Making computer science more attractive:

the effects of an intervention to change girls' perceptions

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1. Abstract

This thesis addresses the underrepresentation of women in the IT sector and computer science study programs, specifically in the Netherlands. The low participation of women in computer science has led to a "shrinking pipeline," resulting in a lack of diversity and inclusivity in the industry and fewer female role models for future generations. The objective of this thesis is to gain insights into the reasons behind the lack of female participation in computer science study programs in higher education in the Netherlands and discover if implementing an intervention can positively influence the perceptions of students of computer science. The research method employed in this study involves conducting a literature review to explore the factors influencing girls' decisions regarding computer science study programs, followed by a survey among Dutch students. The survey consisted of two versions, one with an intervention text that consisted of an intervention text focused on the two aspects: anti-social and isolating with a low communal value description and one with an intervention text with the same two aspects with a high communal value description. Opinions on positivity toward CS, future study motivation, and the perceived importance of CS were given by 143 students. The results showed some interesting findings when analyzing the questions in regard of gender, CS background, and study profile. Furthermore, version differences were noted and explained. The outcome of this thesis gives insight on the possible reasons why there is a lack of female participants in CS study programs. It also provides practical recommendations for (educational) institutions and researchers that elaborates upon existing literature and interventions that have been done in the past years to encourage girls' activity in the world of computer science.

Table of Contents

2. Introduction

In our digitalized world, there has been a persistent struggle to recruit women into the Information Technology (IT) sector. Computer Science (CS) is a big part of the IT sector and is the central focus of this thesis. Women are underrepresented in CS industry (Frenkel, 1990; Galpin, 2002, Margolis & Fisher, 2002; Papastergiou, 2008). In the United States, women contribute to only 30% of the workforce of the IT industry. In the Netherlands, this number is even smaller: only 10% of the employees working in computer-related jobs are female (Meelissen & Drent, 2008).

The lack of female employees in the CS industry are a result of the small number of participating women in high school and higher education CS study programs. Women's participation in computer science can therefore be compared to a 'shrinking pipeline', as the percentage of women involved in computing decreases in the transition from high school to higher education, and from higher education to professional positions in the CS industry (Camp, 1997, Pearl et al, 1990). Currently, in the Netherlands, nine out of ten students that have enrolled in a computer science study program are male (CBS, 2022), which could be seen as an alarming number. Later on, this number can create various implications for the CS industry, including reduced diversity and inclusivity with a higher proportion of male employees. Consequently, there will be a scarcity of female role models, resulting in a decline in the number of girls opting for higher education computer science programs.

Papastergiou (2008) claimed that when women portray a lack of interest in technological fields, this sooner or later results in "the loss of valuable resources for the economy by depriving the IT industry of potentially intelligent and competent workers as well as of a more diverse range of experience, creativity, and expertise." Our technology-driven information society needs highly skilled people from both genders who possess knowledge about CS to keep growing and expanding. Thus, it is important to adress and gain insights into the reasons behind girls' decisions not to enroll in a CS study program. This understanding can provide knowledge to future researchers and (educational) institutions, offering an opportunity to inspire more women to pursue educational tracks and careers in computer science. By doing so, it can contribute to the advancement of our increasingly digitized society.

This thesis focuses on the lack of participating female students in computer science study programs in higher education in the Netherlands. Thus, it starts with an exploratory literature review which discovers various factors that may negatively impact a girl's decision on choosing or not choosing CS as a higher education study program. The acquired findings of the literature review address some of the research questions and shape the direction of this thesis which is summarized in chapter 3. After that, the research method is outlined, which measures the effect of an intervention on the perception that high school students have of CS. The intervention centers around a text that focuses on the high or low communal utility value of CS. The outcome of this thesis gives insight on the possible reasons why there is a lack of female participants in CS study programs. Additionally, it assesses whether an

intervention can effectively alter students' perceptions of computer science in a positive manner. Lastly, the conclusion answers the research questions and provides a summary of the knowledge gained. A small guideline for (educational) institutions and researchers is given that elaborates upon existing literature and interventions that have been done in the past years to encourage girls' activity in the world of computer science. We conclude this research with a discussion that highlights limitations, validity threats, and potential areas for future research.

3. Literature Review Protocol

This thesis starts with an exploratory literature review. The literature review aims to explore factors that can negatively influence girls' behavior on choosing CS as a higher education study. Additionally, it examines the feasability of an intervention that can positively influence this behavior. The research question that this literature review answers is as follows:

What are the factors that contribute to the decision of girls to choose CS as a higher education course?

A narrative literature review was performed so that the existing literature on this thesis' topic could be analyzed and summarized. This type of literature review is chosen as it helps refining, focusing and shaping the research questions that we try to answer. There were several selection criteria and methods used to determine relevant literature. Pearl growing was used to find the first literature source (Schlosser et al., 2006). Then, if the search results did not give any more useful or relevant literature sources, other keywords were used to continue the search. Lastly, the snowball method was used to track down references in documents and find other useful sources from the same or different authors (Badampudi et al., 2015).

The keywords that were used during the search for literature are listed below. These words were combined if the keywords alone did not result in any usable literature sources. An example of this is; "dutch high school + computer attitude among girls".

- Computer attitude among girls
- Dutch secondary education study profiles
- Computer Science Perceptions
- Computer Science tertiary study
- Computer Science major
- Dutch High school
- Women in computer science
- Computer science intervention

The selection criteria for appropriate literature sources were as follows:

1. The majority of the literature source found needs to use or center around at least one of the keywords mentioned to be chosen.
2. The author of the literature source needs to have written or referenced multiple sources that relate to the topic of this thesis. This was done by collecting other papers written by the author and evaluating them to ensure that the author is relevant and that no other other relevant information was lost.

Scientific literature was collected through the following categories:

Academic Search Engines/Platforms:

- Google Scholar: An academic search engine that indexes scholarly literature across various disciplines.[1]

Publishers:

- Springer: A publishing company that specializes in academic journals, books, and reference works in various fields.[2]
- Taylor Francis Online: A publishing company that offers a wide range of peer reviewed academic journals, books, and scholarly resources.[3]

Statistical Institutions:

- CBS (Central Department of Facts and Numbers in the Netherlands): The Netherlands' statistical office responsible for collecting and publishing official statistics.[4]
- Eurostat: The statistical office of the European Union, responsible for collecting and publishing statistical information on various aspects of the EU and its member countries.[5]

Consulting Firm:

- McKinsey & Company: A global management consulting firm that provides services to businesses, governments, and organizations.[6]

Research Institutions Focusing on Women in IT:

- National Science Foundation: A U.S. government agency that supports and funds scientific research in various fields, including computer science and technology.[7]
- Computer Science Teachers Association (CSTA): An organization focused on advancing computer science education at all levels, including promoting diversity and equity in computer science education.[8]
- CSed Research: An institution that aims to improve K-12 computer science (CS) education for all children by enabling and disseminating exemplary evidence-driven research.[9]

[1] https://scholar.google.com
[2] https://www.springer.com/gp
[3] https://www.tandfonline.com
[4] https://www.cbs.nl
[5] https://ec.europa.eu/eurostat
[6] https://www.mckinsey.com/mgi/our-research/all-research
[7] https://www.nsf.gov
[8] https://csteachers.org
[9] https://csedresearch.org

4. Literature Review

The following literature review starts by explaining the current situation of women in CS, with a focus on the situation in the Netherlands, and continues to explore possible factors that contribute to girls' decision to choose or not choose CS as a higher education study program. After several factors are named and explained, certain perceptions are mentioned that are a result of those factors. At the end of this chapter an existing intervention is explored to use as a basis for this thesis' research method.

4.1 The situation of women in CS in the Netherlands

When explaining the situation of women in CS in the Netherlands it is important to provide some background context on the Dutch High school system before diving deeper into the numbers surrounding women in IT. In the Netherlands there are two levels of secondary education that we focuses on: HAVO and VWO, with VWO being more academically advanced than HAVO. There are around 200 thousand VWO students and there are around 247 thousand HAVO students in total (CBS, 2022).

Furthermore, Dutch HAVO and VWO schools also categorize their students by the study profiles. In 1998, the Netherlands passed a new law that implemented a new mandatory way for students to complete their secondary education (van der Vleuten et al., 2016). This law was designed because of international agreements that were formed during that time, aimed at increasing students' intake in STEM (Science, Technology, Engineering, and Mathematics) studies in Europe. Computer Science is one of the subjects within STEM. This new law was the Dutch way of answering to these international agreements. It was one of several attempts to increase students' interest in these studies (Korpershoek et al., 2011). The law created the implementation of study profiles in Dutch high schools. At 15 years old students have to choose between four study profiles that vary in core subjects. The four study profiles are as follows:

- Science & technology: focus on physics, technology and chemistry (N&T)
- Science & health: focus on physics and biology (N&G)
- Economics & society: focus on economics, history and society(E&M)
- Culture & society: modern languages and humanities (C&M)

The chosen study profile will determine the subjects in which the students will graduate after two or three years and thus also determines their knowledge and views on certain topics. These study profiles are mentioned as they provide a base for some of the claims and analyses made further along in this thesis.

In VWO, 52.9% of all students that have a N&T or N&G study profile is female. In HAVO, 49.8% of all students with a N&T or N&G study profile are female (CBS, 2022). This shows that the number of female and male students in STEM courses is almost equal, indicating that a fair number of female students now also choose STEM-focused study profiles.

Additionally, in the Netherlands, an average of 46% of all high schools allows their students to follow computer science as an extracurricular class. A mere 5% of all students that follow this class are female, unfortunately (CBS, 2022). This number has been growing over recent years but remains small in comparison to other eligible extracurricular classes. The aforementioned data shows that there is an interest among female students to participate in science related courses, but less interest to learn about computer science. When observing the amount of female students divided into the study profiles and comparing it to the amount of female students in higher education computer science courses, this number starts out much more balanced and grows much smaller throughout university. Only a minority of all female students enroll in a technology related academic study after high school. In the school year of 2021 and 2022, nine out of ten students that had enrolled in a computer science study were male (CBS, 2022).

When looking at the situation of the current workforce of the IT field, there has been a steady rise of women workers. The number of women with IT or CS jobs has risen from 276,000 in 2013 to 406,000 in 2020, representing an increase of 47%. As of 2021, 12% of all people working in ICT is female (Techniekpact, 2015). In 2022, the percentage increased slightly to 16% (CBS, 2022), indicating that it still falls short of comprising even half of the overall workforce in the field of CS.

4.2 The situation of women in other parts of the world

The same pattern that is visible in the Netherlands can be observed in other parts of the world. In the USA, data shows that only 5.6% of high school students are enrolled in computer science courses and there is a national average participation rate of just 30.6% of young women in high school computer science extracurricular courses (Code.org, CSTA, & ECEP, 2022).

In all of Europe, only 17% of all students that study CS or CS related studies are female. The highest number of participating female students is 37%, which is the case in Belgium (Eurostat, 2020). This is still less than half of the ICT student population.

4.3 The importance of including women in the IT sector

The demand of IT professional keeps rising faster than new (female) professionals are joining the sector. This phenomenon existing in our highly digitalized world could slowly be causing a problem.

Computer science is a significant and integral part of the IT sector. CS forms the foundation for many aspects of IT. Professionals with a background in CS are valuable and play critical roles in IT, including software development or cyber security. While IT encompasses a broader scope, CS provides the theoretical and tehcnical expertise that form the basis of many IT disciplines. That is why it is important to include CS professionals in the IT sector. And as the demand of CS professionals keeps rising faster than new (female) professionals are joining the sector, it could be the cause of many problems, such as lack of diversity, in our highly digitalized world.

The IT sector should acquire more female CS professionals as it can be beneficial for IT companies. It is expected that in the coming years, the increase in demand for suitable labor in the IT sector will exceed its supply (Beyer, 2014; Rheingans, D'Eramo, Diaz-Espinoza, & Ireland, 2018). From a report written by the Flemish Service for Employment and Vocational Training, VDAB, (2020) about shortage professions it was stated that jobs such as IT business analysts, database managers, network managers and IT analysts/developers will become or already are bottleneck professions. This is a result of not having enough people on the employee market to fill these vacancies and of people lacking the right skills (VDAB, 2020). Recruiting and including women in the workfield can help fill in these gaps.

Studies have shown that having more women in IT projects can increase the impact of CS projects, as women offer a wide variety of skills that complement the skills of men (McKinsey & Company, 2019). Furthermore, higher numbers of female employees in the IT sector is essential to increase productivity (Henriksen, 2015), innovation (Corbett & Hill, 2015; Hill, Corbett, & Rose, 2010; Smith, Sobolewska, Bhardwaj, & Fabian, 2017), creativity and competitivity (Hill, Corbett, & Rose, 2010).

An example of how including female employees in the workforce can lead to succes is that men are more likely to approach solutions for a problem from a technical point of view, which can lead to solutions being too technical and complicated for the customers that want the solution. Women on the other hand tend to look for practical solutions tailored to the user and make time for contact with the customer, as they perceive the relationship with the customer as valuable and of great importance.

Women will furthermore likely ensure that specific needs, such as accessibility or ease of use, will be met in the proposed solutions, something that might be overlooked by men (Corbett & Hill, 2015). Ultimately, women carry many skills that are deemed important in the IT sector such as communication skills, the ability to motivate and inspire others, analytical and strategical skills, and have a better capability of recognizing unethical behavior (Snoeck, 2002).

4.4 The factors that influence a girl's study choice

In this section multiple factors are investigated that have an effect on the decision of girls to choose computer science as a higher education study. These factors range from women being a minority in computer science, to women simply feeling inadequate to perform CS tasks due to lack of experience. This chapter dives deeper into those factors, explaining where they come from and what kind of effect they have on study choice.

Stereotypes of computer scientists and their work ethic

Over the past decades several stereotypes have emerged about people who work in CS and their work ethic. They have been widely discussed in both popular culture, society, and academic research. Here,

those stereotypes are revisited by seeing where they originate from and how they can shape girls' perceptions on computer scientists and their work ethic.

