één ovaal.*

- ◯ Student
- ◯ Informatica Docent
- ◯ Middelbare Scholier
- ◯ Anders: _____

6. Wat is uw ervaring met informatica?

*Markeer slechts één ovaal.*

- ◯ Ik heb zelf informatica gehad op de middelbare school
- ◯ Binnen mijn studie komen gelijksoortige onderwerpen als informatica voor
- ◯ Ik studeer om leraar informatica te worden
- ◯ Ik ben docent informatica
- ◯ Ik volg momenteel informatica op de middelbare school
- ◯ Anders: _____

## Algemeen

Deze vragen gaan over hoe het kwartetspel er uit ziet en hoe het speelt

7. Hoe leuk vond u om het spel te spelen?

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Niet leuk | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Erg leuk |

8. Wat vond u leuk of niet leuk aan het spelen van het spel?

_____

_____

_____

_____

_____

9. Waren de regels duidelijk?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee

10. Wat was er onduidelijk? Als alles duidelijk was, laat dit dan leeg.

_____

11. Was het spel makkelijk te spelen?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee

12. Waarom was het spel wel of niet makkelijk te spelen?

_____

13. Wat vond u van het uiterlijk van de speelkaarten?

*Markeer slechts één ovaal.*

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Lelijk | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | ◯ | Mooi |

14. Wat viel u op aan het uiterlijk van de speelkaarten?

_____

15. Wat vond u goed of slecht aan het uiterlijk van de speelkaarten?

_____

_____

_____

_____

_____

16. Heeft u nog extra opmerkingen over het spel in het algemeen?

Inhoudelijk

17. Waren de categoriën duidelijk?

*Markeer slechts één ovaal.*

- Ja
- Nee

18. Als de categoriën niet duidelijk waren, waar lag dat aan? Als ze waren, laat dit dan leeg.

19. Waren de vier leden van de categoriën duidelijk?

*Markeer slechts één ovaal.*

- Ja
- Nee

20. Als de leden niet duidelijk waren, waar lag dat aan? Als ze duidelijk waren, laat dit dan leeg.

*Markeer slechts één ovaal.*

| 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|
| ◯ | ◯ | ◯ | ◯ | ◯ |

21. Waren de stukken uitleg-tekst duidelijk?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee

22. Is er iets wat aan de stukken uitleg-tekst verbeterd kan worden?

Effectiviteit

23. Heeft u iets geleerd door het spelen van dit spel? Zo ja, wat? Zo nee, waar ligt dat aan?

24. De doelgroep van dit spel is middelbare scholieren rond de 3e klas. Denk u dat dit spel past bij de doelgroep?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee

25. Waarom denkt u dat het spel wel of niet bij de doelgroep past?

_____

_____

_____

_____

_____

26. Is het taalgebruik van de termen en de teksten op niveau van de doelgroep denkt u?

*Markeer slechts één ovaal.*

- ◯ Ja
- ◯ Nee

27. Hoe kan het taalgebruik verbeterd worden? Als u denkt dat het taalgebruik niet verbeterd hoeft te worden, laat dit dan leeg.

_____

_____

_____

_____

_____

28. Denkt u dat dit spel de doelgroep kan helpen bij de keuze voor het vak informatica?

*Markeer slechts één ovaal.*

- Ja
- Nee

29. Waarom denkt u dat het wel of niet kan helpen?

Hartelijk dank voor uw hulp!

30. Heeft u nog opmerkingen, suggesties of tips?

31. Als u op de hoogte gehouden wilt worden over dit onderzoek en het eindresultaat kunt hier uw mail-adres invullen.

## Appendix I – Improved Dutch version of the game rules

Aantal spelers: 2 – 8

Tijdsduur: 15 – 30 min.

Leeftijd: 12+

**Doel**

Informati-Kwartet bestaat uit 8 categorieën met elk 4 kaarten die bij die categorie horen, het kwartet. Het doel is om zo veel mogelijk kwartetten te verzamelen.

