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Primary School Students' Scientist Perception and their Attitudes towards Science: A Case Study

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Abstract

Scholars report that the students' interest in STEM declines and suggest to approach them earlier. This case study with the convenient sample of seven primary school students investigates the students' view of science and scientists and examine the following research questions in the Dutch lower secondary school context: (1) What are young students' images and perceptions of scientists and their work? (2) How do young students conceptualize science and scientist? (3) What are young students' attitudes toward science, STEM careers and science involvements? To find an answer to these questions, four different measurements were employed in the study. First, the students joined a photo-elicitation interview (PIE) exploring their values and perceptions, second, a Word Association Test (WAT) searching the cognitive structures, third, responded an attitude questionnaire and lastly, they completed the Draw-a-Scientist Test (DAST) and joined a follow-up semi structured interview individually. The analysis showed that there are stereotypical image of science and scientists among the students in this study. The environmental context and the pandemic period have influence on their perceptions. The students conceptualized science and scientists realistically and showed the higher positive attitude towards science than the STEM career and science involvement in the future. The multiple measurements provided a broader perspective on the students' view. The discussion extended to the methodological aspects and suggestions were given.

Introduction

In Europe, shortages of Science, Technology, Engineering, and Mathematics (STEM) skills have been there for a long time although there is an increasing number of jobs for STEM graduates and a growing demand in Europe for more graduates with STEM qualifications (European Commission, 2021; van der Molen, 2020). Yet, in STEM degrees there is still a low number of students in general and female students in specific (van der Vleuten, Steinmetz & van de Werfhorst, 2018, Trapani & Hale, 2022). As for example, in 2019, 41% of the employed scientists and engineers were female, meaning there is still a gender gap in STEM job occupations in Europe. Considering, there will be more STEM skills requiring jobs in the upcoming years, to target the younger (female) students to become STEM professionals will broaden the pool of applicants (European Commission, 2021).

The students choose their track for the high school at the age of 13-15 years old (Grade 2 or 3 of high school) in the Netherlands, earlier than most of the countries. Therefore, the STEM studies are accessible in the tertiary education for the students who follow a natural science and technology track in their high school period. Thus, their choice affects the students' further educational life and normally their career options later on. The students in STEM education in the Netherlands are lower compared to most other western countries (OECD, 2021). Additionally, the number of females in STEM profiles, studies and professions is even lower (VHTO, 2011; van der Vleuten, et al, 2018; van der Molen, 2020). Currently, the ratio of female and male students who choose the natural science and technology track for their high school education is 50/50 in the Netherlands (VHTO, 2022). However, of these, about 70% of the boys will likely follow a STEM study after high school, while this ratio is less than 50% for the female students. Even a smaller group of these female students, just 10%, proceed in a technology study after their high school graduation, while 44% of the male students choose their study in the STEM track. Moreover, in 2019 about 28% of all the researchers in the Netherlands were female (Rathenau Instituut, 2022, VHTO, 2022). Comparing to other career areas, the women's representation in STEM is respectively low in the Netherlands, as for example, 80% of primary school teachers are female (CBS, 2019), which is higher compared to most other western countries (OECD, 2021). This phenomenon turns researchers' attention to investigating the factors affecting student attitudes and perceptions towards scientists and STEM career path, specifically among the young age school students.

Drawing upon the systematic review of van den Hurk, Meelissen and van Langen (2019), the mediating and moderating factors that affect STEM education choices were summarized under six topics: social context, social environment, school context, educational outcomes, non-malleable student characteristics, and malleable student characteristics. The latest, *malleable student characteristics*, is the focus of this study. These characteristics are motivation, behavior, attitude/preferences and performances. Positively influencing these characteristics could stimulate more students toward a STEM education (van der Hurk et al., 2019) and could explain the student participation in STEM.

The Netherlands has the highest male stereotypical perceptions of science and engineering, compared to 66 other countries (Miller, Eagly & Linn, 2015). Scholars also reported that positive STEM experiences at school or within families and friends could positively affect students' interests in STEM self (European Commission, 2021). Thus, the role models are very important to motivate students in becoming STEM professionals (van der Molen, 2020). Yet, out of every four STEM scientists, one is female in the Netherlands (VHTO, 2016). So, female role models with whom young girls can identify themselves are scarce (VHTO, 2016; van der Molen, 2020). This normally affects the students' leaning, specifically female students, toward STEM studies (Miller et al., 2015).

In a study of the Women in Higher Technical Education (VHTO [Vrouwen in Hoger Technisch Onderwijs]) in 2016, a lessons series and questionnaire for Dutch 6th, 7th and 8th grade (9 - 12 age) students were developed with the purpose to examine if the students would change their attitude toward science and whether the female students' self-confidence towards science and a STEM career increase. Before and after the lesson series the students' attitudes toward science were measured with a digital questionnaire. The study showed that mostly male students think that a STEM career is for male while the female students consider that a STEM career is for both female

and male. The study of VHTO also showed that even after a few lessons, Dutch 6th, 7th and 8th grade students would have a less stereotypical attitude towards STEM professions (VHTO, 2016).

Moreover, there is an ongoing lack of STEM professionals and still a persisting stereotypical image of STEM professionals in the Netherlands (Rathenau Instituut, 2022). Accordingly, it is important to approach the students at a younger age about STEM careers and introduce them to a clearer picture of STEM careers and their possibilities (Xu & Jack, 2023). This could influence their choices toward STEM professionals (VHTO, 2016) and might lead to a less shortage of STEM-skilled professionals (European Commission, 2021). The students' interest in STEM declines around the age of 11 (van der Hurk et al., 2019, van Griethuijsen et al., 2015), the focus age group in this study and also the age group before the choice of track at the high school in the Netherlands. So, it is especially important to investigate this age group of students' science and scientists' image deeply to be able to communicate their educational track choices at the high school.

Hence, this study examines issues related to stereotypical images of science and scientists in the Dutch lower secondary school context. Even though this is an issue that has been explored extensively with the Draw-a-Scientist Test (DAST) in the past and more than 50 years in plethora of the studies internationally (Finson, 2002; Ferguson & Lezotte, 2020) no other study has examined this in the Dutch context, according to literature review at the time of this study. To add more information to this literature gap from the Dutch context would widen the lens of the existing findings internationally and outcomes of this case study would be beneficial for further studies such as an intervention study at the national level and contribute the international literature.

Building upon these, this case study aims to examine the 10-13 years old (7th and 8th primary grade) students' images of scientists, their science and scientist conceptualization and attitudes. Therefore, the research questions of this study are:

(1) What are young students' images and perceptions of scientists and their work?

(2) How do young students conceptualize science and scientist?

(3) What are young students' attitudes toward STEM careers and science involvements?