Stereotype 1: People in CS are not creative

A common stereotype among girls is that people working in CS are not creative. Research suggests that this stereotype may come from the perceived lack of creative activities in computer science (Cheryan et al., 2009). This stereotype originates from the unfamiliarity that girls have about CS and the possible job directions that a CS professional can go in to apply their creativity, such as video game design, graphic design or virtual reality.

Stereotype 2: People in CS are not interested in making a difference

Another stereotype that has originated throughout recent years is that people working in CS are not interested in contributing to society and helping others. A study explained this phenomenon by mentioning that girls have this stereotype as they have lower levels of knowledge on what the CS sector encompasses (Cheryan, Master, & Meltzoff, 2015). A lack of exposure to CS can further encourage this (Margolis et al, 2008). However, the field of computer science offers many opportunities to work on projects that have a significant impact on society, such as creating solutions and assistive technologies for disabled people.

Stereotype 3: People in CS have poor work ethic and are lazy

Societal perceptions about gender and work have caused some girls to think that people who work in CS, a field that is traditionally dominated by men, have poor work ethic due to social perceptions of masculinity and the belonging work ethic. This is because women are often perceived as being more diligent and hardworking than men (Gerson, 2004). This bias influences perceptions of work ethic in different fields too, such as teaching or nursing as they are traditionally dominated by women.

Stereotype 4: People in CS are socially awkward nerds

In modern media, characters that have any relation to computer science are usually portrayed within a specific stereotype, such as socially awkward nerds. For example, the tv series 'The IT crowd' is a valid depiction of this stereotype as its characters are being portrayed as IT nerds (García-Crespo et al., 2008). The film and television industry has popularized the concept of 'nerd' for decades and has been portraying it with several characteristics such as intelligence, interest in technology, science, computers, science fiction, fantasy, and related activities. However, they are also described as physically unfit, awkward, unattractive in terms of weight and clothing, uninterested in sports, socially inept, reclusive, unsociable, and lacking conversational skills (Bednarek, 2012). The lead characters in the tv series 'The Big Bang theory' share many of these characteristics (Lorre et al., 2007). In current media, people that

are branded ‘nerd’ are often the victims of isolation, ridicule, and teasing (Bishop et al., 2004). Many modern and old media reinforce these traditional nerd stereotypes, which is regrettable as it is often exaggerated and does not true in all aspects (Bach, 2006; Bednarek, 2012; Eglash, 2002). The impact of this on girls, who watch mainstream media, is that it might create negative stereotypes about people in STEM careers, thus also for people in CS careers. A study published by Holtom et al. (2005) mentioned that CS professionals scored higher on measures of interpersonal skills than people in other professions, indicating that not all CS professionals are necessarily socially awkard and may carry strong communication skills.

Lack of exposure to CS

Another factor that is evident in modern society is a lack of exposure to computing in early stages of a girl’s life. Computing is claimed as male territory (Margolis & Fisher, 2002), and many parents encourage boys over girls to perform computer related activities (Moorman & Johnson, 2003). Sadly, this is because parents do not understand how a girl can benefit from studying CS, thus they will provide less encouragement to girls to develop the appropriate technological skills and show less support toward computer use (Morgan & Argrawal, 2017). Studies found that girls’ decision to choose science-related fields is often tied to early exposure in informal settings and positive experiences with science, proving that it is crucial to provide these girls with a stable and encouraging digital environment at a young age (National Science Foundation, 2019). If girls receive little to no exposure to CS, girls might feel less inclined to pursue a career or study in this field.

Specific for the Netherlands, another important factor that causes a lack of expure to CS is the fact that computer science is not available in every Dutch high school. In the exam year of 2012, 55% of all 281 high schools in the Netherlands offered students the choice of studying computer science as an extracurricular course (Techniekpact, 2012). Unfortunately, this number declined in 2019 to 46% (243 high schools). This is partly due to the decline in teachers that teach CS. In recent years, there has been a decline from 5.5% to 4.5% in second grade teachers and 2.5% to 4.5% in first grade CS teachers. However, a good sign is that 38% of first and second grade CS teachers in 2022 were female as compared to 26% in 2008 (Techniekpact, 2022).

A CS course at high school can give students a foundation in what CS means and what kind of activities are linked to the subject, while also potentially soften negative or exaggerated stereotypes. It can also increase confidence for both girls and boys as it gives students a chance for a safe learning environment to practice and learn the subject. There are also schools that do offer computer science courses, yet they are limited to students that have a certain study profile. That specific group of students could then be of a particular gender, personality, or competence and exclude other students that might want to gain CS knowledge but simply cannot as they do not have the right study profile in their curriculum.

If there is no computer science course given to students at a high school, this will inevitably result in a lower female participation rate in CS studies from those schools. Women grow to have less affinity with computer science as they must pursue these interests themselves, without any school interference, support or encouragement. Furthermore, girls might feel inadequate or unsure to enroll in CS studies as they have had no proper experience, knowledge, and confidence in performing CS activities. A lack of computer science at high schools can exaggerate the other factors and perceptions that are named, ultimately having an impact on their decision to choose computer science after high school.

Lack of confidence about their ability to perform CS activities

Across the globe, women are stereotyped positively on the dimension of warmth and nurturance, but negatively on the dimension of intellectual competence (Glick et al., 2000). A subset of the negative stereotypes about women's intellects is directly relevant to girls' pursuit of CS activities. Namely, stereotypes about mathematical ability (which is part of acquiring CS knowledge), and stereotypes about "brilliance" (the exceptional intellectual ability in a more general sense) unsubconsciously shy girls away for performing activities related to mathematical ability (Boston & Cimpian, 2018). Furthermore, as parents do not encourage younger girls to perform activities related to computer knowledge, as mentioned before, girls might grow up feeling inadequate to pursuit those activities and knowledge that correspond to studying computer science. This in turn might lead them to not consider it as a possible future career or study choice.

Lack of role models

Role models are important for young, aspiring girls when making educational or career choices, because firstly, a role model can break down gender stereotypes that deter girls from pursuing certain career paths. This is especially important in the CS. Role models who challenge these stereotypes can inspire girls to consider non-traditional career or study paths. A study by Stout et al. (2011) has proven that female role models in STEM can help counteract negative stereotypes and increase girls' interest in STEM careers. Secondly, role models can encourage confidence and resilience in girls. They provide guidance and support on important matters such as education, career, and work-life balance. Dasgupta & Asgari (2004) mention that girls were more likely to engage in activities that were considered to be more masculine or gender-neutral when having female role models. The fact that women are a minority in CS, leads to less female students having role models in high school, as they are simply not there or in such small numbers that it is impossible to create opportunities for girls to meet female role models and peers.

In 2020, the TechniekPact monitor showed that 38% of all Dutch beta classes were taught by women, indicating that a minority is also visible in classes taught in high school, where girls can also

find role models (Lunenberg, Korthagen, & Swennen, 2007). There are also several popular and mainstream IT role models that currently are known by younger generations, however, they are mostly male: think about Steve Jobs or Elon Musk (Nagelhout, 2016). Receiving support and guidance from fellow female role models is not attainable for every girl and this could be a critical factor for career choice or career success in many cases.

Girls have less positive attitudes toward CS

The aforementioned factors can contribute to the formation of a specific attitude that girls may adopt. This "computer attitude," referring to their particular views, perceptions, affinity, and attitudes toward computers, tends to be relatively negative (Veenstra, 1999; Hur, Andrzejewski, & Marghitu, 2017) and is influenced by the factors discussed earlier. The less positive attitude among girls can be attributed to these factors and is closely linked to the portrayal of computer science that has been shaped by our society as our world becomes more digitally oriented. As these factors all bring forth certain attitudes about CS that directly collide with the values and desires of girls. Girls long for a more balanced career, family life and social interaction (Nash, 2017) and this collides with the values and desires of girls. Girls' leisure-time preferences show that not only are girls statistically better in collaborative and social tasks, but they prefer to do such activities more too.

4.5 Perceptions that exist because of the aforementioned factors

All factors mentioned above lead to certain perceptions among girls regarding computer science, which are summarized in table 1 and 2. In table 1, the factors are mentioned that contribute to the specific perceptions that derive from all these factors. This list of perceptions in table 2 can contribute negatively or positively to a girl's study choice of CS and ultimately influence the number of participating women in CS study programs.

Table 1

Factors that influence girls' perceptions

Lack of Role Models
Women are a minority in CS, leading to girls having less access to female role models that can inspire, guide or support girls.
Lack of Exposure
Parents encourage boys over girls to perform computer-related activities Girls do not always have access to CS courses in high school
Lack of Confidence

There are societal gender stereotypes surrounding girls' qualities and boys' qualities.
Parents provide less encouragement or support to develop appropriate technological skills
Lack of positive CS attitudes
Popular media culture reinforces stereotypical identity of 'nerd' Certain stereotypes existing in modern culture about CS professionals CS values are unfamiliar to girls and girls think these values collide with their own

Table 2

Perceptions among girls

CS has no female employees
CS is a male territory
CS is not fitted for the qualities girls possess
CS is too difficult for girls
CS is anti-social
CS is isolating
CS is for isolated nerds who lack social skills
CS activities are not focused on making a difference
CS activities are not creative
CS employees have poor work ethic

4.6 The basis of the intervention

We present a study by Brown et al. (2015) that will form the basis for the research method described in the next chapter. The research by Brown et al. (2015) examines the impact of an intervention to enhance students' perceptions about biomedical science and its work values. The paper tests two types of utility value: communal (other-oriented) and agentic (self-oriented) which directly relates to the stereotypes about CS mentioned before ('CS is anti-social, isolating.. CS employees have poor work ethic'). These are explained in more detail in section 3.7.1. Brown et al. (2015) found that, within biomedical research, an intervention where there were two versions of texts emphasizing the aspects of helping others, working with others and forming connections with others, increased students' motivation for biomedical science, both career- and studywise.

This paper directly impacts earlier perceptions mentioned and could therefore provide valuable insights for the research method.

Communal utility value

To explain the communal utility value, first the expectancy-value theory has to be explained. Eccles and Wigfield (1995) described the expectancy-value theory as "a multiplicative function that identifies both expectations for success in combination with personal valuation of the domain as key predictors of motivation". Career and educational choices are dependent on whether or not people believe 1) they will do well in the field (expectancy), and 2) the field is valuable (value). These expectancies and values are developed and shaped by life experiences, feedback from socializing agents (including parents, teachers, and peers), experiences in the educational settings, and observations of norms within society (Eccles, Barber & Jozefowicz, 1999). Eccles' and colleagues' (1983; 2005; 2009) expectancy-value model of student motivation indicates that values are situationally-based (Eccles & Wigfield, 1995) and thus amenable to intervention; and that different types of values can help motivate students, of which one of those types is the utility value (Eccles, 2005).

The research suggests that influencing or impacting utility value is key for high school and college student populations (Wigfield, 1994). Utility value is the extent to which a domain or task is perceived as providing an opportunity to attain a long- or short-term goal (for example helping others). Recently more scholars have investigated the different types of utility. Harackiewicz et al. (2012) established certain types of utility that can take on many different forms, including other-focused (for example medicine and socializing) and self-focused (for example video games, cell phone use). The "self-focused" values are referred to as agentic values, focused on the person's own interests, power, and gains. The "other-focused" values are referred to as "communal value" and describes values such as working with others, helping others, and allowing for forming lasting bonds with others (Pohlmann, 2001). The communal utility value is applicable to all ages as mentioned in the study by Brown et al. (2015). Therefore, it can be used in this research method as a way to influence the perceptions of students on CS, as focusing on "other-focused" values (so high communal utility value) might change perceptions of girls such as 'CS is anti-social' or 'CS is isolating'.

5. Research Approach

5.1 Research objectives

We have selected the two perceptions of "CS being anti-social" and "CS being isolating" as focus points for this research. While all other perceptions are just as valuable to investigate, the perceptions “CS is anti-social” and “CS is isolating” can make a big impact on the computer attitudes that girls currently have and their future study and career choice. They fit within the “communal utility value” spectrum of the experiment by Brown et al. (2015) and thus can be easily used as aspects that are to be analyzed. We aim to perform an experiment with an intervention already performed before by Brown et al. (2015) that is changed to fit the setting of this thesis. These changes are mentioned below. The experiment determines whether that intervention can positively influence a girl’s perception on what computer science entails. The intervention targets students from both genders, male and female, but in the analysis of the intervention the focus narrows down to the female students, while comparing the results of girls with the results of boys. Furthermore, students’ characteristics, such as gender, study profile, and CS background, are explored to see if any valuable insights can be gained by analyzing them that add up to the decision of girls to choose CS or not. We hypothesize that students randomly assigned to the high (vs. Low) communal value intervention would be more likely to report that computer science projects had communal utility value, thus rating it higher on the perceptions “CS is anti-social” and “CS is isolating”. Furthermore, we hypothesized that the effect of the communal value intervention on positivity toward and motivation to pursue a computer science study would be indirectly explained by students’ feelings that computer science has communal value. This experiment employs a 2 (communal value intervention: high vs low) x 2 (student gender) between-subjects design.

5.2 Changes made to the research

Brown et al. (2015) performed four studies with mutually exclusive and diverse student samples. They examined “whether intervening to explicitly add communal utility value to descriptions of biomedical research enhances students’ motivation to pursue biomedical science by complementing and not replacing the agentic value already present within the culture of science.” (Brown et al., 2015). This was done by letting undergraduate students read a paragraph detailing a biomedical program of research, where randomly assigned students had different intervention conditions (one paragraph with high communal value and one with low communal value).

We chose the first study to perform as an experiment, which focused only on highlighting the communal utility value and examining whether this increased students’ science motivation. Study 2, 3, and 4 are continuations of the first study and did not fit the scope of this thesis and its research questions, as they were more time intensive. These studies could however be explored in future research. There are several changes made to this first study to fit this thesis and its goals:

1. The field of biomedical science was changed to computer science, as that is the primary focus.

2. The participant group was changed to fifth year Dutch high school students.
3. A different intervention was designed where the intervention described a computer science topic, but the intervention condition remained the same. This was done to attract students to the CS topics, which is explained further in the section about the intervention itself.