De bedoeling van dit kwartetspel is dat je een beetje leert welke onderwerpen voorbij kunnen komen bij informatica en wat die betekenen.

**Voorbereiding**

Schud de kaarten goed en deel de kaarten uit. Elke speler krijgt 4 kaarten. De overgebleven kaarten gaan in de pot. Je eigen kaarten mag je bekijken.

**Het spel**

Eén speler begint en vraagt een medespeler om een kaart die hij of zij wil hebben. Hierbij noem je de categorie die boven aan de kaart staat en de naam van één van de 4 kaarten die je wilt hebben. Je mag alleen naar kaarten van een categorie vragen die jij al in je handen hebt. Als diegene de kaart heeft moet hij die kaart aan jou geven. **Je leest stukje tekst van de kaart hardop voor.** Zo leert iedereen een beetje over die kaart. Als diezelfde kaart gedurende het spel kaart door iemand anders wordt teruggevraagd hoeft de tekst niet opnieuw voorgelezen te worden.

De speler die aan de beurt is mag bij de medespelers doorvragen totdat een speler de gevraagde kaart niet heeft. Als dat gebeurt moet een kaart uit de pot gepakt. Heeft de speler dankzij de gepakte kaart een kwartet, dan mag die meteen op tafel gelegd worden. Als er geen kaarten meer in de pot zijn gebeurt er niks. Je gaat met de klok mee, de volgende speler is aan de beurt. Je speelt het spel totdat alle kwartetten zijn gevonden.

Als je een kwartet hebt zeg je: “kwartet” en leg je de set op tafel. Lees alle ongelezen kaarten nog even voor. De speler met de meeste kwartetten aan het eind van het spel wint!

## References


Apiola, M., Tedre, M., & Oroma, J. O. (2011). Improving programming education in Tanzania: Teachers' and students' perceptions. *2011 Frontiers in Education Conference (FIE)*, F3G-1-F3G-7. https://doi.org/10.1109/FIE.2011.6142787

Autoriteit Persoonsgegevens. (n.d.). *Wat zijn persoonsgegevens? [What is personal data?]*. Retrieved July 18, 2020, from https://autoriteitpersoonsgegevens.nl/nl/over-privacy/persoonsgegevens/wat-zijn-persoonsgegevens

Beach, T. E. (2004). *Computer Terminology - Networking and Telecom*. University of New Mexico - Los Alamos. https://www.unm.edu/~tbeach/terms/net.html

BNR Nieuwsradio. (2019). *Krimp informatica als keuzevak door gebrekkige instroom docenten | BNR Nieuwsradio [Shrinkage informatics as elective by inadequate supply of teachers | BNR Newsradio]*. BNR Nieuwsradio. https://www.bnr.nl/nieuws/technologie/10368814/krimp-informatica-als-keuzevak-door-gebrekkige-instroom-docenten

Build-Your-Own-Computer.net. (n.d.). *Gaming Input Devices*. Retrieved July 18, 2020, from https://www.build-your-own-computer.net/gaming-input-devices.html

Busch, T. (1995). Gender Differences in Self-Efficacy and Attitudes toward Computers. *Journal of Educational Computing Research*, *12*(2), 147–158. https://doi.org/10.2190/H7E1-XMM7-GU9B-3HWR

Carmichael, G. (2008). Girls, computer science, and games. *ACM SIGCSE Bulletin*, *40*(4), 107. https://doi.org/10.1145/1473195.1473233

Centraal Bureau voor de Statistiek. (2019). *In een derde van beroepen op hoogste niveau is meerderheid vrouw [In one-third of profession on the highest level a majority is female]*. Centraal Bureau Voor de Statistiek. https://www.cbs.nl/nl-nl/nieuws/2019/46/in-een-derde-van-beroepen-op-hoogste-niveau-is-meerderheid-vrouw