Theoretical Framework

Scientists and Science related Stereotypes

The stereotypical image of a male-scientist is commonly the middle-aged, grey-haired, white male who wears glasses and a laboratory coat, holding a glass test tube in a laboratory (Emvalotis & Koutsianou, 2018) and most of the time seen as "nerdy" and isolated jobs (National Science Foundation, 2018). This stereotypical image is already developed during the first years of primary school and it is unfortunately still common practice among young age students (9 - 13 age) (Emvalotis & Koutsianou, 2018; van der Molen, 2020; Chionas & Emvalotis, 2020). Actually, around the age of 11, the stereotypical image is already present and the interest in STEM has declined (Chambers, 1983; van der Hurk et al., 2019; van Griethuijsen et al., 2015). Since the stereotypical view affects the motivation, interest and further career choices (DeWitt & Archer, 2015; van der Hurk et al., 2019; Lamminpää,Vesterinen & Puutio, 2020) it is essential for the young students to have a clear image of scientists

and their work. Also, research shows that students aged 13-15 often do not have a realistic image of how scientists come to conclusions (Avraamidou, 2013) and if these views persist in adulthood, the image is unlikely to change later (Lamminpää & Vesterinen, 2020). Certainly, to improve the understanding and lower the stereotypical view, it is important to actively engage students in scientific practices and interactions with the experts sooner (Drymiotou, Constantinou & Avraamidou, 2021; Heeg, Smith & Avraamidou, 2022).

As such, in one recent case study, Drymiotou et al., (2021) aimed to investigate the effect of career-based scenarios on the student's interest in STEM with 16 students of grades 8 and 9 within the age 13-15. The purpose of their study was to explore how to change the declining interest of students in a STEM career. To do so, they examined the impact of an intervention, with career-based scenarios, on the students. The participants, 6 females and 10 males of similar socioeconomic status from the same class of a school in Cyprus participated in five sessions over two years. In each session, they participated in a classroom intervention in which a career-based scenario was covered in cooperation with an expert in the field. The data was collected using a questionnaire for all the participants (16) of 21 both open and Likert scale questions to measure the students' perspectives. Besides, semi-structured interviews were performed individually after each session with 10 of the participants (3 females and 7 males). The data was analyzed both qualitative and quantitative, the questionnaires were analyzed by using descriptive statistics and the interviews were analyzed using the content analysis. They conclude that the use of scenarios with experts could enhance the understanding of STEM careers of the students. These findings demonstrate that the experts and real-life based scenarios could affect a student's choice toward a STEM career and still there is a room to operate the stereotypical images at this age level.

Another recent study, Lamminpää and the collegues (2020) investigated students' views on science and scientist using their newly developed instrument Draw a Scientist Comic (DASC) while arguing the challenges with the Draw-A-Scientist-Test (DAST) and variations that are employed in the studies more than 50 years to investigate the stereotypical perception of scientists and science. Researchers examined whether comics drawn by students provide information about scientific activities, emotions and attitudes towards science and scientists in this study. They hypothesized that a comic strip allows students to give a more detailed account of a scientist's activities than a single picture would. To test this hypothesis, the students at the beginning of a science camp were asked to "*draw a comic strip about how you think science is".* The 104 drawings from Finnish students aged between 8 and 13 were collected and the comics were analyzed in these drawings. The analyses were based on four categories: scientific activities, places of research, appearance of scientists and emotions and attitudes. They marked whether a category was depicted in a comic strip. Additionally, they inductively described how multiple images, speech bubbles or other additional text were used to depict these four categories. The authors found that the Draw-A-Comic-Task (DASC) provides sufficient information to analyze students' views on scientific research and emotions or attitudes related to science.

Where are these Stereotypes Presented?

This stereotypical image is in today's world still used in TV shows, films and series (vel Żabik, Tanaś, Iłowiecka-Tańska & Karwowski, 2021). The image used in films and other media is usually a male with extreme madness,

who is an outsider and is uninterested in social trends, not an attractive hero with an obsession with his work and a lonely heroine for a woman (Kool, Azevedo, & Avraamidou, 2022). Not surprisingly, this image causes a scepticism of science among the young age students (Avraamidou, 2013). The scholars report that the role of teaching and teaching quality (Steidtmann, Kleickmann & Steffensky, 2023) and the science education materials are among the notable factors. As for educational materials, scholar reported that there is an inequality of the gender distribution in the representation with the fact that there are more males than females are depicted as science professionals (Chi, Wang & Qian, 2023, Montizaan, 2023; Murray, Anderson, Simms & Seery, 2022). Additionally, there is an inadequacy to provide a comprehensive understanding of science and scientists' work (Chi, et al., 2023; Kerkhoven, Russo, Land-Zandstra, Saxena & Rodenburg, 2016). This use of stereotypical images in textbooks influences the performances of students as scholars reported that when students follow a lesson with images of scientists of their gender, they score higher than they do in a lesson with images of the other gender (Good, Woodzicka & Wingfield, 2010). Hence, the students are learning from their environment that STEM careers are male-dominated professions within this frame of teaching and a science career is more for boys rather than girls (VHTO, 2016; Danielsson, Avraamidou & Gonsalves, 2023).

Yet, scholars in the Dutch context also showed that the primary school girls' attitude towards science changes when they are in touch with female STEM role models (Kerkhoven et al., 2016). In this line, the findings of this case study would offer further information and expand the knowledge to understand the students' conceptualization of science and scientist that covers the COVID-19 pandemic influence at the time of the study as well. Given the scarcity in the current professional literature, additional outcomes of such research are needed to have a more comprehensive picture of how young age students perceive science and scientist in the Dutch context.

Overview of Dutch Educational Context

In the Netherlands, students are attending primary school from the age of 4 till the age of 12. During the last years of primary school (grades 7 and 8) students are being prepared for high school. To choose the secondary education track, in the 8th-grade students take an aptitude test (e.g. Cito Eindtoets Basisonderwijs, CITO) which suggests the high school level (1), have the recommendation the 8-grade teachers (2) and the opinion of the student and the parents (3). The last two are essential to choose one of the tracks below for secondary education.

First, Pre-vocational secondary education (*Voorbereidend middelbaar beroepsonderwijs*-VMBO), which takes four years (12-16 age). It combines vocational training with theoretical education in languages, mathematics, history, arts and sciences. The VMBO has five different levels; each level combines a different mix of practical vocational training and theoretical education. Second, Senior general secondary education (*Hoger Algemeen Voortgezet Onderwijs*- HAVO) which takes five years (12-17 age). The first three years students follow the same subjects such as languages and sciences. Third, Pre-university education (*Voorbereidend Wetenschappelijk Onderwijs*-VWO), which takes six years (12-18 age) and about one fifth of all Dutch secondary school pupils follow this route. Students who adhere to the conditions of the targeted pathway can switch from one to the other during their training period.

The education was chosen after the second (VMBO) or third year (HAVO/VWO) and students who follow the VWO level and complete a natural science and/or technology track are eligible to follow STEM studies at the university. Thus, the number of STEM courses throughout high school is dependent on the educational track chosen. For example, a student who follows a nature and technology track, with courses such as mathematics B, physics, biology and chemistry among the standard courses of VWO is eligible to attend a STEM study at the university. Before choosing their educational track, all secondary school students follow a number of STEM subjects up to 6 class hours weekly. The total weekly teaching hours are 32. In addition, secondary schools and primary schools can participate in the extra science projects as they find suitable for themselves (Ministry OWC, 2021).