The communal utility value consists in the paper by Brown et al. (2015) of these aspects: serving the community, working with others, caring for others, connection with others, helping others, and attending to others' needs. The communal utility value consists of only a part of those aspects (working with others and forming connections with others) as they are seen as the opposites of anti-social and isolating, which are the perceptions chosen in this thesis to influence.

5.3 Research Questions

The main research question for this project is as follows:

What is the effect of an intervention that focuses on the high communal utility value of CS on the perception that high school students have of CS?

This main research question is targeted to all genders but is narrowed down in the results section. The main research question is divided into several sub-questions that together form an answer to the main research question. The first sub-question comes directly from the main research question and is stated as follows:

1. *What are the factors that contribute to the decision of girls to choose CS as a higher education study program?*

This research question is answered in the literature review. There are multiple factors which lead to perceptions. Those perceptions lead to the answer of the second sub-question, as it specifies which direction the intervention has to focus on. By defining a way which possibly changes the perception girls have that fits completely with the circumstances of this thesis, being on a Dutch High school and focusing on all students instead of just female students, it can contribute to a final answer of the main research question.

2. *In what way can we change the perceptions students have on what computer science entails?*

The last two sub-questions analyze the intervention further from two different viewpoints They focus on gaining insights from the relationships between student characteristics and the topics used in the intervention text.

3. *How do students with different characteristics (study profile, gender, CS background) perceive computer science?*
4. *How do students with different characteristics (study profile, gender, CS background) perceive different topics within CS?*

5.4 Participants

The participants of this study are girls and boys between the age of 16-18. The intervention is performed at a Dutch High School, where 5th year students from every study profile (E&M, C&M, N&T, and N&G) are selected for this experiment. There are a total of 69 havo students and 95 vwo students which have different study profiles. There is only one specific selection criteria, which is that the student wants to voluntarily participate. The researcher has a professional relationship with the students: they teach some of those students, but not all. The students are notified and informed via an informed consent (added in appendix C). The study itself has been approved by an ethics quick scan provided by the University of Utrecht, ensuring adherence to ethical research guidelines and principles.

5.5 Procedure

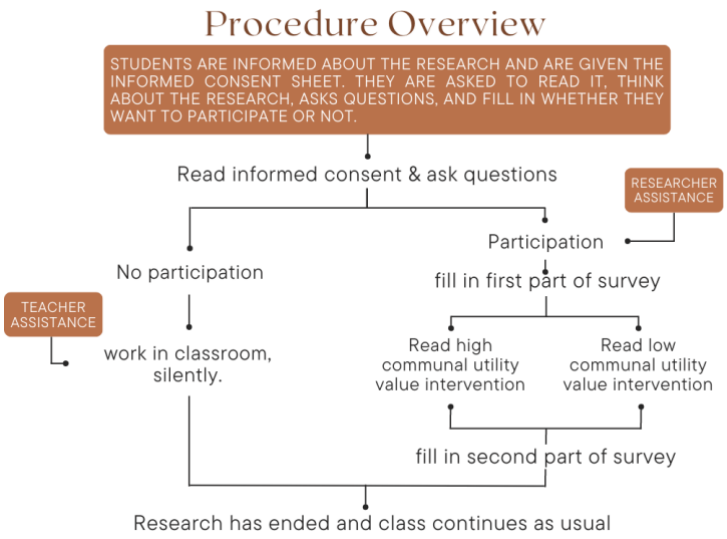
Participants were visited in their own lessons in the span of a week to participate in the experiment. Arrangements with teachers teaching the class at that moment were made in advance, they were informed about the experiment and what their part in it was. The task of the teacher was simply to remain in the classroom while the experiment was performed by the researcher. They were asked to support the students who did not want to participate in the experiment, as all students had to stay in the classroom.

Students were informed on the purpose of the experiment and the informed consent form was handed out. They were given time to read the informed consent and ask questions about the experiment to the researcher. Then, the forms were collected and the class was briefed on the procedure of the experiment. Students who did not participate continued working for themselves for 30 minutes, accompanied by the teacher of that class. The experiment began by using a sequential assignment process to allocate students to one of two surveys. For instance, Student 1 was assigned Version 1, Student 2 was assigned Version 2, Student 3 was assigned Version 1 again, and so forth. This sequential assignment method ensured an equal and unbiased opportunity for each student to be assigned to either survey group, mitigating potential biases and enhancing the study's validity. Then, students rated the following items: their beliefs that computer science has communal utility value, positivity toward computer science projects, and motivation to pursue a computer science study in the future using the established measures mentioned in section 4.7. Demographic information was also collected. This survey was either done digitally with Qualtrics, a tool used by Utrecht University students and staff to create surveys that meet a variety of needs, or physically on paper.

To give a visual overview of the procedure, figure 1 explains the steps taken during the experiment from the point of view of the student.

Figure 1

Procedure overview of the experiment



5.6 Intervention

All students read three small texts each detailing a different computer science topic. There are three topics which all focus on different projects centered around the use of CS in society. These three different topics are chosen to adhere to different types of people (creative maker/innovator, the explorer, the social applicator), so that most students could find a connection to a certain topic they were reading about. The topics of the texts for the intervention are based on the model: Bèta & Techmentality by Moha, Muller, & Thijssen from 2019. It is a model based on qualitative and quantative research among 9 to 17 year old students, where five different kinds of students were described that each have different motives, values and incentives toward CS. From these five different types, three were chosen to represent one topic for the intervention text: the creative maker/innovator, the explorer, and the social applicator.

The creative maker type

The first type, with the text named “The future is now: Live breakdance battles in VR are rising in popularity”, belongs to the creative maker/innovator. These students have positive associations with computer science and feel eager to use technology as innovations and solutions. This is emphasized in the text as it focuses on very new and important technologies to fully control body movement inside a virtual reality, which has been an upcoming trend in recent years. It was collected from a news article written by Lang (2021).

The explorer type

The type targeted with the second text is the explorer, to which the text named "Printed Food: Would you eat it?" belongs. Their values lie with the exploration of their interest in technology and with some being unsure about what role and feelings they have within and toward computer science. They are still exploring and forming their interests and opinions, and therefore this aspect is visible in the content of the project itself as it focuses on the more "fun" side of technology that might stimulate them further. It was collected from a news article written by Canfield (2023).

The social applicator type

This type is targeted in the text named "AI system can monitor and detect cardiac arrest". Social applicators have little to no interest in technology or computer science. Nonetheless, they do see the value that technology can bring for our society but doubt that they fit in the field. Therefore, this text is solely focused on the benefits of technology for society as it describes a recent project helping people through an AI that is able to detect when a cardiac arrest is happening. It was collected from a news article written by the National Science Foundation (2019).

The three texts were shortened to fit this experiment's circumstances, as the students needed to finish the survey in a limited amount of time (teachers would be more willing to give us the time in their lesson to perform the experiment, and students would be more willing to participate in the whole survey). All text was translated into Dutch, as the participants of this study are Dutch. Both versions (English and Dutch) can be seen in appendix A and B. Appendix A contains the text where the focus lies on a high communal value intervention condition and appendix B contains the text where the focus lies on a low communal value intervention condition. Across both conditions, the topics of the texts remained the same. In each text a picture was added that belongs to that topic and visualizes the content.

We only manipulated two aspects of commonal utility value between conditions, high and low. For the students randomly assigned to the *high communal value intervention condition (version 2)*, the contents of the texts were manipulated by adding extra words that related to the "working with others" and "forming connections with others" aspect of communion. Words such as "together", "close-knit", "collectively", "us/we", "with each other" were added to enhave the feeling of communion within each topic. For example, the sentence "Students in Boz's class are helping envision the future of 3D food printers." in the low communal utility value text was changed to "Students in Boz's class are *working together as a close-knit group of friends* to help envision the future of 3D food printers *that can help others*" in the high communal utility value text. In appendix A, the changes are highlighted.

The students that were randomly assigned to the *low communal value intervention condition (version 1)* got the original paragraph of the project, with no mention of words such as "working with others" and "forming connections with others".

5.7 Measures within the survey

Initial perceptions of CS

Before students read the texts containing the CS project topics, two questions are asked to collect students's initial perceptions of CS. These two questions were rated on a scale of 1 (not at all) to 5 (extremely):

1. Computer Science is anti-social
2. Computer Science is isolating

These questions are repeated at the end of the survey, after the students have read the text and answered the other questions (question 1 and 2 thus become question 22 and 23). A brief explanation of anti-social and isolating is given in the question (in Dutch).

Measures about communal utility value

Students' beliefs that computer science has communal utility value (focused on the two aspects "working with others" and "forming connections with others") are assessed with four items on 1 (not at all) to 5 (extremely) scales. Below are the two questions that were asked twice: once in the beginning of the survey and once at the end of the survey.

3. How much do the texts that you just read about fulfill the following goal: working with others
4. How much do the texts that you just read about fulfill the following goal: forming connections with others

The communal utility value scales were described and validated in Diekman et al. (2010; 2011) that was originally developed by Pohlmann (2001) and Bakan (1966). Even though their experiment questions focus on students older than 18, the questions were still chosen for this experiment as the focus group is expected to answer these questions on the same level as people older than 18 can. Therefore, no changes were made to the content and phrasing of all the questions mentioned in this thesis.

Positivity toward Computer Science

Students' positivity toward computer science topics they read about is assessed with four items on a scale of 1 (not at all positive/enjoyable) to 5 (extremely positive/enjoyable) listed below:

5. What is your impression of the topics you read about?
6. What is your impression of a study that conducts topics like what you read about?
7. How enjoyable do you believe you would find the topics that you read about?
8. How enjoyable do you believe that a study that conducts the topics that you read about would be?

Students' motivation to discuss these topics among friends, which also counts as positivity toward CS, is assessed with one item on a scale from 1 (not at all willing) to 5 (very willing):

9. How willing would you be to tell a friend about the topics you read about?

These items were validated by Diekman et al. (2011).

Future study motivation

Students' future study motivation for computer science is assessed with two items on a scale from 1 (not at all) to 5 (extremely):

10. How interested are you in applying to study programs in the area of computer science?
11. How interested are you in learning more about study programs related to computer science?

All items were originally modeled after Harackiewicz and Elliot (1993) and were validated by Smith, Sansone, and White (2007).

Importance of computer science

Students' beliefs about the importance of computer science is assessed with four items on 1 (strongly disagree) to 5 (strongly agree) scales:

12. I think these are valuable topics
13. These are useful topics
14. I think these topics are a waste of time
15. I think these topics are important

These items were used in and validated by Smith et al. (2013) to test importance and value of a given task. The importance items were originally developed from Smith et al. (2007) and the value items were originally developed by Harackiewicz, Manderlink, and Sansone (1984).

Interests in the different project topics

Students are asked to write down the topic that interested and inspired them the most of all three topics, and were also asked to write down in one sentence why this topic inspired or interested them. The question here is as follows:

16. Rate the topics from 1 (most interesting) to 3 (least interesting)
17. Why did you choose that topic as the most interesting? Please refrain to one sentence to explain your reasoning.

This is done to answer the fourth research question and to investigate whether there is any pattern or connection between chosen topic, reasoning, and study profile. In the analysis, question 17 is analyzed differently than the other questions of this survey as it contains qualitative responses instead of quantitative responses. This analysis entails an examination of the data to identify patterns, themes, and trends that emerge, followed by a process of categorization. The categories that eventually followed from the examination of data are based on the content and context of the arguments that were given. A

set of two main categories will be discussed, together with their belonging sub-categories and the reasoning behind the chosen (sub-)categories.

Demographic Information

Demographic information on the participants was gathered. This includes the following items:

18. Age
19. Gender (Male, female, Other, prefer not to say)
20. Study profile (C&M, E&M, N&T, N&G)
21. Currently following computer science class taught at school (y/n)

6. Results

This section presents the findings derived from the analysis of the acquired research data. It begins by providing general statistics, including demographic information and relevant variables, such as student profiles. After that, each sub-research question is examined and answered by focusing on the different characteristics of the students, aiming to uncover valuable insights.

6.1 General statistics

The total number of participants was 143 out of 164 eligible students with 136 online responses and 7 paper-based responses. From the 143 responses, 23 were incomplete and therefore not considered in the final calculations, as this helps maintain the integrity of data and ensures the accuracy of the subsequent analysis. In total, 120 students completed version 1 or version 2 (version 1: 58 students, version 2: 62 students).

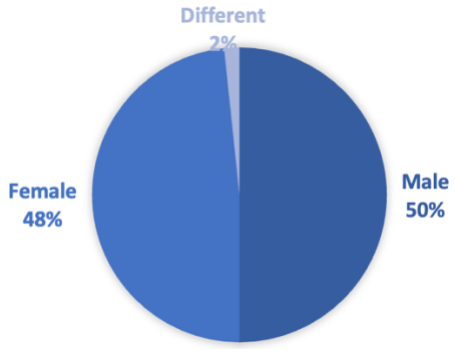
6.2 Incomplete Responses

Among the 23 non-completers, version 1 accounted for ten students, while version 2 compromised thirteen students. There were four instances where multiple respondents provided identical answers and started the survey around the same time and date (and where an identical answer pattern was detected in a completed survey responses). These observations raise the possibility that some participants may have scanned the QR code for the survey multiple times or encountered a situation where it was necessary for them to start the survey again, and eventually finishing one complete survey, potentially explaining why there are some incomplete responses**.**

Among all participants, two individuals identified as "Different/Anders" in version 1 and version 2. Furthermore, there were 60 male participants (V1: 29, V2: 31). Additionally, the survey captured the participation of 58 female participants (V1: 28, V2: 30). Figure 2 displays the percentages of the gender distribution among participants.

Figure 2

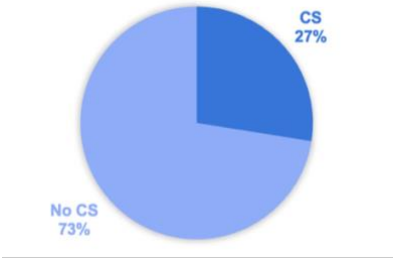
Gender distribution among participants



There were 33 individuals among the participants that currently had computer science as a subject in their curriculum (V1: 13, V2: 20). Figure 3 shows a pie chart displaying the percentages of students with a background in computer science.