Cheryan, S., Master, A., & Meltzoff, A. N. (2015). Cultural stereotypes as gatekeepers: increasing girls' interest in computer science and engineering by diversifying stereotypes. *Frontiers in Psychology*, *6*, 49. https://doi.org/10.3389/fpsyg.2015.00049

College voor Toetsen en Examens. (2019). *Examenprogramma informatica havo/vwo [Exam program informatics havo/vwo]*. https://www.examenblad.nl/examenstof/informatica-havo-en-vwo-3/2020/f=/examenprogramma_Informatica_havo-vwo.pdf

Cooper, J. (2006). The digital divide: the special case of gender. *Journal of Computer Assisted Learning*, *22*(5), 320–334. https://doi.org/10.1111/j.1365-2729.2006.00185.x

Eurostat. (2016). *Being young in Europe today - digital world - Statistics Explained*. https://ec.europa.eu/eurostat/statistics-explained/index.php/Being_young_in_Europe_today_-_digital_world

Eurostat. (2017). *ICT sector - value added, employment and R&D - Statistics Explained*. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_sector_-_value_added,_employment_and_R%26D

Eurostat. (2019). *ICT education - a statistical overview*. Eurostat Statistics Explained. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=ICT_education_-_a_statistical_overview&oldid=454538

Examenblad.nl. (2020). *Examenprogramma informatica havo/vwo [Exam program informatics havo/vwo]*. https://www.examenblad.nl/vak/informatica/2020

Fuentes, A., Andersson, J., Johansson, A., & Nilsson, P. (2005). *Gender and Programming : A Case Study*. https://www.researchgate.net/publication/333133273_Gender_and_Programming_a_Case_Study

Girls Who Code. (2020). *About Us - Girls Who Code*. GirlsWhoCode.Com. https://girlswhocode.com/about-us/

Goel, A. (2020, May 26). *Best Programming Language to Learn in 2020 (for Job & Future)*. https://hackr.io/blog/best-programming-languages-to-learn-2020-jobs-future

Google. (n.d.). *Our history in Depth - Google Company*. Retrieved July 18, 2020, from https://web.archive.org/web/20160722171451/http:/www.google.com/about/company/history/

Google Inc. (2017). Blockly | Google Developers. In *Google for Education* (p. 1). https://developers.google.com/blockly

Google Inc. (2019a). *Blockly Games*. https://blockly.games/?lang=en

Google Inc. (2019b). *CS First: Teach computer science & coding to kids*. https://csfirst.withgoogle.com/s/en/home

Greenfoot.org. (n.d.-a). *Greenfoot | About Greenfoot*. Retrieved August 3, 2020, from https://www.greenfoot.org/overview

Greenfoot.org. (n.d.-b). *Greenfoot | Documentation*. Retrieved August 3, 2020, from https://www.greenfoot.org/doc

Hakker, B. (2019). IT'ers voor de klas: 'hybridedocent' moet tekort oplossen [ITers in front of the classroom: "hydridteacher" is supposed to solve shortage]. *Intermediair*. https://www.intermediair.nl/beroepen-functies/onderwijs/it-docent-onderwijs-opleiding?utm_referrer=https%3A%2F%2Fwww.google.com%2F

Harvard Creative Computing Lab. (2020). *Creative Computing Curriculum*. http://scratched.gse.harvard.edu/guide/index.html

Henriksen, P., & Kölling, M. (2004). Greenfoot: Combining object visualisation with interaction. *Proceedings of the Conference on Object-Oriented Programming Systems, Languages, and Applications, OOPSLA*, 73–82. https://doi.org/10.1145/1028664.1028701

Hermans, F. (2019, April 4). *The mission of Felienne Hermans - Leiden University*. https://www.universiteitleiden.nl/en/news/2019/04/the-mission-of-felienne-hermans

Het Klokhuis. (2019). *Uitzending - Wifi [Episode - Wifi]*. https://www.hetklokhuis.nl/tv-uitzending/4006/Wifi