Compulsory education ends when students graduate from VWO, HAVO or VMBO at the age of 16-18. The Dutch grading scale runs from 1 (very poor) to 10 (excellent). In primary and secondary education, students are assessed annually by their teachers who determine whether they have progressed sufficiently to move on to the next class. Retaking the year is common, even in the most academic streams such as VWO (Eurydice, 2023; Ministry OWC, 2021).

Method

Research Design

A qualitative case study design (Denscombe, 2021) was chosen to have a deep understanding of the Dutch lower secondary school students' views of science and scientists with the multiple measures to have richer data and evidence (Yin, 2018). To do so, four different measurements were used: first, a Photo-Elicitation Interview (PEI) explore the values and perceptions of a student, second, a Word Association Test (WAT) shows the cognitive structures of a student, third, a paper pencil questionnaire reports their attitude and lastly the Draw a scientist Test (DAST) examine the students' ideas about the scientist.

Reliability and validity: The combination of techniques was administered to the students for a stronger conclusion as it was suggested with the DAST studies previously (Farland-Smith, 2009; Symington & Spurling, 1990). Thus, the triangulation was achieved to increase the reliability and validity (Flick, 2018; Korstjens & Moser, 2018). For reliability, first, the student response was compared with their own responses and with the other participants' responses to assess whether there was consistency in their answering. Second, the two conducted interviews (PEI and the semi structured follow up interview of DAST) supported the search to what extent the consistency within each student's own and across the participants' responses. Third, two researchers of this study with the inductive approach listened to these interviews, read the transcripts and analyzed the students' drawings independently based on the checklist (Emvalotis & Koutsianou, 2018; Lamminpää et al., 2020), discussed their outcomes and finalized.

As for validity, a senior science teacher with over 23 years of teaching experience and teacher of these students for two years reviewed the measures (face validity) before the study. The environmental factors were taken under measures such as there was only one set used for the data collection, as location one classroom was used for the study within the same school, one researcher contacted the students after familiarizing with the design and the

protocols that were followed (ecological validity). Assistance to the students was kept low, limited only to support to their participation, such as participants were reminded that the task is about their ideas, there is no right or wrong answer (Lamminpää et al., 2020) and the assignment protocols were followed.

Sample

The convenient sample of this case study consists of the seven students (10-13 age, 7th- and 8th-grade) at a small public Dutch lower secondary school in the Dutch school system in the Netherlands. In their daily routine, students start with math and reading lessons. During the rest of the day, they study on the different project books and science classes according to their schedule. Additionally, they participated in the First Lego League (https://firstlegoleague.nl/), a STEM program that contains twelve sessions and focuses on students' technological skills. The class works as a team on building a robot in this frame in the data collection period.

The class consisted of ten students (six girls and four boys) in total and seven of these students (5 girls and 2 boys) voluntarily participated in this study. Contacting the school and the teacher about the planned research, the parents' informed consent was provided. Previous to the data collection, the students were informed about the ethical process and the choice of refusing to participate in the task(s) or to be withdrawn any time from the study. Data was collected in April 2022. Of all participants, five completed all the assignments. Two participants did not perform the second-word association task (WAT) due to their own choice. Their data included in the results since one of their word association tasks was performed.

Measurements

Following the van der Hurk et al. (2019) conceptualization to explain factors positively influencing the students' participation in STEM education, this qualitative case study focuses on the *malleable student characteristic* and explores students' attitude/preferences and performances. The measures of the study are summarized in Table 1 are shared in the below section.

Table 1. Measure of this Case Study

	Measure	Factors (this study)	Factors (van der Hurk et al., 2019)
1.	Photo-Elicitation Interview (PEI)	Perception	Performances
2.	Word Association Test (WAT)	Cognitive structures	Behavior/Attitude
3.	Questionnaire (Kind et al., 2007)	Attitude	Attitude/Preferences
4.	Draw A Scientist Test (DAST)	Image	Performances

Photo-Elicitation Interview (PEI)

Using pictures could sharpen a participant's memory (Collier, 1957) and in-depth interviews would help them to longer remain focused throughout the interview which is named as the Photo-Elicitation Interview (PEI) (Harper,

2002). This method is used to cope with the reported limitations of working with the children (Clark, 1999; Epstein, Stevens, Mckeever & Baruchel, 2006), to better understand (Torre & Murphy, 2015) and engage (Epstein et al., 2006) them. Torre and Murphy (2015) described the five steps of using PEI in their systematic literature review, namely: (1) Researcher identifies a topic, (2) Researcher identifies and invites participants, (3) Participants can take the relevant pictures or take a photo, (4) Researcher uses these visuals for an interview and (5) The data is analyzed. In this study, these steps were followed and asked the students to self-select a scientist photo from the internet instead of taking photos due to the practical reason at step 3. By that way students had control on their decision, thoughts, feelings and reflection to bring their own view (Epstein et al., 2006) and they were in charge of their interview. The PEI method is, of our knowledge, not yet used for the young students' view of scientists and science so far.

Word Association Test (WAT)

To understand how the students conceptualize science and scientists and understand their cognitive structures, a modified method of WAT as described in Schmäing and Grotjohann (2021) were followed in this study. The science and scientist were chosen as two stimulus words (Table 2) for a controlled test with a loose limitation of five words (Kostova & Radoynovska, 2008; Nielsen & Ingwersen, 1999). The students were informed about the possibility of completing the test with fewer or more words.

Table 2. Motivation of the Chosen Stimulus Words

Stimulus Word	Selection Reason
Science	This stimulus word was chosen to see whether stereotypical words were associated with the word science. Besides, to see how the participant conceptualizes the word.
Scientist	This stimulus word was chosen to see whether stereotypical words were associated with the word scientist. Besides, to see how the participant conceptualizes the word.

Attitude Questionnaire

Students' attitudes towards science were measured using the instrument developed by Kind, Jones and Barmby (2007) for ages 11-14. This self-reported measure consists of 44 items corresponding to the seven scales, namely, Learning science in school, Self-concept in science, Practical work in science, Science outside of school, Future participation in science, Importance of science, and General attitude towards school. Responses were rated on a 5-Likert scale from strongly disagree (1) to strongly agree (5). For this study, two scales, Future participation in science (5 items, *I would like to study more science in the future*) and Importance of science (5 items, *Science and technology is important for society*), were chosen. In the original study, the Cronbach alpha (α) of these two scales is 0.88 and 0.72 respectively (Kind et al., 2007).