Figure 3

Student distribution with or without CS in their curriculum



Lastly, among the participants, the study profile distribution can be seen in table 3. Here, the numbers per version are displayed. In terms of percentages, the distribution of study profiles within the completed survey responses is presented in the figure 4.

Figure 4

Study profile distribution of all students

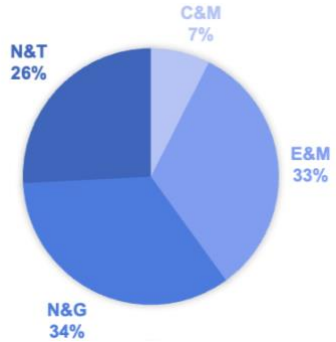


Table 3

Study profile distribution per version

	V1	V2
C&M	6	3
E&M	17	22
N&G	23	18
N&T	12	19

Table 4

Overview of all means, standard deviations, and p-values of students chracteristics

Question	Gender				
	Female *n=58*		Male *n=60*		total
	Mean	SD	Mean	SD	p-value
Impression of Topics	3.52	0.591	3.58	0.655	0.2380
Impression of Study	2.50	0.989	2.93	1.047	**0.0110**
Enjoyment of working on topics	2.59	1.056	3.07	1.093	**0.0080**
Enjoyment of Study	2.26	1.147	2.80	0.909	**0.0030**
Willingness to tell a friend	2.77	1.049	2.87	1.053	0.3130
Applying to study programs	1.83	1.017	2.02	0.920	0.1460
Interest in learning about study programs	2.18	0.922	2.38	0.947	0.1160
Valuable topics	3.28	0.911	3.48	0.818	0.1050
Useful topics	3.60	0.887	3.40	0.623	0.0850
Importance for society	3.09	1.267	2.77	1.154	0.0780
Waste of time for society	2.81	1.027	2.78	1.125	0.4530

Question	CS Background				
	CS *n=33*		No CS *n=87*		
	Mean	SD	Mean	SD	p-value
Impression of Topics	3.73	0.517	3.49	0.645	**0.033**
Impression of Study	3.12	1.053	2.56	0.985	**0.004**
Enjoyment of working on topics	3.33	0.957	2.62	1.081	**<.001**
Enjoyment of Study	3.21	1.023	2.29	0.963	**<.001**
Willingness to tell a friend	2.94	1.059	2.79	1.042	0.245
Applying to study programs	2.48	1.004	1.74	0.882	**<.001**
Interest in learning about study programs	2.67	0.990	2.13	0.878	**0.002**
Valuable topics	3.70	0.810	3.28	0.863	**0.009**
Useful topics	3.70	0.728	3.43	0.775	**0.045**
Importance for society	3.03	1.447	2.88	1.152	0.282
Waste of time for society	2.67	1.242	2.84	1.016	0.222

Question	Study Profile								
	C&M *n=9*		E&M *n=39*		N&G *n=41*		N&T *n=31*		
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	p-value
Impression of Topics	3.33	0.556	3.51	0.866	3.59	0.591	3.65	0.661	0.560
Impression of Study	1.78	0.850	2.74	0.667	2.59	1.048	3.13	1.118	**0.003**
Enjoyment of working on topics	1.89	0.966	2.74	0.782	2.71	1.055	3.32	1.166	**0.003**
Enjoyment of Study	1.78	0.854	2.49	0.667	2.39	1.093	3.03	1.169	**0.005**
Willingness to tell a friend	2.44	1.144	2.82	0.882	2.63	1.102	3.23	0.762	0.063
Applying to study programs	1.33	0.724	1.72	0.707	1.95	1.048	2.39	1.054	**0.006**
Interest in learning about study programs	2.11	0.680	2.10	1.167	2.15	0.864	2.71	1.131	**0.028**
Valuable topics	3.22	0.847	3.38	0.847	3.28	0.960	3.61	0.761	0.381
Useful topics	3.33	1.044	3.46	0.707	3.40	0.744	3.74	0.729	0.236
Importance for society	2.44	1.226	2.85	1.014	2.90	1.215	3.19	1.327	0.396
Waste of time for society	3.00	0.977	2.85	0.707	2.95	1.085	2.65	1.279	0.559

Note

Bold = p<.05

N= 120

6.3 Students' perception of Computer Science

All questions regarding gender and CS background are analyzed by using a one-sided independent samples t-test. As only 2 participants identified as neither male or female, which is not enough to compare to the male and female opinions, they have not been considered for the statistical tests that were performed. The rating that is used for all questions is as follows: 1 being the most negative rating a student can give, and 5 being the most positive rating, e.g., 1 = not at all willing, 5 = extremely willing, or 1 = totally disagree, 5 = totally agree.

For the questions regarding study profile, an ANOVA test was performed, as there are multiple variables that need to be accounted for. The chosen significance level is 0.05 for all statistics. In table 2, all means, standard deviations, and p-values are mentioned per question and characteristic. In appendix E, all hypotheses can be found as they are not mentioned in the text below.

Positivity toward computer science

Question 5: What is your impression of the topics you read?

The analysis of this question revealed that there was no significant difference in the impressions of the topics between male and female students and between different study profiles. However, students with a CS background had more positive impressions compared to those without a CS background. This might imply that a background in CS can bring with it higher impression of specific CS topics.

Question 6: What is your impression of a study that discusses the topics that you read?

For gender, a significant difference was found, with male students having a more positive impression compared to female students. Regarding computer science background, students with CS had a more positive impression than those without CS. Lastly, the study profiles revealed a significant difference between the four profiles, with C&M students rating the study the lowest and N&T students rating it the highest. These findings all support the alternative hypotheses and suggest that factors such as gender, computer science background, and study profiles influence participants' impressions of studies where CS topics are discussed.

Question 7: How enjoyable would you find it to work on one of the topics that you read?

Male students exhibit a greater desire to work/build on the topics compared to female students. The same can be said for students with CS in their curriculum. C&M students find it the least interesting and N&T students have the highest inclination to work on the topics. In conclusion, the findings support all alternative hypotheses, suggesting that male students, students with CS, and students with a specific study profile (N&G) exhibit a greater willingness to work on the topics.

Question 8: How enjoyable do you believe that a study that researches the topics that you read would be?

Male students had a higher willingness to participate compared to female students. Similarly, students with CS also had higher willingness to participate compared to students without CS. Lastly, the ANOVA test performed for the study profiles showed that there is a significant difference in willingness among the different profiles, with C&M having the lowest rating and N&T having the highest rating, just as the questions before.

Question 9: How willing would you be to tell a friend about the topics you read?

There is no strong evidence supporting that any characteristic can result in significantly different ratings of students' willingness to tell friends about the mentioned topics. All students feel a rather low intention to tell their friends about these topics. The average regardless of student classification was 2.82, with a standard deviation of 1.051, showing a rather neutral stance among students when it comes to sharing these topics.

Overall conclusion on positivity toward CS

Students with CS in their curriculum generally have a more positive opinion of CS as a study, as for questions 6, 7 and 8 the answers were significantly more positive ($p = 0.011$, $p = 0.008$, $p = 0.003$) when compared to students without CS. While questions 5 and 9, on the general likability of the topic and the students' willingness to share showed no significant difference. Also, the C&M students are the least positive, while the N&T students are generally most positive. Furthermore, it was interesting how students generally did not really have an opinion about telling their friends about the topics mentioned in the intervention, as most means center between 2.4 and 3.2.

Future Study Motivation

Question 10: How interested are you in applying to study programs in computer science?

Students with CS are much more interested in applying to a CS study program, than any other characteristics. Female and male students have the same interest ratio, both relatively low. The N&T students prove to be the most interested in applying to a CS study program.

Question 11: how interested are you in learning more about study programs related to computer science?

While there was no significant difference between male and female students in their interest, students with a computer science background showed a higher level of interest compared to those without. Also, when considering different study profiles, there was a statistically significant difference in interest, with the N&T study profile showing the highest level of interest.

Overall conclusion on future study motivation

Students with CS have more interest in applying to CS study programs than other students. The statistical difference between these two groups is very strict ($p= 0.001$ and $p = 0.002$), showing that having CS in your profile strongly determines your general interest in studying something CS related. This is sensible, since students who chose CS in their profile are more likely to have an interest in CS related topics. Overall, C&M students are the least interested while N&T show the highest interest out of all students. There is no significant diference between male and female answers ($p = 0.146$, $p = 0.116$), suggesting that there is not a clear distinction between genders. Female means are just slightly lower than that of male students.

Perceived Importance of Computer Science

Question 12: I think these are valuable topics

In terms of gender and study profile, there were no significant differences in how the groups of students perceived the value of the topics. However, when considering computer science background, students with CS had a more positive perception of the value compared to students without CS. Therefore, these findings suggest that computer science background plays a role in shaping students' perception of the value of the topics, while gender and study profiles had less influence in this regard.

Question 13: These are useful topics

Regarding gender and study profile, there were no significant differences in how students perceived the usefulness of the topics. Students with a computer science background perceived the topics as more useful compared to those without a computer science background, as with the previous question. The students did overall agree with the usefulness of the read topics.

Question 14: I think these topics are important for society

The results showed that there were no significant differences in the perception of importance based on gender, computer science background, or study profiles. In other words, both male and female students, those with and without a computer science background, and students with different study profiles had similar perceptions of the importance of the topics for society.

Question 15: I think these topics are a waste of time to society

The results indicate that there were no significant differences in the perception of importance based on gender, computer science background, or study profiles.

Overall conclusion on importance of CS

The only partly significant difference on the importance of CS among students happens when comparing the students having CS in their curriculum with the students that do not have a CS background. As for question 13 a strong significant ($p = 0.009$) was measured, while for question 14 only a moderate effect ($p = 0.045$) was measured. The other questions did not provide any significant effect. However, this outcome only applies to the opinion about the topics in the intervention text being valuable and useful. All students replied relatively neutral to the aspect of CS being a waste of time for society. Furthermore, students found that CS is relatively useful and valuable as all means are above a 3.2. Female students, students with CS and N&T think that CS is important for society.

6.4 Students' perception of the 3 different topics

To analyze the acquired data and gain insights into the students' perspectives on the 3 different CS topics used in the intervention text, the responses to questions 16 and 17 from the survey were explored. We will look at differences between gender, following CS or not, and study profile. As question 16 contains quantitative data, it is analyzed differently than question 17 which contains qualitative data. Question 17 will be analyzed thematically by looking for certain patterns in students' responses and categorizing these responses under specific themes so that they can be identified and interpreted according to the different genders, study profiles and cs background.

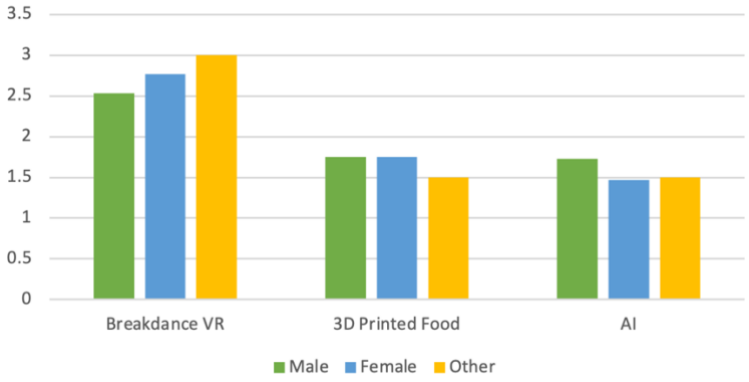
Question 16: rating of the topics

Gender

The analysis of mean ratings for the topics among male, female, and other students reveals interesting insights regarding their varying levels of interest. Here, the rating was as follows: 1 = most interesting topic, 3 = least interesting topic. While there are some similarities in interest levels across gender groups (all groups overall perceive the topic about breakdancing in VR to be the least interesting), notable differences also emerge. For instance, when considering the topic "Breakdance VR," both male and female students display a lower level of interest, but males demonstrate slightly higher enthusiasm. This finding suggests that virtual reality applications in the context of breakdancing may resonate more with male students. Interestingly, the topic of "3D Printed Food" garners high interest among all three groups, indicating its broad appeal and potential significance across different genders. On the other hand, the topic of "AI" generates a high interest among male students but relatively less enthusiasm among females.

Figure 5

Mean ratings of topics by gender

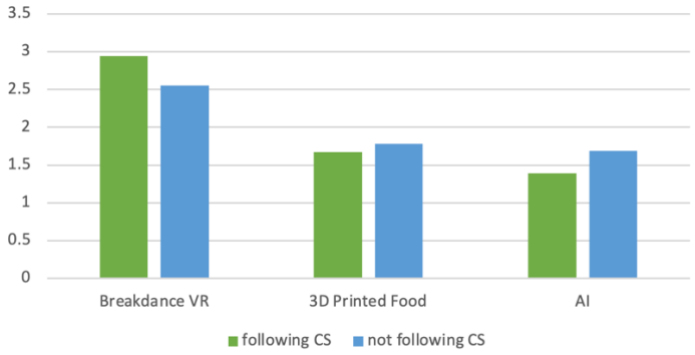


Following CS or not

Students following CS courses exhibit a higher mean rating of 2.94 for the topic "Breakdance VR" than students not following CS, indicating a lower interest in the intersection of breakdancing and virtual reality. For the topic "3D Printed Food," students following CS display a lower mean rating of 1.67, signifying a higher level of interest, while students not following CS show a slightly higher mean rating of 1.78. This might indicate that students with a background in CS possibly recognize the potential applications of 3D printing in the food industry and find it more intriguing more than students following CS. In terms of the topic "AI," students following CS exhibit a notably lower mean rating of 1.39, indicating a higher level of interest, while students not following CS have a higher mean rating of 1.69. This might suggest that students with CS are more enthusiastic about exploring the complexities and possibilities of artificial intelligence and 3D printed food, while with students not following CS these mean ratings are more balanced out among the three topics. These findings could highlight the impact of prior CS exposure on students' interests and underscore the importance of incorporating engaging CS content to attract and sustain interest among students who are not yet following CS, but this is something we cannot say for sure.