Heur van, R. (2005, November 18). Keuzevak informatica onderschat [Elective informatics underestimated]. *Computable.Nl*. https://www.computable.nl/artikel/achtergrond/onderwijs/1295207/1444691/keuzevak-informatica-onderschat.html

I&I. (2020a). *Nieuwsbrief 108 vakvereniging I&I [Newsletter 108 Trade Union I&I]*. https://mailchi.mp/4a4dd1c31424/vakvereniging-ieni-1679414

I&I. (2020b). *Vakvereniging i&i [Trade Union i&i]*. https://ieni.org/

Kaspersky.nl. (n.d.). *Wat is een firewall? [What is a firewall?]*. Retrieved July 18, 2020, from https://www.kaspersky.nl/resource-center/definitions/firewall

Kaučič, B., & Asič, T. (2011). Improving introductory programming with Scratch? *Proceedings of the 34th International Convention MIPRO*, 1095–1100.

Kiryakova, G., Angelova, N., & Yordanova, L. (2014). *Gamification in Education*.

Kölling, M. (2010). The Greenfoot Programming Environment. *ACM Trans. Comput. Educ*, *10*(14). https://doi.org/10.1145/1868358.1868361

KwartetCadeau.nl. (n.d.-a). *Kwartetspel maken met je eigen foto's [Make a quartets game with your own photos]*. Retrieved July 18, 2020, from https://www.kwartetcadeau.nl/

KwartetCadeau.nl. (n.d.-b). *Spelregels kwartetten [Game rules quartets]*. Retrieved July 19, 2020, from https://www.kwartetcadeau.nl/spelregels_kwartet

Law, K. M. Y., Lee, V. C. S., & Yu, Y. T. (2010). Learning motivation in e-learning facilitated computer programming courses. *Computers & Education*, *55*(1), 218–228. https://doi.org/10.1016/j.compedu.2010.01.007

Lepeltak, J. (2019, March 1). In veel EU-landen wordt Computational Thinking/Coding een verplicht schoolvak! [In many EU-countries Computational Thinking/Coding will become a mandatory subject!]. *KomenskyPost*. https://komenskypost.nl/?p=4535

Lyceo. (2020). *Cursus Leren Programmeren voor Kinderen | CodeLab Lyceo [Learning Programming for Children Course | CodeLab Lyceo]*. Lyceo.Nl. https://www.lyceo.nl/cursus-leren-programmeren/?gclid=EAIaIQobChMI2bTMgdTM6AIVheJ3Ch1m6wOtEAAYASAAEgKIsfD_BwE

Mader, A., & Eggink, W. (2014). *A Design Process for Creative Technology*. The Design Society. https://research.utwente.nl/en/publications/a-design-process-for-creative-technology

Malwarebytes.com. (n.d.). *Alles over hacken [Everything about hacking]*. Retrieved July 18, 2020, from https://nl.malwarebytes.com/hacker/

Mannila, L., Peltomäki, M., Back, R. J., & Salakoski, T. (2006). Why complicate things? Introducing programming in high school using Python. *Proceedings of the 8th Australasian Conference on Computing Education*, *52*, 71–80.

Meerbaum-Salant, O., Armoni, M., & Ben-Ari, M. (2011). Habits of programming in scratch. *Proceedings of the 16th Annual Joint Conference on Innovation and Technology in Computer Science Education - ITiCSE '11*, 168. https://doi.org/10.1145/1999747.1999796

Ministerie van Onderwijs Cultuur en Wetenschap. (2016). *Key Figures Education | Publicatie | OCW in cijfers*. https://www.ocwincijfers.nl/documenten/publicaties/2016/05/31/key-figures-education

Ministerie van Onderwijs Cultuur en Wetenschap. (2019a). *Bijlage 5 Relevante cijfers Arbeidsmarkt Leraren 2019 [Attachement 5 Relevan figures Labourmarket Teachers 2019]*. https://www.rijksoverheid.nl/documenten/kamerstukken/2019/12/16/kamerbrief-over-de-arbeidsmarkt-voor-leraren-2019