Draw a Scientist Test (DAST)

Drawings is considered as a reliable method to detect the mental conceptions and the constructive learning experiences, specifically for the young age participants (Piaget, 1971). This study approached the Draw a Scientist Test (DAST), first introduced by Chambers (1983), one of the well-known and most used measuring methods to analyze and investigate the views and images about science and scientists (Chang et al., 2020; Miller, Nolla, Eagly & Uttal, 2018). Its main advantage is not to rely on the verbal or written responses which make an easy application with the young age groups who could challenge with the questionnaires. Moreover, the young students often love to draw and it is an activity that mostly encouraging the participation (Chamber, 1983; Chang, 2012). Weighting with these, over the years, the critique on the DAST has increased mainly the test can only be one picture, which is also the concern in the analyses for the reason that the adults interpret a child's drawing and some of the elements of these drawing may be inaccurately analyzed or the bias of the researcher can be big (Losh, Wilke & Pop, 2008). Thus, literature reports that only a DAST is no longer sufficient to show the participants' conceptualization of science and scientists (Bozzato, Fabris & Longobardi, 2021). Therefore, different alternatives or changes for DAST were studied to overcome these limitations (Lamminpää & Vesterinen, 2020; Symington & Spurling, 1990). Hence, it is suggested to analyze the drawing by multiple researchers, to follow a list of criteria strictly and to conduct additional interviews with the participants about their drawings (Ozogul, Miller & Reisslein, 2019; Lamminpää et al., 2020; Farmer, Knapp & Benton, 2007; Leblebicioglu et al., 2021). Following these caution notes, this study employs multiple measures, followed the existing checklist for the DAST (Emvalotis & Koutsianou, 2018; Lamminpää et al., 2020) and used the prompt, "*draw scientists during a workday*" which was shared both verbally and written.

The following procedure was applied for the translation of the measures. The measures were independently translated from English to Dutch and Dutch to English by two researchers, one native Dutch speaker with English proficiency (back and forth translation) (ITC, 2018). Another Dutch native speaker revisited the transcribed measures with English proficiency. The class teacher reviewed the final version for the content, semantics and appropriateness for the students' level and non-gendered wording selected to prevent any gender inclination.

Procedure and Task

The assignments were divided into two sessions based on the regular school timetable and performed in Dutch. The students carried out the tasks individually at their own pace in a classroom reserved for this research at their school. The stationery material set was provided for each of them. An identification number was given to the students before the start, they were reminded that they could request anytime to be withdrawn from the assignments and there were no right or wrong answers. Students were asked not to communicate with each other about their assignments in case of being encountered during the break times and work individually all the time. The two interviews (PEI and the semi-structured follow up interview of DAST), conducted in the study were audio recorded and transcribed afterwards. Before the recordings, the students were communicated why the interview would be recorded and were informed that the recording would be erased right after the transcription.

Prior to the Study

The students received the assignment from their teacher "Choose a photo from the internet of someone you think is a scientist [Kies een foto van internet van iemand waarvan jij vindt dat het een wetenschapper is]" verbally in the classroom. They were reminded via email three days before the data collection. Meanwhile, their teacher made inquiries about whether the task was clear or did they need any further support.

During the Study: Session 1

The researcher worked with the seven students in four rounds during the first session. After the students were informed that they would be working individually without consulting each other, the students' pair were formed randomly. In the first three rounds, the students were approached in pairs; in the last round (the fourth), one student worked alone due to the odd number of the sample.

Assignment I- Photo-Elicitation Interview (PEI)

During the session, the participants were interviewed about their self -selected scientist photos. They were approached with the questions Can I see your photo? / This is your photo, right? (Mag ik je foto zien?/dit is jou foto toch?) (1), Why did you choose this photo? (Waarom heb je voor deze foto gekozen?) (2), Why do you think this person is a scientist? (Waarom denk je dat deze persoon een wetenschapper is?) (3), What do you think this scientist is doing? (Wat denk je dat deze wetenschapper doet?) and further freedom was given to the students if they wanted to share anything more about their choices.

Assignment II- Word Association Test (WAT)

The second task was a WAT that none of the participants was familiar with. Therefore, the trial task with a word: *exercise* was shared. When the student needed further support to perform, the second trial word: *dancing* was given. After these two trials, all the students familiarized with the WAT and the chosen stimulator keywords: *science and scientist* were introduced on a separate sheet of paper to the students. The students were invited to write five words that they associated with science and scientist. When a student could not associate five words, s/he was encouraged to think in the frame of protocol and informed that writing less than five words or more is possible.

Assignment III- Questionnaire

The last assignment of session 1 was the paper pencil questionnaire (Kind et al., 2007). Before the start, the response scale was explained to the students with an example. They were reminded not to discuss with each other but ask the researcher when they have any questions. When it was needed, the researcher worked in the frame of relevant protocol with the student(s).

During the Study: Session 2

After the break, the second session started with the *Draw a scientist Test (DAST)* (4th Assignment). The students were told that the quality of their drawings did not matter and there was an extra time for them to explain their drawings. The prompt based on Lamminpää et al., (2020) "*Draw a scientist during a work day (Teken een wetenschapper op het werk.)*" was shared both written and verbal. After completing the drawing, the students were invited to the semi-structured follow up DAST interview individually. Students were approached with the questions; you tell me what you drew? (Kan je mij vertellen wat je hebt getekend?) (1), What is your scientist's name? (Wat is de naam van je wetenschapper?) (2), Why do you think this person is a scientist? (Waarom is dit person volgens jou een wetenschapper?) (3). What is your scientist doing? (Wat is je wetenschapper aan het doen?) (4), Where is your scientist doing that? (Waar is je wetenschapper dat aan het doen?) (5), What is your scientist good at? (Waar is je wetenschapper goed in?) (6). The students' interviews and their further verbal explanations of the drawings were audio recorded.

After the Study

The students were thanked for their participation and informed that they can keep their drawings to themselves. and they return to their regular classroom program. The researcher said "goodbye *(tot ziens*)'' to the students in their classroom and discussed with the teacher about the following communication.

Analysis

To answer the first research question**,** the self-chosen scientist photos, the Photo-Elicitation Interview (PEI)'s and the draw a scientist Test (DAST) were analyzed by following the five categories of the DAST-Checklist (Emvalotis & Koutsianou, 2018; Lamminpää et al., 2020) namely, (1) The gender of the scientist (Drawings or written elements about the gender of the main characters); (2) The appearance of the scientist (e.g. lab coat, eyeglasses, outfit, age); (3) The location of the research/story (e.g. laboratory, office, field, home); (4) The props or other signs in the drawing (e.g. computers, rockets, laboratory equipment) and (5) The specialization (Drawings or written elements about the specialization of the scientists, e.g. Biology, Chemistry, Earth science, etc.). The categories of this checklist are found suitable for disentangling the students' perceptions and views of scientist and previously tested in multiple studies (Ferguson & Lezotte, 2020). The two researchers of this study analyzed the data independently based on the checklist. In the semi structure follow up interviews of DAST, the students were encouraged to share more insights for their drawings and these were addressed on the checklist (Table 3). The phrases reasoning the choosing of the photo were taken into account and highlighted in the PEI accordingly.

To answer the second research question, in the Word Association Tasks (WAT) analysis, association between the chosen words and the concepts of "*science*" and "*scientist*" were considered. The frequency of each association was analyzed per student and across the participants (Chionas & Emvalotis, 2022). Evaluating these associations are essential to understand the students' conceptualization of science and scientist.