Figure 6

Mean ratings of topics by CS background



Study Profile

For the topic "Breakdance VR," students in the C&M study profile have a mean rating of 2.22, indicating a relatively higher interest compared to students in the E&M (2.56), N&G (2.73) study profiles, with N&T (2.80) study profiles having the lowest rate of interest toward the topic. This might suggest that students in the C&M study profile find the concept of breakdancing in virtual reality interesting enough to rate them the highest.

Similarly, for the topic "3D Printed Food," students in the C&M study profile again have a mean rating of 2.22, which is higher than the mean ratings of students in the E&M (1.82), N&G (1.51), and N&T (1.83) study profiles. This might imply that students in the C&M study profile exhibit a relatively lower or perhaps more balanced interest in the potential applications of 3D

printing in the food industry in comparison to the other students. In terms of the topic "AI," students in the C&M study profile have a mean rating of 1.56, while students in the E&M (1.64), N&G (1.76), and N&T (1.37) study profiles also show relatively high interest. These findings could suggest that students in the C&M study profile, followed closely by those in the E&M study profile, demonstrate a higher level of interest in exploring the complexities and possibilities of artificial intelligence. Overall, these observations highlight the variations in topic preferences and interests among students with different study profiles. It is also remarkable that the C&M students portray the most balanced depiction of the rating of the three topics. Again, the topic about smart AI being able to identify cardiac arrests shows the most potential among students by being the highest rated topic of interest, except for N&G students, who find 3D printed food slightly more interesting.

Table 5

Mean ratings of topics by study profile

Topic	*C&M*	*E&M*	*N&G*	*N&T*
Breakdance VR	2.22	2.56	2.73	2.80
3D Printed Food	2.22	1.82	1.51	1.83
AI	1.56	1.64	1.76	1.37

Question 17: reasons why students rated the topics as they did

This part discusses the responses given by students as to why they have rated certain topics as most interesting to them. Two main categories are named, ‘societal impact and added value’ and ‘personal interest and experience, which both have their own sub-categories. The categorization of all the responses can be found in appendix D, providing an overview of the different categories and their responses that belong to it.

Societal impact and added value

This category encompasses arguments and reasoning that highlight the broader impact and value of the discussed topics (Breakdance VR, 3D printed food, AI) for society. The arguments emphasize that the treatment of medical conditions, saving lives, addressing societal issues, and improving the health and well-being of individuals are important and valuable aspects. They are more people/society-focused arguments. Under this main category, there are 3 sub-categories that can be derived from all answers.

Medical Use

These are the arguments that point to the potential of the topics when applied within the medical field, for example to treat medical conditions, save lives and improve people's health. Below are some quotes from students that belong to this sub-category:

- "It is a big advantage to help the medical world with AI."
- "This way you can help people that are sick."
- "This can save lives and thus has a function."

Solutions to social problems

These are the arguments categorized into reasoning that relates to solving social problems within society such as food shortages, famine, and medical needs. Below are some quotes from students that belong to this sub-category:

- "It can save lives and solve problems, for example in poorer parts of the world."
- "It has a positive impact on nature and human life."
- "It might develop into a solution for world famine."

Positive impact on daily human life

These arguments emphasize a topic's ability to improve daily life, whether by providing convenience, efficiency, or new possibilities to life. Below are some quotes from students that belong to this sub-category:

- "It can change daily life and offer convenience."
- "It has a positive function/impact on society."
- "It has a positive impact on the lives of people."

Personal interest and experience

This category encompasses arguments that are based on individuals' personal interests, experiences, or preferences. They indicate that individuals find the topic interesting, enjoyable, inspiring, or fascinating due to their own experiences or passions. These arguments are more subjective and self-focused than the previous category and reflect the individuals' personal involvement with the topic.

Interests, experiences, and hobbies

These are arguments based on individuals' personal interests, hobbies, or experiences, indicating that they are drawn to the topic due to their personal affinity or passion, or having already had an experience with the subject. Examples of answers belonging to this category are:

- "I find breakdance interesting."
- "I also have VR and have been to a VR party, so I find it interesting."
- "It seems really cool to get food from a printer."

Curiosity and eagerness to learn

These are arguments indicating that the topic, although students don't know much about it, intrigues them, and makes them curious to learn more. Some examples of this sub-category are:

- "It was about a subject I find interesting but don't know much about."
- "I think it's remarkable that new developments can save people's lives."
- "I believe this could be a solution or substitute for potential future problems."

To better identify the sub-categories of reasons and possibly give them a deeper meaning, the characteristics of the student choosing a specific reason in a category were analyzed. However, no specific patterns were found. The reasons in all different categories were given by both male/female, CS/no CS, and divided among all 4 study profiles. There was nothing that stood out and thus no conclusions can be made on this.

6.5 The effect of the intervention on students' perceptions

This section will answer the research question: *"What is the effect of an intervention that focuses on the high communal utility value of CS on the perception that students have of CS in their fifth year of Dutch high schools?"* It does this by measuring the effect of the low communal utility intervention and comparing it with the effect of the high communal utility intervention. Furthermore, a statistical analysis in the form of a multivariate ANOVA is performed to measure the statistical significance of the possible difference in version, the possible difference in gender and the gender differences when comparing the different versions. To accept or reject the null hypothesis for this study, a significance level of 0.05 was used. This is not as strict as a significance level of 0.01 but is considered strict enough for the purposes of this study. To reflect on this choice, the stricter 0.01 significance level is referenced in later sections of the results.

The section on version differences provides detailed descriptions of the low and high communal utility interventions, followed by an analysis of their respective effects. The section on gender differences explores the role of gender as a variable and conducts statistical analyses to identify potential gender differences. Lastly, the section on gender differences by version and study profile differences by version examines the interaction between gender, study profile, and intervention type, analysing how gender and study profile might influence the effects within each version.

Communal utility value of the different versions

In the intervention the students were asked to fill in how much the texts had fulfilled the goal of working with others and forming connection with others. It measured the communal utility value opinion of the students. However, the means for both versions were high, as seen below, and there were no significant differences ($p = 0.541$ and $p = 0.264$). This suggests that students thought that both text contained aspects of working together and forming connections with others. Or the students did not understand the underlying idea of the text fully.

Table 6

Mean ratings of the measures of communal utility value rated by students

	v1	v2
working with others	3.42	3.51
forming connections with others	3.44	3.61

Version differences

Two different versions were considered when performing the student survey. Version 1 contained an intervention text with a low communal value description of 3 topics within CS. Version 2 contained an intervention text with a high communal value description of the same 3 topics. 58 students

participated in version 1, 62 students participated in version 2. To analyze the difference between these versions and the effect it had on the students, a paired samples t-test was performed. This analysis showed that there was one significant difference in the responses within version 1 (isolating aspect), the low communal value intervention. The anti-social aspect had no significant difference. However, the difference for the isolating aspect is significant when it is one-sided, but if it a two-sided significance is considered (also considering the possibility of the intervention having a negative effect instead of only positive being possible), there is no significant difference anymore. This means that this version, version 1, did not seem to have a significant effect on the student's perception of CS, regarding anti-social, but had a small significant effect on the isolating aspect. For version 2, there was a different outcome. Version 2 (high communal utility value) had a significant effect on the students' perception of both the anti-social and isolating aspects of CS ($p = 0.003$ and $p = 0.002$), one sided. This means that regardless of gender, CS background, or study profile, the high communal utility value intervention (version 2) has a significantly bigger effect on improving students' perception of the isolating and anti-social aspects of CS even when comparing it to the isolating aspect of version 1. Brown et al. (2015) held a significance level of 0.01 for their test analysis, if that were applied to this study, version 2 would still have a significant effect, while version 1 would not. Below in table 7, the means and p-values are displayed for both versions. It shows the difference in answers before and after the intervention, for each different version of the intervention.

Table 7

Means and p-values of the performed paired samples t-test for versions 1 and 2. Showing the difference in response before and after the intervention of the same questions (pairs) for each of the different versions of the interventions.

Version 1		Mean	Significance one-sided p	Significance two-sided p
Pair 1 (anti-social)	Q1	2.76	0.057	0.115
	Q22	2.59		
Pair 2 (isolating)	Q2	2.86	0.029	0.057
	Q23	2.64		
Version 2		Mean	Significance one-sided p	Significance two-sided p
Pair 1 (anti-social)	Q1	2.61	0.003	0.006
	Q22	2.29		
Pair 2 (isolating)	Q2	2.85	0.002	0.004
	Q23	2.50		

Study profile and CS background differences by version

There are no significant differences between study profiles and the different versions. This suggests that study profile has nothing to do with the effectiveness of the versions. The same holds true for students with or without a CS background.

Gender Differences

Besides the effect of the different versions, another important aspect of this study was to research the effect of the versions on the genders of the students. With the earlier performed ANOVA test, it was found that regardless of the type of intervention, males were statistically more likely to improve their perception of the anti-social and isolating aspects of CS based on the intervention [P = 0.009 (question 1, 22 anti-social), and P = 0.001 (question 2, 23 isolating)). Female students did not show any significant improvement regardless of version [P= 0.105 and P = 0.109). Female students did show some general improvements after both interventions; however, it was not as statistically significant as they were with the male students. This shows that overall male students seem to be affected by the intervention more than female students when it comes to their perception of the anti-social and isolating aspects of CS.

To further analyze the difference between version and gender, the final analysis consists of the effect of the type of intervention on gender. One gender might provide different outcomes when given a high or low communal value intervention. Table 7 shows the p-values for Gender x Version x Questions (anti-social and isolating) that were asked.

Table 8

Gender comparison to version of all students

Gender/version	**Version 1 (low communal value)**	**Version 2 (high communal value)**
Male	p = 0.184 (anti-social) p = 0.025 (isolating) moderate effect	p = 0.025 (anti-social) p = 0.032 (isolating) significant effect
Female	p = 0.501 (anti-social) p = 1 (isolating) no effect	p = 0.109 (anti-social) p = 0.062 (isolating) moderate effect

The table shows that the low communal value intervention (version 1) has a moderate effect (p = 0.184) on male students for the isolating aspect of CS, it shows that only when answering the isolating question pairs there was a significant effect measurable with males (p = 0.025). On female students however, version 1 had no moderate or significant effect at all.

The high communal value intervention (version 2) has a significant effect ($p = 0.025$, $p = 0.032$) on male students for both the anti-social and isolating aspect of CS. Showing that males are more affected by the high communal intervention when compared to the low communal intervention. Regarding female students, only the isolating aspect of the version has a moderate effect on female students ($p = 0.062$), while no moderate significant effect ($p = 0.109$) was seen with the anti-social perception of CS among female students.

7. Discussion

It is important to consider certain limitations and unexpected outcomes that emerged throughout the research process. By addressing these limitations in future research, the practical implications of this study can be further enhanced and in turn, a more comprehensive understanding of changing perceptions in computer science can be acquired. Therefore, in this discussion, several points are stated that analyze and discuss the implications of the findings.

Firstly, it is worth noting that there was a limited representation of students from the C&M study profile in the research sample, with only 9 students. This disparity in numbers between the C&M study profile and the larger other samples (e.g., 41 N&G students) may have provided implications for the generalizability of the experiment. It is challenging to draw direct comparisons and make detailed conclusions between the four study profiles.

Furthermore, the participants in this study were solely from one school, which means that the findings may be influenced by the specific school culture and environment. The characteristics of the school (only students with an N&G and N&T profile may have CS in their curriculum, the ratio of female and male students in a CS class is almost 50/50, all students use a laptop for classes and studying since the first class) might have unconsciously influenced the students' responses and perceptions. Their experience with technology being perceived as 'normal' and always around them, as they use a laptop in every class for learning, might have given them more neutral opinions on CS in general. There is also the possibility that students provided socially desirable responses when asked about the anti-social and isolating perceptions of computer science (as they were asked twice in the same survey). This response bias could have affected the accuracy and reliability of the data.

Not all students had completed the questionnaire, of which most stopped after or while reading the intervention text in both versions. This dropout rate could potentially impact the validity of the results as it introduces the possibility of non-response bias or missing data. A solution for this could be to refine the intervention text. For instance, using a shorter text to describe the topics used in the intervention text, or maybe even limiting the text to only one topic.

Finally, it is important to acknowledge that this study had a broad focus, which limited to a certain extent the depth of analysis regarding changing perceptions. It did provide valuable insights into the overall attitudes and perceptions among the school population of computer science of one specific school. The students also rated the 'working with others' and 'forming connections with others' aspects in both the intervention texts from version 1 and version 2 relatively the same, which could mean that the intervention text from version 1 did not have enough subtle differences in comparison to version 2 to make a difference in student perceptions. Future research could consider narrowing down the scope and focusing more on changing the perception rather than conducting a comprehensive but broad study as it could yield more specific and targeted results. By emphasizing and focusing only on the specific aspects of computer science that challenge anti-social or isolating

perceptions, the intervention may be more effective in altering students' perspectives and may result in changing negative perceptions that students have into positive ones, thus maybe influencing their view on CS and inspiring them to pursue a career or study toward the field.

8. Conclusion

The underrepresentation of women in the IT sector and computer science study programs is a persistent issue in our digitalized world, with women comprising only a small percentage of the IT workforce. The lack of female participation in computer science leads to a "shrinking pipeline," resulting in fewer women entering higher education and professional positions in IT. This gender disparity has consequences for diversity and inclusivity, ultimately impacting the growth and expansion of our technology-driven society. As the demand for IT professionals continues to rise, it might be beneficial for society to include more women in the IT sector.

This thesis focused on understanding the reasons behind the lack of female participation in computer science study programs and tried to find a way to positively influence a female student's opinion of Computer Science. To dive deeper into this phenomenon, a literature review was performed that answered the following question:

What are the factors that contribute to the decision of girls to choose CS as a higher education course?

The literature review described the current situation of girls within CS and found several factors that influence girls' study choices. Topics such as media depiction, stereotypes, and lack of exposure or limited access to CS were discussed. Then, ten perceptions were drawn from these eight factors which concluded the findings. By understanding these perceptions and their impact on girls' decision-making processes, an intervention was designed that analyzed students' opinions on and perceptions about CS. This experiment has answered the following main research question:

What is the effect of an intervention that focuses on the high community utility value of CS on the perception that students have of CS in their fifth year of Dutch High Schools?