Ministerie van Onderwijs Cultuur en Wetenschap. (2019b). *Rapport De Staat van het Onderwijs 2019 | Onderwijsverslag over 2017/2018 [Report The State of Education 2019 | Education report for 2017/2018]*. https://www.onderwijsinspectie.nl/documenten/rapporten/2019/04/10/rapport-de-staat-van-het-onderwijs-2019

Ministerie van Onderwijs Cultuur en Wetenschap. (2019c). *Digitization agenda*. https://www.rijksoverheid.nl/onderwerpen/toekomst-onderwijs/documenten/publicaties/2019/03/22/digitaliseringsagenda-primair-en-voortgezet-onderwijs

National Girls Collaborative Project. (n.d.). *Statistics*. Retrieved April 13, 2020, from https://ngcproject.org/statistics

Nationale Academie voor Media & Maatschappij. (n.d.). *Offline Ganzenbord [Offline Game of the goose]*. Retrieved July 17, 2020, from http://mediawijsopschool.weebly.com/offline-ganzenbord.html

Nationaleberoepengids.nl. (n.d.). *Leraar Informatica: Salaris, Vacatures, Opleiding, Taken, Toekomst & Skills [Informatics Teacher: Salary, Vacancies, Education, Tasks, Future & Skills]*. Retrieved August 3, 2020, from https://www.nationaleberoepengids.nl/leraar-informatica

Navarro-Prieto, R., & Cañas, J. J. (2001). Are visual programming languages better? The role of imagery in program comprehension. *International Journal of Human Computer Studies*. https://doi.org/10.1006/ijhc.2000.0465

Niehe, T. (2019, February 6). Keuzevak informatica zucht onder lerarentekort [Informatics elective suffers from teacher shortage]. *AgConnect.Nl*. https://www.agconnect.nl/artikel/keuzevak-informatica-zucht-onder-lerarentekort

Noone, M., & Mooney, A. (2018). Visual and textual programming languages: a systematic review of the literature. *Journal of Computers in Education*, *5*(2), 149–174. https://doi.org/10.1007/s40692-018-0101-5

Oxford English Dictionary. (n.d.-a). *app, n.* Retrieved July 18, 2020, from https://oed.com/view/Entry/249075?redirectedFrom=apps#eid

Oxford English Dictionary. (n.d.-b). *firewall, v.* Retrieved July 18, 2020, from https://oed.com/view/Entry/429623?rskey=0DX7IZ&result=2&isAdvanced=false#eid

Oxford English Dictionary. (n.d.-c). *internet, n.* Retrieved July 18, 2020, from https://oed.com/view/Entry/248411?redirectedFrom=internet+of+things#eid1191443070

Oxford English Dictionary. (n.d.-d). *internet, n.* Oxford English Dictionary. Retrieved July 18, 2020, from https://oed.com/view/Entry/248411?rskey=nOJAQD&result=1#eid

Oxford English Dictionary. (n.d.-e). *operating system, n.* Retrieved July 18, 2020, from https://oed.com/view/Entry/330223?redirectedFrom=operating+system#eid

Oxford English Dictionary. (n.d.-f). *router, n.6*. Retrieved July 18, 2020, from https://oed.com/view/Entry/272580?rskey=vf2gQS&result=6#eid

Oxford English Dictionary. (n.d.-g). *sensor, n.* Retrieved July 18, 2020, from https://oed.com/view/Entry/176005?redirectedFrom=sensors#eid

Oxford English Dictionary. (n.d.-h). *syntax, n.* Retrieved July 18, 2020, from https://oed.com/view/Entry/196559?redirectedFrom=syntax#eid

Parsons, D., & Haden, P. (2006). Parson's programming puzzles: A fun and effective learning tool for first programming courses. *In Proceedings of the 8th Australasian Conference on Computing Education*, *52*, 157–163. https://www.researchgate.net/publication/262160581