Table 3. Checklist for the DAST (Emvalotis & Koutsianou, 2018; Lamminpää et al., 2020)

	Category	Description	
1.	The gender of the scientist	Drawings or written elements about the gender of the main character(s)	Female, Male, Both Unclear
2.	The appearance of the scientist	Drawings or written elements about the appearance of the main character(s)	Laboratory coat, Eyeglasses, Outfit, Facial-hair, Age
3.	The location of the research/story	Drawings or written elements about the location of the story	Laboratory, Office, Field Home
4	Specialization	Drawings or written elements about the specialization of the scientists	Physics, Chemistry Biomedical science Astronomy, Earth science Mathematics, Space science Engineering/technology
5	The props or other signs	Drawings or written elements about the props or other signs	
		-Props	Laboratory equipment Flasks, Computers, Rockets, Robots
		-Signs	Indication of danger Secrecy, Non-realistic Other

To answer the third research question, the selected two scales from the attitude questionnaire (Kind et al., 2007) were analyzed descriptively to find the highest and lowest score in the corresponding statements. The average scores were calculated per participant and for the sample.

Results

The first round of results given below summarizes each student's responses per measure in the line they were introduced to them.

Student 1, Grade 8, Male, 13 years old

Photo-Elicitation Interview (PEI): The Student-1 chose Albert Einstein's portrait photo. In this photo, he wore a blouse with the facial appearance of a mustache and wild gray hair. The photograph had no specific location. The student reasoned the choice as he knows Albert Einstein is a scientist because of his discoveries and he is famous. Also, he is the only scientist this student knows (see Table 4a).

Word Association Task (WAT): The student shared five words or short sentences for "*science"* (discovery of things, medicines, how things work, to discover and being smart) and five words for "*scientist*" (to discover, to

invent, to discover new things, helping people and being smart for it) (see Table 4b).

Table 4a. The Student-1: The PEI, DAST and the Follow up Interview's Highlights

The chosen photo	DAST

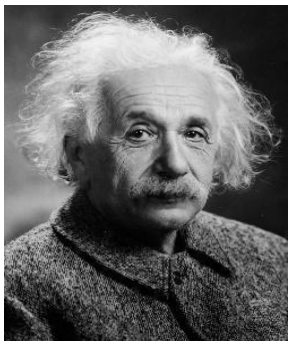
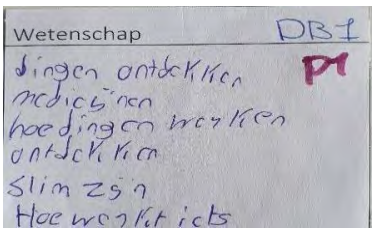



Photo-Elicitation Interview (PEI)	**The follow up interview based on the DAST**
"*I don't know that many scientists and the only one I know was him*" "*Well he has discovered a lot of things and I just find that interesting*"	"*He is discovering how to fight the virus*." "*He is experimenting a bit and there is a drink that can against the virus*" "*all scientists are working to fight the virus*." "*No time to grab his weird suit*"

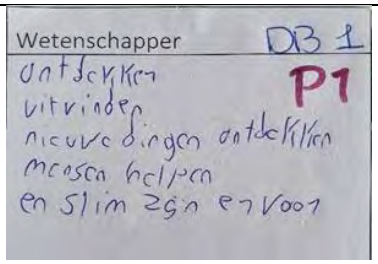
Table 4b. The Student-1's the Word Association Test (WAT)

Wetenschap | The student-1's original text



Dutch typed text	Translation
Wetenschap	*Science*
1. Dingen ontdekken	Discovery of things
2. Medicijnen	Medicines
3. Hoe dingen werken	How things work
4. Ontdekken	To discover
5. Slim zijn	Being smart

Wetenschapper | The student-1's original text



Dutch typed text	Translation
Wetenschapper	*Scientist*
1. Ontdekken	To discover
2. Uitvinden	To invent
3. Nieuwe dingen ontdekken	To discover new things
4. Mensen helpen	Helping people
5. Slim zijn er voor	Being smart for it

Student 2, Grade 8, Male, 12 years old

Photo-Elicitation Interview (PEI)**:** Nicola Tesla's photograph was chosen for the PEI by the Student-2. In this photo, the scientist wore a suit, his facial appearance was with a moustache and short neat hair and no specific location. The reason why the Student-2 chose his photo was that he was famous, smart and well-known for his discoveries, such as light (see Table 5a).

Word Association Task (WAT): The Student-2 gave five words for "*science''* (Smart, Reading, Learning, To discover, Famous) and five words for "*scientis*t'' (Smart, Important, Famous, Rich and Kind) (see Table 5b) which was in line with his reasoning for his choice indicating that the values and perception of science are based on discovering and being famous. The Student-2 was the only one who mentioned the personal aspects like kindness, fame, richness and cleverness during the WAT.

Attitude Questionnaire: The average of the five questions in the scale "Future participation in science'': was *3.4*/5 (strongly agree) with the highest score of 4 *(I would like to become a science teacher, I would like to study science at university*) and the lowest score of 3 (*I would like to study more science in the future, I would like to have a job working with science*). As for "The importance of science'': the average of five questions was 4/5 (strongly agree) with the highest score of 5 (*Science and technology is important for society, Science and technology make our lives easier and more comfortable*) and the lowest score of 3 (*Science and technology are helping the poor, There are many exciting things happening in science and technology*). The student average score for both scales was 3.7/5 (strongly agree) (see Table 11).

Draw a scientist Test (DAST): The Student-2 drew multiple males (*gender*). *The appearances* of the scientists were not illustrated. In the follow up interview, the student did not talk about the appearance of the scientists in his drawing, either. *The props* of science depicted in the drawing were laboratory equipment, flasks and computers. *The signs* of the drawing contain an indication of danger: illness. *The activities* the scientists worked on: studying illnesses, bacteria, organs and the sea; discovering new fish, animals and plants; working on the computer; searching under the ground for dinosaurs and treasures and doing police work. *The location* of the research in the drawing was in a giant building where laboratories, fields and offices were. *The specialisations* of the scientists depicted in the drawing were chemistry, biomedical science, engineering, medicine and archaeology. During the follow up DAST interview, the Student-2 mentioned that he drew a large building, in which all kinds of scientists were working at the same time. He described the work in the interview as follows, one of the scientists in the group was discovering new fish, plants and animals while one was looking at organs. Another scientist was working on the computer. There was one looking underground at dinosaurs, treasures, or doing police work. The last one was working with small bacteria (see Table 5a). The student-2 had a broad view of science and scientists. He drew the multiple scientists working individually on various disciplines and materials in a large building. Among other things, he depicted the work on the plants and animals; organs and computers; investigations about the dinosaurs, treasure chests and work for the police (forensic science). His drawing shows no signs of fame, which was found in the WAT and PEI. Student-2 showed in his perception, image and conception of science and scientists was about being smart, discovering and inventing things. Generally speaking, his perception is based on

common knowledge and overlaps with the gender-specific stereotype to some extent.