The students' current view on Computer Science showed some interesting results. Students with CS and N&T students in general think more positive of CS than their peers. They also have more interest in applying to CS study programs. Usually, male students tend to think more positive of CS too, however this is not as much the case as it is for CS or N&T students. Students with C&M profile have the least interest toward CS in almost all cases and usually rated it the lowest when discussing things like importance, usefulness, or enjoyability.

During the analysis of the introduced topics, several findings emerged. Among them, it was revealed that students rated the topic of AI as the most interesting out of the three topics presented. On the other hand, breakdance was consistently ranked as the least interesting. This suggests that most students consider it important to have AI systems capable of recognizing cardiac arrests, indicating their preference for topics that involve the intersection of technology and healthcare to benefit society. The students' reasoning behind their preferences primarily stemmed from considerations of societal impact and added value, as well as personal experiences and interests.

The results showed that version 1 had only a small significant effect on students' perception of the isolating aspects of CS, while no significant effect on the anti-social aspect. Version 2 had a significant effect on both aspects. Additionally, male students were more likely to improve their perception of the anti-social and isolating aspects of CS, regardless of the intervention version, whereas female students did not show significant improvements. When analysing the interaction between gender and intervention version, version 2 had a significant effect on male students' perception of both aspects, while only the isolating aspect showed a significant effect for female students. There were no perceived significant differences when comparing study profiles and versions, and CS background and versions, suggesting that these two characteristics do not have any effect on how the students perceive the different versions. This means that the intervention did indeed have a significant effect on the perception that students have on CS, with male students being more influenced than female students.

There are several ways in which future research and expansion can happen to expand upon these research findings. These areas are based on the limitations and gaps identified in this study. First, it is possible the extend the investigation to other schools which would provide a broader perspective and enable a more comprehensive analysis of the effectiveness of the intervention. This approach would allow for the exploration of other potential outcomes across different educational environments and cultural contexts. Focusing only on female students might also bring about other interesting results. Secondly, to assess the long-term effects of the experiment, a follow-up study is recommended, to discover if there are any long-lasting effects on the changes observed among (female) students in this experiment. Finally, another research direction could be to explore alternative forms of interventions or to change the focus of the experiment to other perceptions. Comparing the effectiveness of these alternative interventions or perceptions can provide valuable insights and can help identify the most impactful strategies in changing perceptions.

In conclusion, this thesis contributes to the knowledge surrounding the underrepresentation of women in computer science. By identifying influential factors and perceptions, as well as implementing an intervention to positively shape perceptions, this thesis provides a foundation for further research and initiations to encourage more women to pursue computer science studies and careers.

Practical recommendations derived from this thesis can include integrating CS-related concepts and discussions into various subjects to broaden students’ exposure, engagement, and knowledge. We have noted that generally students with a CS background were more positive than other students. Therefore, making other students more aware of the applications of technology could improve their opinions too. To give an example: explore how technology can be applied in healthcare, as this topic has shown significant interest among all students. This can shine a light on the relevance and real-world applications of CS beyond traditional stereotypes which could lead to improved perceptions and opinions of CS. Another recommendation is to be mindful of the language used to

describe CS-related concepts. Highlight the opposite aspects of the earlier mentioned perceptions so that the focus shifts on the positive aspects of CS that might pique students' interests, which was visible in the results of this study when analyzing version 1 and version 2 and the impact it had on the students. Emphasizing different aspects of CS in a positive light can help reshape students' perceptions.

By implementing these recommendations, educational institutions can build a positive and engaging experience, encouraging more students to explore or pursue computer science. Overall, this research contributes to the ongoing efforts aimed at reducing the gender disparity in computer science and emphasizes the importance of creating an inclusive and diverse environment within the field. It is our collective responsibility to create a more inclusive and appealing environment around computer science for all genders and to empower women to pursue computer science careers and studies.

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Appendix A: Text version 1 – high communal value

Figure 3: VR Breakdance battles are connecting people from around the world

The future is now: Live breakdance battles in VR are rising in popularity

If you aren't paying close attention to VR, you'd have no idea that some insanely futuristic stuff is already happening today. Yes, it looks pretty janky at times, and the hardware is surely a pain to strap on, but there's no denying we're living in the future when we are donning headsets, stepping into anime avatars, and breakdancing with each other in virtual reality.

These are real people like us, connected virtually from around the world, performing these dance moves in real-time together. Dance battles like these have been cropping up in VRChat, a social VR application which has connected people, embraced both full-body motion tracking and an 'anything goes' approach to avatars; the culmination of which has led to this unbridled level of digital self-expression in a group. Dancing together in VRChat has been a thing from the outset, from simple spontaneous dance parties to players going as far as doing actual pole dancing in virtual reality while forming connections with others.

Communities are beginning to form around these activities, with organizers coordinating virtual get-togethers, mentorship, and competition, collectively connecting people from across the globe who would almost certainly not have met otherwise. While such communities are still fledgling, the grass-roots dancing movement in VRChat and beyond is yet another example of VR's ability to remotely connect people in truly unique ways and bring them together to form unique relationships.

Dutch Translation:

De toekomst is hier: Live breakdance-battles in VR worden steeds populairder

Als je zelf niet op de hoogte bent van de nieuwste VR ontwikkelingen, zou je geen idee hebben dat er tegenwoordig al waanzinnige futuristische dingen gebeuren. Ondanks dat het er gek uit ziet en de hardware zeer lastig is om aan te trekken, ziet het er naar uit dat we in een toekomst leven waarin wij headsets opzetten, in anime-avatars stappen en met elkaar breakdancen in virtual reality.

Het zijn echte mensen zoals wij, virtueel met elkaar verbonden vanuit de hele wereld, die deze dansbewegingen samen in realtime uitvoeren. Dansgevechten als deze duiken op in VRChat, een sociale VR-applicatie die mensen met elkaar verbindt, zowel het volgen van bewegingen van het hele lichaam als een 'alles mag'-benadering van avatars heeft omarmd; waarvan het hoogtepunt heeft geleid tot dit niveau van digitale zelfexpressie om te laten

zien aan anderen. Samen dansen in VRChat is vanaf het begin iets speciaals geweest, van eenvoudige spontane dansfeesten tot spelers die zelfs paaldansen in virtual reality terwijl ze connecties vormen met anderen.
Rondom deze activiteiten beginnen zich gemeenschappen te vormen, met organisatoren die virtuele bijeenkomsten, mentorschap en competitie coördineren en mensen van over de hele wereld met elkaar in contact brengen die elkaar anders zeker niet zouden hebben ontmoet. Hoewel dergelijke gemeenschappen nog in de kinderschoenen staan, is de gezamenlijke dansbeweging in VRChat en daarbuiten nog een ander voorbeeld van het vermogen van VR om mensen op werkelijk unieke manieren op afstand met elkaar te verbinden.

English text collected from (and has been modified to fit experiment conditions):
https://www.roadtovr.com/vr-dance-battle-vrchat-breakdance/

Figure 4: a 3D printer printing different shapes of food

Printed food.. would you eat it?

For years, 3D printers have become an increasingly useful technology for us for creating everything from rollercoaster models to houses. But what about printing food? Adam Watson and Ziynet Boz have worked together and have been rethinking the power of 3D printers, specifically their ability to print food to help others.
One of these 3D printers sits in their lab ready for use. With the touch of a fingertip, the machine beeps and an array of designs populate on the touchscreen. Once a design is selected, the mechanical arm makes a high-pitched whirr as it begins its meticulous work of careful layering, first starting with the base. Then, a viscous food substance like mashed potatoes is squirted out of cylinders of varying nozzle sizes until the design is completed.
Its benefits for society may extend beyond creative experimentation in food presentation. For instance, the machine may also be useful for those who suffer from dysphagia, or difficulty swallowing. Those affected by dysphagia often rely on foods that are soft and moist like yogurt or mashed fruits and vegetables. There are other benefits as well. 3D food printers also give people the ability to pick and choose what goes inside the foods they eat. “It could be a great way for parents to ensure their children are getting the necessary nutrients from fruits and vegetables,” Boz said.
Students in Boz’s class are working together as a close-knit group of friends to help envision the future of 3D food printers that help others. In the courses, students together learn not just the machine’s ability to change a food’s form but also its ability to reconstruct food. From developing modeling tools to improve the transformation and flow of matter to predicting food’s printability, the students are collectively pushing the limits to see what can and can’t be done, while creating strong bonds with each other.

Dutch Translation:

3D geprint eten... zou jij het proberen?

3D-printers zijn voor ons al jaren een steeds nuttigere technologie voor het maken van achtbaanmodellen tot huizen. Maar hoe zit het met het printen van voedsel? Adam Watson en Ziynet Boz hebben samengewerkt en opnieuw nagedacht over de kracht van 3D-printers, in het bijzonder over hun vermogen om voedsel te printen om anderen te helpen.

Een van deze 3D printers staat in hun lab, klaar voor gebruik. Met een vingerdruk piept de machine en verschijnt een reeks ontwerpen op het touchscreen. Zodra een ontwerp is geselecteerd, maakt de mechanische arm een hoog gezoem terwijl hij begint met zijn nauwgezette werk van zorgvuldige lagen, eerst beginnend met de basis. Daarna wordt een kleverige voedingsstof zoals aardappelpuree uit cilinders van verschillende grootte gespoten tot het ontwerp klaar is.

De voordelen kunnen voor de maatschappij verder reiken dan creatieve experimenten in voedselpresentatie. De machine kan bijvoorbeeld ook nuttig zijn voor mensen met dysfagie, oftewel slikproblemen. Mensen met dysfagie zijn vaak aangewezen op zacht en vochtig voedsel, zoals yoghurt of gepureerde groenten en fruit. Er zijn ook andere voordelen. 3D voedselprinters geven veel mensen ook de mogelijkheid om te kiezen wat er in het voedsel zit dat ze eten. "Het kan een geweldige manier zijn voor ouders om ervoor te zorgen dat hun kinderen de nodige voedingsstoffen uit fruit en groenten halen," zei Boz.

Studenten in Boz' klas werken samen als een hechte groep vrienden en helpen de toekomst van 3D printers vorm te geven om anderen te helpen. In de cursussen leren de studenten niet alleen hoe ze samen het vermogen van de machine om de vorm van voedsel kunnen veranderen, maar ook hoe ze samen het vermogen om voedsel kunnen reconstrueren. Van het ontwikkelen van modelleermiddelen om de transformatie en stroom van materie te verbeteren tot het voorspellen van de bedrukbaarheid van voedsel, de samenwerkende studenten verleggen collectief de grenzen om te zien wat wel en niet kan, terwijl ze een sterke band met elkaar creëren.

English text collected from (and has been modified to fit experiment conditions):
https://blogs.ifas.ufl.edu/news/2023/02/02/uf-ifas-scientists-rethink-food-possibilities-with-3d-food-printer/

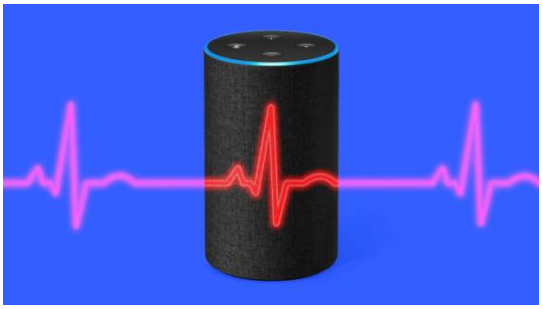

Figure 5: A smart speaker is able to detect cardiac arrests

AI system can monitor and detect cardiac arrest

Almost 500,000 Americans die each year from cardiac arrest. People experiencing cardiac arrest suddenly become unresponsive and stop breathing or begin gasping for air, a sign known as agonal breathing. Immediate CPR can double or triple someone's chance of survival, but that requires a bystander to be present.

Cardiac arrests often occur outside of a hospital. Recent research suggests that one of the most common locations for an out-of-hospital cardiac arrest is in a patient's bedroom, where no one is likely around or awake to respond and provide care.

A close-knit group of researchers at the University of Washington have developed a new tool to monitor people for cardiac arrest while we're asleep. They have collectively created an AI system that lets a smart speaker -- like Google Home or Amazon Alexa -- or a smartphone detect the gasping sound of agonal breathing and call for help. Because the group has successfully worked together, the system was able to detect agonal breathing events 97% of the time from up to 20 feet away. "A lot of people have smart speakers in their homes, and these devices have amazing capabilities that we can take advantage of," said co-corresponding author Shyam Gollakota. "We envision a contactless system that works by continuously and passively monitoring the bedroom for an agonal breathing event, and alerts anyone nearby to provide CPR. Then if there's no response, the device can automatically call 911."

Dutch Translation:

AI-systeem kan hartstilstand bewaken en detecteren

Bijna 500.000 Amerikanen sterven elk jaar aan een hartstilstand. Mensen met een hartstilstand reageren plotseling niet meer en stoppen met ademen of beginnen naar lucht te happen, een signaal genoemd agonale ademhaling. Onmiddellijke reanimatie kan iemands overlevingskans verdubbelen of verdrievoudigen, maar daarvoor moet een omstander aanwezig zijn. Hartstilstanden vinden vaak plaats buiten het ziekenhuis. Recent onderzoek suggereert dat een van de meest voorkomende locaties voor een hartstilstand buiten het ziekenhuis de slaapkamer van de patiënt is, waar waarschijnlijk niemand in de buurt of wakker is om te reageren en zorg te verlenen.

Een hechte groep onderzoekers van de Universiteit van Washington hebben een nieuw instrument ontwikkeld om mensen te controleren op een hartstilstand terwijl we slapen. Ze hebben samen een systeem ontwikkeld dat een slimme luidspreker - zoals Google Home of Amazon Alexa - of een smartphone het hijgende geluid van een ademstilstand laat detecteren en direct om hulp kan vragen.