PCMag. (n.d.). *Definition of buffering*. Retrieved July 18, 2020, from https://www.pcmag.com/encyclopedia/term/buffering

Peckham, J., Harlow, L. L., Stuart, D. A., Silver, B., Mederer, H., & Stephenson, P. D. (2007). Broadening participation in computing. *ACM SIGCSE Bulletin*, *39*(3), 9. https://doi.org/10.1145/1269900.1268790

Pijpers, R. (2019, July 11). Werken aan digitale geletterdheid: van visie naar praktijk [Working on digital literacy: from vision to practice]. *Kennisnet.Nl*. https://www.kennisnet.nl/publicaties/werken-aan-digitale-geletterdheid-van-visie-naar-praktijk/

Powers, K., Gross, P., Cooper, S., McNally, M., Goldman, K. J., Proulx, V., & Carlisle, M. (2006). Tools for teaching introductory programming. *Proceedings of the 37th SIGCSE Technical Symposium on Computer Science Education - SIGCSE '06*, 560. https://doi.org/10.1145/1121341.1121514

Processing. (2020a). *Processing.org*. Processing.Org. https://processing.org/

Processing. (2020b). *Processing.org - Overview*. https://processing.org/overview/

Qompas. (2019). *Populariteit van schoolvakken 2019 [Popularity of schoolsubjects 2019]*. https://corporate.qompas.nl/media/42613/Populariteit van schoolvakken - Qompas 2019.pdf

Rajaravivarma, R. (2005). A games-based approach for teaching the introductory programming course. *ACM SIGCSE Bulletin*, *37*(4), 98. https://doi.org/10.1145/1113847.1113886

Ramalingam, V., LaBelle, D., & Wiedenbeck, S. (2004). Self-efficacy and mental models in learning to program. *Proceedings of the 9th Annual SIGCSE Conference on Innovation and Technology in Computer Science Education - ITiCSE '04*, 171. https://doi.org/10.1145/1007996.1008042

Rijksoverheid.nl. (n.d.). *Ministerie van Onderwijs, Cultuur en Wetenschap [Minestry of Education, Culture and Science]*. Retrieved August 3, 2020, from https://www.rijksoverheid.nl/ministeries/ministerie-van-onderwijs-cultuur-en-wetenschap

Samsung. (n.d.). *What is 8K TV?* Retrieved July 18, 2020, from https://www.samsung.com/levant/tvs/tv-buying-guide/what-is-8k-tv/

Schellevis, J. (2017, January 30). *Steeds minder informatica-les op school, tekort aan ict'ers groeit [Increasingly less informatics-class at school, shortage of ICT professionals grows]*. NOS. https://nos.nl/artikel/2155764-steeds-minder-informatica-les-op-school-tekort-aan-ict-ers-groeit.html

Scratch. (2020a). *Scratch - About*. https://scratch.mit.edu/about

Scratch. (2020b). *Scratch - Statistics*. https://scratch.mit.edu/statistics/

Scratch Meetup. (2020). *Scratch Educator | Meetup Pro - Meetup*. https://www.meetup.com/nl-NL/pro/scratched/

Self-efficacy. (n.d.). In *Cambridge English Dictionary*. Retrieved April 15, 2020, from https://dictionary.cambridge.org/dictionary/english/self-efficacy

Skinner, B. F. (1969). *Contingencies of Reinforcement: A Theoretical Analysis*. Englewood Cliffs, NJ: Prentice-Hall.