Table 5a. The Student-2, The PEI, DAST and the follow up Interview's Highlights

The chosen photo	DAST

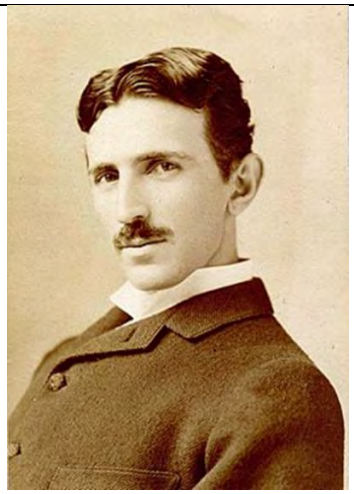
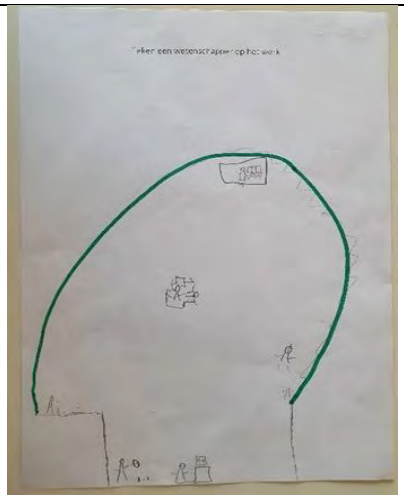
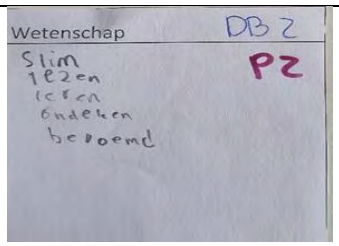

	

Photo-Elicitation Interview (PEI)	**The follow up interview based on the DAST**
"*He is a very famous man, smart man and he has achieved many things in life*." "*He invented the light*"	"*discover new fish and new animals and new plants*" "*looking at organs*" "*studies with small bacteria*" "*On the computer*" "*things underground. Dinosaurs, treasures and what the police do when someone dies*"

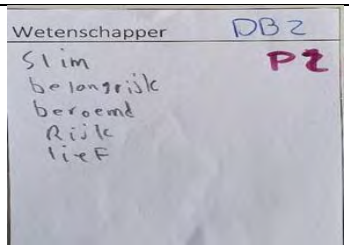
Table 5b. The Student-2's the Word Association Test (WAT)

Wetenschap | The student-2's original text



Dutch typed text	Translation
Wetenschap	*Science*
1. Slim	Smart
2. Lezen	Reading
3. Leren	Learning
4. Ontdekken	To discover
5. Beroemd	Famous

Wetenschapper | The student-2's original text



Dutch typed text	Translation
Wetenschapper	*Scientist*
1. Slim	Smart
2. Belangrijk	Important
3. Beroemd	Famous
4. Rijk	Rich
5. Lief	Kind

Student 3, Grade 7, Female, 11 years old

Photo Elicitation Interview (PEI): The Student-3 brought a photo of an early 30's male wearing a suit with a tie, a lab coat and has a moustache and beard with neat short brown hair. This scientist carried the latex gloves and safety glasses. The photo was from a laboratory and the scientist working on an experiment, for which he filled a test tube and a microscope were seen in the background. In the PEI, the Student-3 reasoned her choice as the person looks like a scientist because of the gloves, goggles, laboratory coat and "*he is testing things*", "*he is sitting in a lab*" and "*he is working with a microscope*" *(see Table* 6a).

Word association Test (WAT): The Student-3 shared five words for *science* (Experiments, Laboratory, Being precise, Studying and School) and five words or sentences for *scientist* (Laboratory, Microscope, Safety glasses, You make the world a better place and A white coat) (see Table 6b). Her focus was laboratory, experiment, the relevant elements and the laboratory safety which indicates that the values and perceptions of scientists are based on laboratories and testing. Shortly, her perception, image and conception of science and scientists was about being in a laboratory and different aspects of laboratory work, such as safety which is among the very rarely reported indicators (Fergusson & Lezotte, 2020).

Attitude Questionnaire: The average of the scale "Future participation in science" was 3.2/5 (strongly agree) with the highest score of 5 *(I would like to study more science in the future*) and the lowest score of 1 (*I would like to become a science teacher*). As for the scale "Importance of science'': the average was 4.6/ 5 (strongly agree) with the highest score of 5 in multiple statements (*Science and technology is important for society, Science and technology makes our lives easier and more comfortable, Science and technology are helping the poor, There are many exciting things happening in science and technology*) and the lowest score was 3 (*The benefits of science are greater than the harmful effects*). The student average score for both scales was 3.9/5 (strongly agree). Hence, the student wants to study more science (3.2/5) and she finds science very important (4.6/5) (see Table 11).

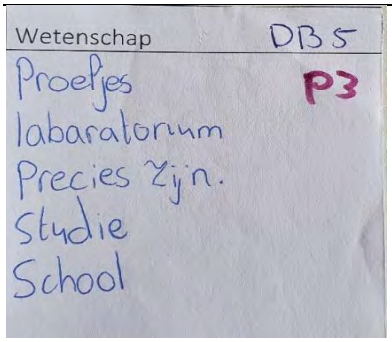
Draw a scientist Test (DAST): The Student-3 drew a female scientist (*gender*). *The appearance* of the scientist was a female with loose half-long blond hair and wore her black working pants and a laboratory coat. *The location* was a colorful laboratory environment with frames in the background. *The props* of science depicted in the drawing were laboratory equipment, a microscope, flasks and the female scientist worked on plants, examining them under a microscope. *The signs* of the drawing contain an indication of danger: a virus. *The activity* the scientist was testing whether grass could heal burns on peoples' hands. *The specialisation* of the scientist depicted in the drawing was chemistry and biomedical science (see Table 6a). During the follow up DAST interview, the Student 3 detailed her drawing and talked about her female scientist studies with an example "*whether grass heals well against burns on your hand*". She was the only one who referred to the laboratory safety although in her drawing the female scientist did not have a laboratory coat which was elaborated in the follow up interview as her scientist carried a laboratory coat daily, but she did not need her safety glasses because this was not a dangerous experiment (see Table 6b). Thus, this student showed the awareness and understanding of general laboratory safety. Except for choosing a male photo and depicted a female scientist, she was consisted with the working environment and its element across the measures, such as microscope, laboratory safety.