Omdat de groep zo goed samen werkte is het ze samen gelukt om ervoor te zorgen dat het systeem agonale ademhalingsgebeurtenissen gemiddeld 97% van de tijd van maximaal 20 meter afstand detecteerde. "Veel mensen hebben slimme luidsprekers in hun huis, en deze apparaten hebben geweldige mogelijkheden waar we gebruik van kunnen maken," zei de samenwerkende onderzoeker Shyam Gollakota. "We stellen ons een contactloos systeem voor dat werkt door continu en passief de slaapkamer te controleren op een agonale ademhalingsgebeurtenis, en iedereen in de buurt waarschuwt om reanimatie te geven. Als er dan geen reactie komt, kan het apparaat automatisch 112 bellen."

English text collected from (and has been modified to fit experiment conditions):
https://beta.nsf.gov/news/researchers-develop-first-contactless-cardiac

Appendix B: text version 2 – low communal value

Figure 3: a live VR Breakdance battles

The future is now: Live breakdance battles in VR are rising in popularity

If you aren't paying close attention to VR, you'd have no idea that some insanely futuristic stuff is already happening today. Yes, it looks pretty janky at times, and the hardware is surely a pain to strap on, but there's no denying people living in the future when people are donning headsets, stepping into anime avatars, and breakdancing in virtual reality.

These are real people, performing these virtual dance moves in real-time. Dance battles like these have been cropping up in VRChat, a VR application embracing both full-body motion tracking and an 'anything goes' approach to avatars; the culmination of which has led to this unbridled level of digital self-expression. Dancing in VRChat has been a thing from the outset, from simple spontaneous dance parties to players going as far as doing actual pole dancing in virtual reality.

People are beginning to form around these activities, with organizers coordinating virtual mentorship and competition with people from across the globe who would almost certainly not have met otherwise. While such activities are still fledgling, the grass-roots dancing movement in VRChat and beyond is yet another example of VR's ability to portray people in truly unique ways.

Dutch Translation:

De toekomst is hier: Live breakdance-battles in VR worden steeds populairder

Als je zelf niet op de hoogte bent van de nieuwste VR ontwikkelingen, heb je geen idee dat er vandaag al waanzinnig futuristische dingen gebeuren. Ja, het ziet er soms nogal gek uit, en de hardware is zeker lastig om aan te doen, maar het valt niet te ontkennen dat mensen in de toekomst leven als ze headsets opzetten, in anime-avatars stappen en breakdancen in virtual reality.

Dit zijn echte mensen, die deze virtuele dansbewegingen in real-time uitvoeren. Dansgevechten als deze zijn opgedoken in VRChat, een VR-toepassing die zowel het volgen van bewegingen over het hele lichaam als een 'alles kan' benadering van avatars omarmt; het hoogtepunt daarvan heeft geleid tot dit niveau van digitale zelfexpressie. Dansen in VRChat is vanaf het begin een ding geweest, van eenvoudige spontane dansfeestjes tot spelers die zo ver gingen dat ze echt gingen paaldansen in virtual reality.

Rond deze activiteiten beginnen zich groepen mensen te vormen, met organisatoren die virtueel mentorschap en competitie coördineren tussen mensen van over de hele wereld die elkaar anders zeker niet hadden ontmoet. Hoewel dergelijke activiteiten nog in de kinderschoenen staan, is de dansbeweging in VRChat en daarbuiten opnieuw een voorbeeld van het vermogen van VR om mensen op werkelijk unieke manieren te laten zien.

English text collected from:
https://www.roadtovr.com/vr-dance-battle-vrchat-breakdance/

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One of these 3D printers sits in their lab ready for use. With the touch of a fingertip, the machine beeps and an array of designs populate on the touchscreen. Once a design is selected, the mechanical arm makes a high-pitched whirr as it begins its meticulous work of careful layering, first starting with the base. Then, a viscous food substance like mashed potatoes is squirted out of cylinders of varying nozzle sizes until the design is completed.

Its benefits may extend beyond creative experimentation in food presentation. For instance, the machine may also be useful for those who suffer from dysphagia, or difficulty swallowing. Those affected by dysphagia often rely on foods that are soft and moist like yogurt or mashed fruits and vegetables. There are other benefits as well. 3D food printers also give people the ability to pick and choose what goes inside the foods they eat. “It could be a great way for parents to ensure their children are getting the necessary nutrients from fruits and vegetables,” Boz said.

Students in Boz’s class are helping envision the future of 3D food printers. In the courses, students learn not just the machine’s ability to change a food’s form but also its ability to reconstruct food. From developing modeling tools to improve the transformation and flow of matter to predicting food’s printability, students are pushing the limits to see what can and can’t be done.

Dutch Translation:

Geprint eten... zou jij het proberen?

3D-printers zijn al jaren een steeds nuttigere technologie voor het maken van achtbaanmodellen tot huizen. Maar hoe zit het met het printen van voedsel? Adam Watson en Ziynet Boz hebben opnieuw nagedacht over de kracht van 3D-printers, in het bijzonder over hun vermogen om voedsel te printen.

Een van deze 3D printers staat in hun lab, klaar voor gebruik. Met een vingerdruk piept de machine en verschijnt een reeks ontwerpen op het touchscreen. Zodra een ontwerp is geselecteerd, maakt de mechanische arm een hoog gezoem terwijl hij begint met zijn nauwgezette werk van zorgvuldige lagen, eerst beginnend met de basis. Daarna wordt een kleverige voedingsstof zoals aardappelpuree uit cilinders van verschillende grootte gespoten tot het ontwerp klaar is.

De voordelen kunnen verder reiken dan creatieve experimenten in voedselpresentatie. De machine kan bijvoorbeeld ook nuttig zijn voor mensen met dysfagie, oftewel slikproblemen. Mensen met dysfagie zijn vaak

aangewezen op zacht en vochtig voedsel, zoals yoghurt of gepureerde groenten en fruit. Er zijn ook andere voordelen. 3D voedselprinters geven mensen ook de mogelijkheid om te kiezen wat er in het voedsel zit dat ze eten. "Het kan een geweldige manier zijn voor ouders om ervoor te zorgen dat hun kinderen de nodige voedingsstoffen uit fruit en groenten halen," zei Boz.

Studenten in Boz' klas helpen die toekomst vorm te geven. In de cursussen leren studenten niet alleen het vermogen van de machine om de vorm van voedsel te veranderen, maar ook het vermogen om voedsel te reconstrueren. Van het ontwikkelen van modelleermiddelen om de transformatie en stroom van materie te verbeteren tot het voorspellen van de bedrukbaarheid van voedsel, studenten verleggen de grenzen om te zien wat wel en niet kan.

English text collected from:
https://blogs.ifas.ufl.edu/news/2023/02/02/uf-ifas-scientists-rethink-food-possibilities-with-3d-food-printer/

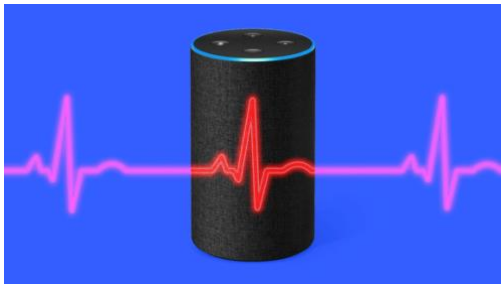

Figure 5: A smart speaker is able to detect cardiac arrests

AI system can monitor and detect cardiac arrest

Almost 500,000 Americans die each year from cardiac arrest. People experiencing cardiac arrest suddenly become unresponsive and stop breathing or begin gasping for air, a sign known as agonal breathing. Immediate CPR can double or triple someone's chance of survival, but that requires a bystander to be present.

Cardiac arrests often occur outside of a hospital. Recent research suggests that one of the most common locations for an out-of-hospital cardiac arrest is in a patient's bedroom, where no one is likely around or awake to respond and provide care.

Researchers at the University of Washington have developed a new tool to monitor people for cardiac arrest while they're asleep. A smart speaker -- like Google Home or Amazon Alexa -- or a smartphone lets the device detect the gasping sound of agonal breathing and call for help.

On average, the proof-of-concept tool detected agonal breathing events 97% of the time from up to 20 feet away. "A lot of people have smart speakers in their homes, and these devices have amazing capabilities that we can take advantage of," said co-corresponding author Shyam Gollakota. "We envision a contactless system that works by continuously and passively monitoring the bedroom for an agonal breathing event, and alerts anyone nearby to provide CPR. Then if there's no response, the device can automatically call 911."

Dutch Translation:

AI-systeem kan hartstilstand bewaken en detecteren

Bijna 500.000 Amerikanen sterven elk jaar aan een hartstilstand. Mensen met een hartstilstand reageren plotseling niet meer en stoppen met ademen of beginnen naar lucht te happen, een signaal genoemd agonale ademhaling . Onmiddellijke reanimatie kan iemands overlevingskans verdubbelen of verdrievoudigen, maar daarvoor moet een omstander aanwezig zijn. Hartstilstanden vinden vaak plaats buiten het ziekenhuis. Recent onderzoek suggereert dat een van de meest voorkomende locaties voor een hartstilstand buiten het ziekenhuis de slaapkamer van de patiënt is, waar waarschijnlijk niemand in de buurt of wakker is om te reageren en zorg te verlenen.

Onderzoekers van de Universiteit van Washington hebben een nieuw instrument ontwikkeld om mensen te controleren op een hartstilstand terwijl ze slapen. Met een slimme luidspreker - zoals Google Home of Amazon Alexa - of een smartphone kan het apparaat het hijgende geluid van een ademstilstand detecteren en direct om hulp vragen.

Gemiddeld detecteerde het systeem agonale ademhalingsgebeurtenissen 97% van de tijd van maximaal 20 meter afstand. "Veel mensen hebben slimme luidsprekers in hun huis, en deze apparaten hebben geweldige mogelijkheden waar we gebruik van kunnen maken," zei co-corresponderende auteur Shyam Gollakota. "We stellen ons een contactloos systeem voor dat werkt door continu en passief de slaapkamer te controleren op een

agonale ademhalingsgebeurtenis, en iedereen in de buurt waarschuwt om reanimatie te geven. Als er dan geen reactie komt, kan het apparaat automatisch 112 bellen."

English text collected from:

https://beta.nsf.gov/news/researchers-develop-first-contactless-cardiac

Appendix C: informed consent letter + consent form

Utrecht, 28 maart 2023
Betreft: Deelname aan master thesis onderzoek van Sabrina Hersman van de Universiteit Utrecht “Percepties onder jongeren over informatica”

Beste leerling, ouder/verzorger,

Deze brief gaat over mijn onderzoek naar de perceptie van jongeren van informatica. In deze brief geef ik je informatie over het onderzoek en aan het einde vraag ik of je aan het onderzoek wilt meedoen.

Wat onderzoek ik?
In mijn onderzoek ontdek ik wat de percepties zijn van jongeren wat betreft het onderwerp informatica. Het onderzoek is een vragenlijst waarbij gevraagd wordt naar de percepties van informatica voor en na het lezen van een tekst. Hiermee hoop ik te ontdekken of het mogelijk is om de percepties van jongeren bij te stellen om zo een mogelijke vergrote interesse voor informatica te creëren.

Wat ga jij doen in het onderzoek?
Je zult een vragenlijst beantwoorden die ongeveer tien minuten duurt. Dit bestaat uit het invullen van wat algemene informatie over jezelf, en daarna vraag ik naar je perceptie van informatica. Je leest een stuk tekst waarover je vragen beantwoord. Als je deelneemt aan dit onderzoek, zal ik de volgende gegevens verzamelen, namelijk:

- Leeftijd, geslacht, profiel, en of je informatica volgt
- Je perceptie over informatica
- Je interesse naar informatica
- Je motivatie tegenover informatica
- Je houding tegenover informatica
- Je interesse naar verschillende onderwerpen binnen informatica

Je deelname is vertrouwelijk en vrijwillig

Je neemt geheel vrijwillig en vrijblijvend aan dit onderzoek deel. Je kunt op elk moment je deelname beëindigen of weigeren. Hiervoor hoef je geen enkele reden op te geven. Het heeft bovendien geen enkel nadelig gevolg. Er wordt geen gebruik gemaakt van sensoren, eye tracking, photos, audio, of video. Ik bewaar alle gegevens vertrouwelijk. Jouw identiteit en de onderzoeksgegevens bewaar ik altijd gescheiden en alleen ik heb toegang om ze aan elkaar te koppelen. De gegevens worden geanonimiseerd, zodat ze op geen enkele wijze op jou terug te leiden zijn. Er zijn geen andere doelen aan het onderzoek verbonden dan het opdoen van kennis over de percepties onder jongeren van informatica. Ze worden gebruikt in een wetenschappelijke publicatie over het onderzoek en blijven 1 jaar bewaard.

Als je vragen of klachten over het onderzoek hebt en deze niet wilt bespreken met de onderzoeksleider, kun je terecht bij je mentor of de vertrouwenspersoon van school. Als je klachten over het onderzoek hebt, kun je contact opnemen met Hieke Keuning (h.w.keuning@uu.nl). Als je zorgen hebt over de manier waarop met privacy wordt omgegaan, kun je dit melden via privacy@uu.nl.

Toestemming

Als je wilt deelnemen, vul je onderstaande toestemmingsverklaring in.
Mocht je nu of achteraf vragen hebben over dit onderzoek en het verzamelen en gebruiken van je persoonlijke gegevens, dan kun je contact opnemen met mij, s.a.hersmanan@students.uu.nl.

Als je deel wilt nemen, onderteken jij de toestemmingsverklaring en geeft het aan mij.

Met vriendelijke groeten,
Sabrina Hersman
Universiteit Utrecht
Mail: s.a.hersman@students.uu.nl

Toestemmingsverklaring voor deelname in het onderzoek: “Percepties onder jongeren over informatica”

Door jouw toestemming te geven, verklaar jij het volgende:

> Ik verklaar dat ik de informatiebrief over het onderzoek van de Universiteit van Utrecht heb gelezen en begrepen. Ik heb de mogelijkheid gekregen om vragen te stellen over het onderzoek. Ik ben voldoende geïnformeerd.
>
> Ik ben ervan op de hoogte dat ik op elk moment mijn toestemming voor de dit onderzoek kan intrekken, zonder opgaaf van redenen. Intrekking van mijn toestemming zal op geen enkele wijze nadelige gevolgen voor mij hebben.