SLO.nl. (n.d.). *Visie en missie [Vision and mission]*. Retrieved August 3, 2020, from https://www.slo.nl/over-slo/visie-missie/

Snap! (2020a). *Snap! Build Your Own Blocks*. https://snap.berkeley.edu/

Snap! (2020b). *Snap! Build Your Own Blocks - About*. https://snap.berkeley.edu/about

Spelregels.eu. (n.d.). *Spelregels kwartet [Game rules quartets]*. Retrieved July 19, 2020, from https://www.spelregels.eu/PDF/spelregels-kwartet.pdf

Statista. (2019). *ICT R&D spending in U.S. and globally* . https://www.statista.com/statistics/732308/worldwide-research-and-development-information-communication-technology/

Stichting Leerplan Ontwikkeling. (n.d.). *Karakterisering van de vernieuwing [Caracterising of the renewal*. Retrieved August 3, 2020, from https://www.slo.nl/handreikingen/havo-vwo/handreiking-se-info-hv/algemene-informatie/karakterisering/

Stichting Leerplan Ontwikkeling. (2019a, December 4). *21-eeuwse vaardigheden - Achtergrondinformatie [21st-century skills - Backgroundinformation]*. https://slo.nl/thema/meer/21e-eeuwsevaardigheden/achtergrondinformatie/

Stichting Leerplan Ontwikkeling. (2019b, December 12). *21e-eeuwse vaardigheden [21st century skills]*. https://slo.nl/thema/meer/21e-eeuwsevaardigheden/

Tindle, A. (2018, December 13). *Learn to code (or do anything): top down, bottom up and other approaches*. Medium.Com. https://medium.com/datadriveninvestor/learn-to-code-or-do-anything-top-down-bottom-up-and-other-approaches-bd2fd8eb89dd

Tolboom, J., Kruger, J., & Grgurina, N. (2014). *Informatica in de bovenbouw havo/vwo : naar aantrekkelijk en actueel onderwijs in informatica - SLO [Informatics in upper secondary education havo/vwo : towards appealing and topical education in informatics - SLO]*. https://slo.nl/@4251/informatica/

TUDelft. (2020). *MOOC: Scratch: Programmeren voor kinderen | TU Delft Online [MOOC: Scratch: Programming for kids | TUDelft Online]*. https://online-learning.tudelft.nl/courses/scratch-programmeren-voor-kinderen/

Ultimate Top Trumps. (n.d.). *Top Trumps History and Game Rules*. Retrieved July 19, 2020, from https://archive.is/20130114033130/http:/www.ultimate-top-trumps.co.uk/game_rules.htm#selection-409.0-415.895

Ultimate Top Trumps. (2013). *Top Trumps History*. https://archive.is/20130114033130/http://www.ultimate-top-trumps.co.uk/game_rules.htm#selection-409.0-415.895

van der Vleuten, M., Jaspers, E., Maas, I., & van der Lippe, T. (2016). Boys' and girls' educational choices in secondary education. The role of gender ideology. *Educational Studies*, *42*(2), 181–200. https://doi.org/10.1080/03055698.2016.1160821

VeiligInternetten.nl. (n.d.). *Wat zijn cookies? [What are cookies?]*. Retrieved July 18, 2020, from https://veiliginternetten.nl/themes/situatie/wat-zijn-cookies/

Weert van, J. (n.d.). *Introductie informatica Klas 3 [Introduction to informatics Class 3]*. Retrieved May 6, 2020, from https://informatica.sgdb.nl/index.php/overig/introductie-informatica-klas-3

Woldhuis, E. (2020, March 23). *Het examenprogramma - SLO [The examprogramme - SLO]*. SLO. https://slo.nl/handreikingen/havo-vwo/handreiking-se-info-hv/examenprogramma/

Zeemeijer, I. (2019, February 6). Leraren slaan alarm: scholen stoppen met informatica in de bovenbouw [Teachers are alarmed: schools stop with informatics in upper secondary school]. *FD.Nl*.

ZonMw.nl. (n.d.). *Belang van ICT in de zorg [Importance of ICT within healthcare]*. Retrieved July 18, 2020, from https://www.zonmw.nl/nl/over-zonmw/ehealth-en-ict-in-de-zorg/belang-van-ict-in-de-zorg/