Table 6a. The Student-3: The PEI, DAST and the follow up Interview's Highlights

The chosen photo	DAST
	
Photo-Elicitation Interview (PEI)	**The follow up interview based on the DAST**
"He is testing things" "He looks like a scientist" "He is in a lab" "he is wearing a white vest"	*"Just plants, to research" "Al lot of drinks" "She is researching whether grass heals well against burns on your hand." "I forgot the glasses"*

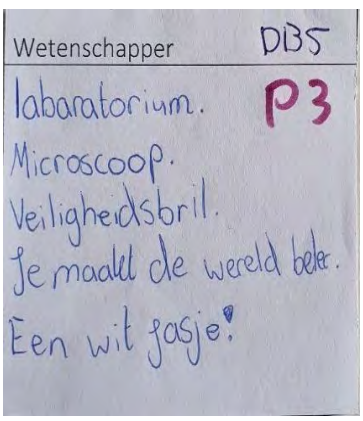
Table 6b. The Student-3's the Word Association Test (WAT)

Wetenschap | The student-3's original text



Dutch typed text	Translation
Wetenschap	*Science*
1. Proefjes	Experiments
2. Laboratorium	laboratory
3. Precies zijn	Being precise
4. Studie	Studying
5. School	School

Wetenschapper | The student-3's original text



Dutch typed text	Translation
Wetenschapper	*Scientist*
1. Laboratorium	laboratory
2. Microscoop	Microscope
3. Veiligheidsbril	Safety glasses
4. Je maakt de wereld beter	You make the world a better place
5. Een wit jasje	A white coat

Student 4, Grade 7, female, 11 years old

Photo-Elicitation Interview (PEI): The Student-4 selected a portrait photo of a mid-age, brown hair female with a bun who wore a black shirt and plain earrings without a specific location. She was the only student who chose a female photo for this round. In the PEI, the Student-4 explained that she had the impression that this woman was a scientist because of her neat appearance and it seems that she can conduct crazy experiments (see Table 7a).

Word association Test (WAT): The three words for "*science"* (Experiments, Microscope and Chemicals) and five words or sentences for "*scientist*'' (Doing crazy experiments, White coat, Microscope, Experiment tube and Classes of a scientist) (see Table 7b) were shared by this student. The "microscopes'' and "experiments'' mentioned both science and scientist. The appearance of a scientist was described with "lab coat'' or "glasses''. Based on the PEI and WAT, the Student 4 conceptualized the words science and scientist as doing experiments with the supplies for these experiments in a laboratory.

Attitude Questionnaire: The average of the scale "future participation in science'' was 2/ 5 (strongly agree) with the highest score of 4 *(I would like to study more science in the future*) and the lowest score of 1 (*I would like to become a science teacher, I would like to study science at university, I would like to become a scientist*). As for the scale "importance of science'', the average of five questions was 3.6/ 5 (strongly agree) with the highest score of 5 (*Science and technology makes our lives easier and more comfortable*) and the lowest score of 1 (*The benefits of science are greater than the harmful effects*). Although the Student-4 did not want to study more science (2/5), she found science is important (3.6/5). The student's average score for both scales was 2.8/5 (strongly agree) (see Table 11).

Draw a scientist Test (DAST): The Student-4 drew a female scientist (*gender*). *The appearance* of the scientist was a female with loose long blond hair and wearing a pink shirt, pink shoes and blue pants. *The location* was a colourful laboratory. *The props* of science depicted in the drawing were laboratory equipment, chemicals and flasks. *The signs* of the drawing contained an indication of the danger of a virus. *The activities of the* scientist were to search for bacteria, viruses and small animals that were sent to the laboratory (from the follow up DAST interview). *The specialization* of the scientist depicted in the drawing was chemistry and biomedical science. During the follow-up DAST interview, the Student-4 shared the details about the colorful scientific space and the female scientist's work with chemicals to keep away a virus (see Table 11b).

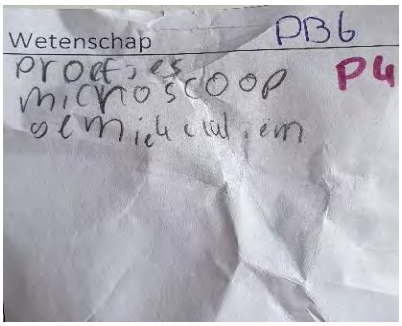
To conclude, the Student-4's image and conception of science and scientists, were related with experiments, working with chemicals and microscopes which is partially in line with the stereotypical image of scientists but also the common practice of most natural sciences. Additionally, the influence of the COVID-19 pandemic was seen in this view clearly, such as virus during the interviews while this was not seen directly neither in the drawing nor in the WAT. The Student-4's PEI, DAST and the follow up interview's highlights along with Word Association Test (WAT) are provided in Table 7a and Table 7b.

Table 7a. The Student-4: The PEI, DAST and the Follow up Interview's Highlights

The chosen photo	DAST
	
Photo-Elicitation Interview (PEI)	**The follow up interview based on the DAST**
"She is doing crazy experiments" *"She looks like a scientist"*	*"Colourful scientist space"* *"Keeping away a virus"* *"Chemicals"* *"Looks through the microscope at bacteria and animals that people have sent"*

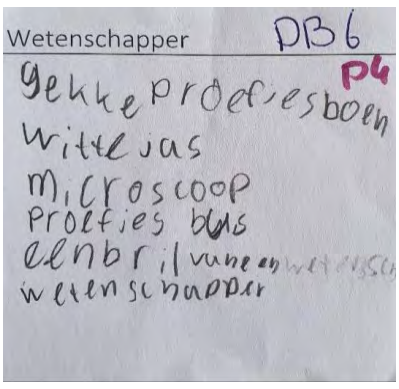
Table 7b. The Student-4's the Word Association Test (WAT)

Wetenschap | The student-4's original text



Dutch typed text	Translation
Wetenschap	Science
1. Proefjes	Experiments
2. Microscoop	Microscope
3. Chemicaliën	Chemicals

Wetenschapper | The student-4's original text



Dutch typed text	Translation
Wetenschapper	Scientist
1. Gekke proefjes doen	doing crazy experiments
2. Witte jas	White coat
3. Microscoop	Microscope
4. Proefjes buis	Experiment tube
5. Een bril van een wetenschapper	Glasses of a scientist

Student 5, Grade 7, Female, 10 years old

Photo-Elicitation Interview (PEI): A portrait of Albert Einstein was chosen by the Student-5 similar to the Student-1. In the PEI, the Student-5 could not specify why she chose this photograph but she said that she knows he is a scientist (see Table 8a).

Table 8a. The Student-5: The PEI, DAST and the Follow up Interview's Highlights

The chosen photo	DAST

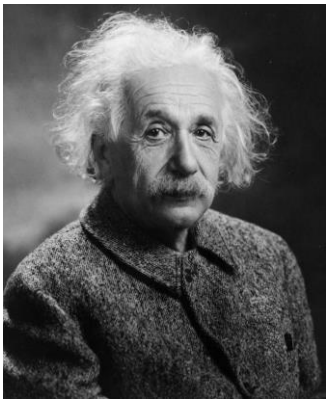
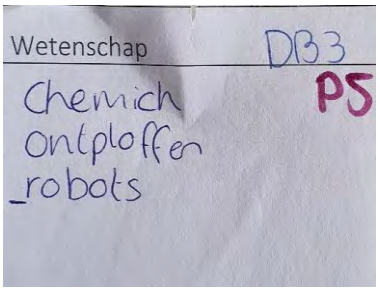



Photo-Elicitation Interview (PEI)	The follow up interview based on the DAST
"*I already knew he was a scientist"*	*"Making things that are better for the environment and things that are better for many things"* *"explosions and burns"* *"he is at the desk chair, behind his desk. And he's trying to make things again"*

Table 8b. The Student-5's the Word Association Test (WAT)

Wetenschap | The student-5's original text


Dutch typed text	Translation
Wetenschap	*Science*
1. Chemisch	Chemical
2. Ontploffen	Explosion
3. robots	Robots

Wetenschapper | The student-5's original text:
Not completed

Word association Test (WAT): The Student-5 wrote three words for "*science"* (Chemical, Explosion and Robots) and did not complete the second part of the WAT, "*scientist*'' (see Table 8b). She was the only student, mentioned robots in the WAT while keeping in mind that the group of students in this sample were participating in the First Lego League at the time of data collection.