Als je toestemming geeft, wil je hieronder dan de vakjes aankruisen?

◯ Ik geef toestemming voor deelname aan het onderzoek

Toestemming van de leerling:
Voorletters leerling: _____
Achternaam leerling: _____
Roepnaam leerling: _____
Geboortedatum leerling: _____
Datum en plaats: _____
Handtekening: _____

Lever dit formulier in terug bij mij

Appendix D: List of reasons categorized

Medical Use

Zo kan je mensen helpen die ziek zijn

Het is een groot voordeel om de medische wereld te helpen met A.I.

Omdat het heel erg handig is want mensen kunnen patienten niet 24/7 onder controle houden.

Ik vind het erg bijzonder dat de nieuwe ontwikkelingen mensen hun leven kunnen redden

Omdat dat levens kan redden en dus een functie heeft

Medische toepassing en mogelijk redden van levens

Omdat het vooruitstrevend voor de geneeskunde is.

het is heel bijzonder dat een programma een hartstilstand kan herkennen, iets wat we vroeger nooit gedacht hadden.

omdat dit levens kan redden en dit vind ik heel mooi dat wetenschap voor dit soort dingen word gebruikt

Omdat het mensen kan helpen

Omdat dat leven kan redden

Ik vind het wel interessant hoe een artificiël systeem een hartstilstand kan opmerken

Omdat het levensreddend kan zijn.

Kan levens redden

Het is heel belangrijk voor medische dingen

Ik ben geïnteresseerd in ontwikkelingen in de gezondheidszorg

Omdat dit levens van mensen kan redden en echt iets toe kan voegen voor de gezondheid van mensen

Het is cool km te zien dat technologie het vermogen heeft om hartstilstanden te detecteren voordat het gebeurd

Het kan levens redden.

Omdat ik het echt revolutionair vind omdat dit mensen hun leven kan redden.

Bij tekst 1 gaat het om het redden van levens en ik denk dat het veel impact heeft.

Omdat dat mensen kan redden

Omdat het heel erg helpend is voor de medische wereld

Het feit dat medische problemen als hartstilstand door AI beholpen kan worden is erg interessant an het feit dat technologie zo ver is is super inspirerend Een AI dat een hartstilstand kan herkennen lijkt mij erg handig in het leven. Dit kan ervoor zorgen dat er minder mensen overlijden aan een hartstilstand.

Omdat het heel handig kan zijn voor iedereen wanneer je een vergrote kans hebt voor een hartstilstand
vetere kans om mensen sneller medisch te kunnen helpen, gaaf!
Het gaat over hartstilstanden
Deze tekst laat een nieuwe manier zien om mensen hun leven te redden en dit vind ik wel indrukwekkender dan de andere 2 teksten.
Omdat het mensen kan helpen
Gezondheid is belangerijk Gezondheid is t belangrijkst en dus meer interessant om onderzoek naar te doen
Ik vind deze tekst het intressants omdat ik het bijzonder vind hoe technologie samen met zorg gaat.
Zo kunnen veel mensen gered worden van een hartstilstand omdat, een mens dat niet altijd snel kan opmerken.
Ik vind het interessant dat iets van een computer mensen kan helpen met een hartstilstand en ik denk ook dat dat heel belangrijk is
Het helpt de samenleving
Het kan mensen die ziek zijn beter laten eten.
Het kan levens redden wat beter is voor de maatschappij.

Solutions to social problems

Omdat je het altijd in van die futuristische films ziet en het nu ook bijna mogelijk is.
Omdat het letterlijk voedsel kan printen. Dit zou veel problemen kunnen oplossen.
Is het meest boeiend/behulpzaam voor de samenleving
Meest nuttig voor de samenleving.
Omdat ik denk dat dit een oplossing of vervanging kan zijn voor problemen die in de toekomst zouden kunnen gebeuren
Omdat ik denk dat dit het meest nuttige is van de drie
Het heeft een positieve functie in de maatschappij
Omdat dit een probleemoplossende uitvinding is
Omdat 3d voedsel printers kunnen meedragen aan het oplossen van maatschappelijke problemen.
hongersnood is al heel lang een groot probleem
eten is echt mijn favo ding om te doen, hierdoor trok dit meer mijn interesse. Ook is wereld honger een groot probleem en dit kan misschien ontwikkelen in een oplossing

Het laat zien dat AI erg belangrijke en revolutionaire ontwikkelingen heeft
Omdat ik het bijzonder vind dat technologie zich zo snel ontwikkeld dat het medische dingen kan herkennen.
tekst 1 gaat over eten en is vooruitstrevend
omdat het zo'n belangrijke toepassing is
Voedsel kan een hoop levens redden in bijvoorbeeld armere werelddelen.
Dat lijkt mij het belangrijkste voor de wetenschap

Positive impact on daily human life

oprechte toegevoegde waarden aan de maatschappij.
Het kan het dagelijks leven aanpassen
Zo kan je mensen echt helpen.
Deze sprak me het meest aan. Ik denk ook dat dit een belangrijk punt is van technologie wat het leven een stukje makkelijk gaat maken.
Omdat het handig en interessant lijkt.
Het heeft positieve impact op de natuur en het leven van de mens
Omdat het heel nuttig kan zijn
Het gaat om het leven
Omdat het mensen kan helpen
Nuttig
Revolutionair
Is denk ik heel nuttig
Omdat dat handig kan zijn voor later
Omdat het iets doet voor de maatschappij vergeleken breakdance heb je er daadwerkelijk niks aan
Omdat het handig is
Omdat we letterlijk ons eigen eten kunnen bouwen
Het helpt de samenleving
Dit is handig en goed voor de wereld.

Interests and hobbies

Ik vind het onderwerp het meest interessant
Leuke tekst
ik vond het breakdancen het meest interessant en leuk om te lezen.

Ik vind breakdance interessant
Aangezien ik breakdance leuk vind
Omdat ik het onderwerp het belangrijkste vind.
Ik vindt het bijzonder en ook een beetje eng dat een AI zoiets kan herkennen, wel is het een heel goed hulpmiddel voor mensen met hartproblemen.
Omdat ik van eten hou
Eten is belangrijk in het leven. Dat vond ik heel inspirerend
Ik vind VR een interessant onderwerp
Breakdance is heel cet
3d printers die voedsel kunnen printen zijn zo hilarisch nutteloos.
eten is echt mijn favo ding om te doen, hierdoor trok dit meer mijn interesse. Ook is wereld honger een groot probleem en dit kan misschien ontwikkelen in een oplossing
Omdat de andere teksten vooral niet zo interessant waren
Het sprak mij het meest aan
ik hou van eten dus dan is het interessanter om te lezen over eten
Het lijkt me heel cool om eten uit een printer te krijgen
ik vind eten gewoon leuk en het is best interessant dat een 3d printer dat nou zou kunnen maken lijkt een beetje op het regent gehaktballen
onderwerp spreekt me het meest aan
Ik zit op dansen dus daarom
Ik vind vr leuk om te doen
Omdat deze tekst het meest bij mijn interesses aansluit.
Het onderwerp sprak me het meest aan
Zelf game ik best veel, dus deze tekst vond ik wel interessant om te lezen.
het onderwerp interesseert me
Ik vond het een interessante tekst
Omdat ik honger heb
ik vind ai heel interessant
Ik hou van eten
het komt overeen met mijn interesses
ik heb zelf ook vr en ben ook wel eens op een vr feest geweest en vind het dus interessant.
Ik vind eten lekker en ben benieuwd naar hoe geprint eten smaakt.
Het is iets wat een beetje onwerkelijk lijkt.
Lijkt onwerkelijk

Omdat het mij zelf heel raar en niet fijn lijkt om zo eten te eten. Maar ik vond het wel interessant om erover te lezen.
Ik denk dat het heel cool is om mijn eigen eten te ontwerpen zonder dat ik hoef te koken.
Omdat ik dat persoonlijk best vet vind en daar als klein kind altijd aan dacht.
Ik vind 3D printer interessant omdat het de toekomst is
omdat het cool is hoe ze dat doen
Het ging over vr

Curiosity and eagerness to learn

Dit heeft in de toekomst wellicht betrekking tot mijzelf.
Het ging over een onderwerp dat ik wel interessant vind maar niet veel over weet.
Get lijkt me wel cool om in bijvoorbeeld de mac donalds te zien hoe je eten word geprint
Ik zou graag zelf ook mensen willen helpen en met techniek kan dat alleen maar meer.
Omdat ik heb interassant vond dat mensen steeds nieuwe dingen bedenk op gebied van eten
VR heeft veel coole mogelijkheden
Lijkt me een leuke mogelijkheid om eten gewoon te printen
Hier heb ik al eerder over gelezen

Appendix E: hypotheses per question

Question 5:

Null hypothesis:

There is no significant difference in the impression of the read topics among female and male students.

There is no significant difference in the impression of the read topics among students with or without CS.

There is no significant difference in the impression of the read topics among students with different study profiles.

Alternative hypothesis:

Male students have more positive impressions of the read topics than female students.

Students with CS have more positive impressions of the read topics than students without CS.

There is a significant difference in the impression of the read topics among students with different study profiles.

Question 6:

Null hypothesis:

There is no significant difference in the impression of a study that discusses the read topics between female and male students.

There is no significant difference in the impression of a study that discusses the read topics between students with CS or students without CS.

There is no significant difference in the impression of a study that discusses the read topics between students with different study profiles.

Alternative hypothesis:

Male students have a more positive impression of a study that discusses the read topics compared to female students.

Students with CS have a more positive impression of a study that discusses the read topics compared to students without CS.

There is a significant difference in the impression of a study that discusses the read topics between students with different study profiles.

Question 7:

Null hypothesis:

There is no significant difference in the opinion of working/building on the read topics between female and male students.
There is no significant difference in the opinion of working/building on the read topics between female and male students.
There is no significant difference in the opinion of working/building on the read topics between female and male students.

Alternative hypothesis:
Male students have a greater desire to work/build on the read topics compared to female students.
Students with CS have a greater desire to work/build on the read topics compared to students without CS.
There is a significant difference in the opinion of working/building on the read topics between female and male students.

Question 8:

Null hypothesis:
There is no significant difference in the willingness of female and male students to participate in those studies.
There is no significant difference in the willingness of female and male students to participate in those studies.
There is no significant difference in the willingness of female and male students to participate in those studies.

Alternative hypothesis:
Male students have a higher willingness to participate in those studies compared to female students.
Students with CS have a higher willingness to participate in those studies compared to students without CS.
There is a significant difference in the willingness of female and male students to participate in those studies.

Question 9:

Null hypothesis:
There is no significant difference in the willingness to tell a friend about the mentioned topics between male and female students.

There is no significant difference in the willingness to tell a friend about the mentioned topics between students with or without CS.
There is no significant difference in the willingness to tell a friend about the mentioned topics between students with or without CS.

Alternative hypothesis:
Male students are more inclined to tell their friends about the mentioned topics than female students.
Students with CS are more inclined to tell their friends about the mentioned topics than students without CS.
There is a significant difference in the willingness to tell a friend about the mentioned topics between students with or without CS.

Question 10:

Null hypothesis:
There is no significant difference in the interest of female or male students to apply for a study program in CS.
There is no significant difference in the interest of students with or without CS to apply for a study program in CS.
There is no significant difference in the interest of students with different study profiles to apply for a study program in CS.

Alternative hypothesis:
Male students have more interest than female students in applying for a study program in CS.
Students with CS have more interest than students without CS in applying for a study program in CS.
There is a significant difference in the interest of students with different study profiles to apply for a study program in CS.

Question 11:

Null hypothesis:
There is no significant difference in the interest of female and male students to learn more about study programs related to CS.
There is no significant difference in the interest of students with or without CS to learn more about study programs related to CS.

There is no significant difference in the interest of students with or without CS to learn more about study programs related to CS.

Alternative hypothesis:
Male students are more interested to learn about study programs related to CS.
Students with CS are more interested to learn about study programs related to CS.
There is a significant difference in the interest of students with or without CS to learn more about study programs related to CS.

Question 12:

Null hypothesis:
There is no significant difference in the perception of the value of the read topics between male and female students.
There is no significant difference in the perception of the value of the read topics between students with or without CS.
There is no significant difference in the perception of the value of the read topics between students with different study profiles.

Alternative hypothesis:
Male students have a more positive perception of the value of the read topics than female students.
Students with CS have a more positive perception of the value of the read topics than students without CS.
There is a significant difference in the perception of the value of the read topics between students with different study profiles.

Question 13:

Null hypothesis:
There is no significant difference in the perception of the usefulness of the read topics between female and male students.
There is no significant difference in the perception of the usefulness of the read topics between students with or without CS.
There is no significant difference in the perception of the usefulness of the read topics between students with different study profiles.

Alternative hypothesis:

Female students have a more positive perception of usefulness regarding the read topics than male students.

Students with CS have a more positive perception of usefulness regarding the read topics than students without CS.

There is a significant difference in the perception of the usefulness of the read topics between students with different study profiles.

Question 14:

Null hypothesis:

There is no significant difference in the perception of the importance for society of the read topics between female and male students.

There is no significant difference in the perception of the importance for society of the read topics between students with or without CS.

There is no significant difference in the perception of the importance for society of the read topics between students with different study profiles.

Alternative hypothesis:

Female students have a more positive perception of importance for society of the read topics than male students.

Students with CS have a more positive perception of importance for society of the read topics than students without CS.

There is a significant difference in the perception of the importance for society of the read topics between students with different study profiles.

Question 15:

Null hypothesis:

There is no significant difference in the perception of the topics being a waste of time to society between female or male students.

There is no significant difference in the perception of the topics being a waste of time to society between students with or without CS.

There is no significant difference in the perception of the topics being a waste of time to society between students with different study profiles.

Alternative hypothesis:

Female students have a more positive perception of the topics being a waste of time to society than male students.

Students with CS have a more positive perception of the topics being a waste of time to society than students without CS.

There is a significant difference in the perception of the topics being a waste of time to society between students with different study profiles.