The Attitude Questionnaire: The average of "Future participation in science'' was 3.2/5 (strongly agree) with the highest score of 5 *(I would like to become a scientist*) and the lowest score of 2 (*I would like to become a science teacher, I would like to have a job working with science*). For the scale "Importance of science'', the average of five questions was 2.8/5 (strongly agree) with the highest score of 5 (*There are many exciting things happening in science and technology*) and the lowest score of 1 (*Science and technology are helping the poor*). To sum, the Student-5 found that science and technology were not very important for society although she was interested in becoming a scientist herself. Her average score for both scales was 3/5 (strongly agree) (see Table 11).

Draw a scientist Test (DAST): The Student-5 drew a male scientist (*gender*) and also named as Albert Einstein (from follow-up DAST interview). *The appearance* of the scientist was a male with grey messy hair and a moustache. The scientist carried safety glasses and leisure wear: a green shirt with red pants. *The location* of the story was a laboratory. *The props* of science depicted in the drawing were laboratory equipment and flasks. *The signs* of the drawing contain indications of danger: smoke, slime, poison, explosions and illness. *The activities* the scientist was: inventing things that were better for the environment. *The specializations* of the scientist depicted in the drawing were chemistry and engineering (see Table 8a). During the follow-up DAST interview, the students elaborated the information about the depicted scientist's work was about how to improve the environment which showed environmental awareness although Albert Einstein is known as a theoretical physicist.

Student 6, Grade 7, Female, 10 years old

Photo-Elicitation Interview (PEI): The Student-6 was the third student selected for Albert Einstein's portrait. She reasoned her choice in the PEI as she saw him often in videos and his hair looks like a scientist's (see Table 9a). She was the only student who shared the videos and gave examples based on and the inspiration from these sources.

Word association Test (WAT): The three words for "*science*'' (To discover, Drinks and Smart) were shared and the student preferred not to complete the second part of the WAT, "*scientist*'' (see Table 9b).

The Attitude Questionnaire: The scale average for the "future participation in science'' was 3.6/5 (strongly agree) with the highest score of 5 *(I would like to become a science teacher*) and the lowest score of 1 (*I would like to study science at university*).The average for " importance of science'' was 3.8/ 5 (strongly agree) with the highest score of 5 (*Science and technology is important for society*) and the lowest score of 3 (*The benefits of science are greater than the harmful effects, Science and technology are helping the poor*). According to these, the Student-6 considers science and technology are important for society and she is interested in becoming a science teacher. Her average score for both scales was 3.7/5 (strongly agree) (see Table 11).

Draw a scientist Test (DAST): The Student-6 drew a male scientist (*gender)* and named as Albert Einstein (from the follow up interview) *The appearance* of the scientist is a male with grey messy hair. The scientist wore casual clothes: an orange shirt with blue pants while holding a recipe book. *The location* was a laboratory. *The props* of science depicted in the drawing were laboratory equipment, flasks and computers. *The signs* of the drawing

contained indications of danger: illness. *The activity* of the scientist was to cure people. *The specialisations* of the scientist depicted in the drawing were chemistry and biomedical engineering, although Albert Einstein was known as a theoretical physicist. During the follow up DAST interview, student detailed as Albert Einstein held a receipt book for drinks that could cure people which also showed the COVID-19 pandemic influences. She said that she saw some jars on the videos and added them to these on her drawing. Strangely, her scientist, Einstein, worked on a laptop even though laptops were unavailable.

Table 9a. The Student-6: The PEI, DAST and the follow up Interview's Highlights

The chosen photo	DAST

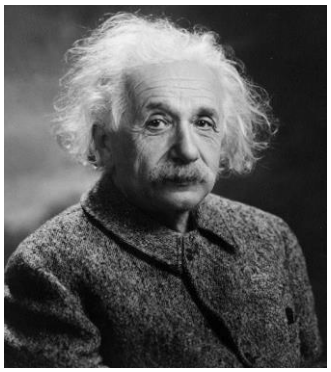
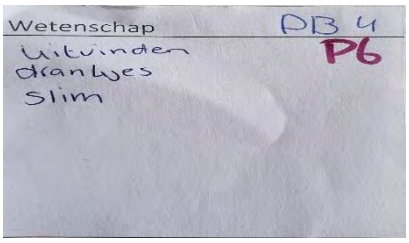



Photo-Elicitation Interview (PEI)	**The follow up interview based on the DAST**
"I saw a lot of videos of him" "His hair" "discoveries"	*"In his office" "Receipt book for drinks" "Drinks to cure people" "Small jars, I see them on videos" "On a laptop"*

Table 9b. The Student-6's the Word Association Test (WAT)

Wetenschap | The student-6's original text



Dutch typed text	Translation
Wetenschap	*Science*
1. Uitvinden	To discover
2. Drankjes	Drinks
3. Slim	Smart

Wetenschapper | The student-1's original text
Not completed.

Student 7, Grade 8, female, 13 years old

Photo-Elicitation Interview (PEI): The Student-7 chose a photo of around 50's years old male with a beard and untidy short brown hair as a scientist. This scientist wore a suit, a tie and a laboratory coat, carried a round glasses and held a marker. The photo had a specific location where the scientist was in front of a lightboard with all graphs

and numbers on it and working on a calculation. In PEI, the Student-7 detailed her reasoning by adding her scientist was wanting to discover something like a graphic because the scientist wrote weird things that could help him to think (see Table 10a). Moreover, the Student 7 said that the scientist wore a suit that is important as a scientist. Clearly her perception of science was different from the rest of the group and based on mathematics, graphics and calculation.

Table 10a. The Student-7: The PEI, DAST and the follow up Interview's Highlights

The chosen photo	DAST

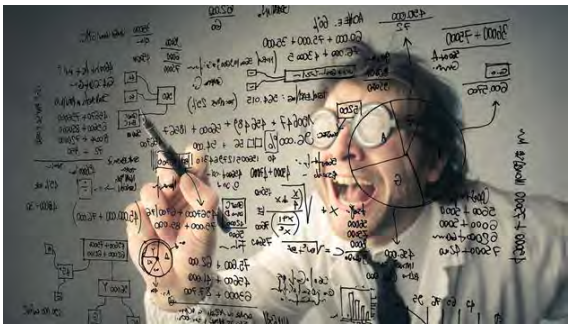
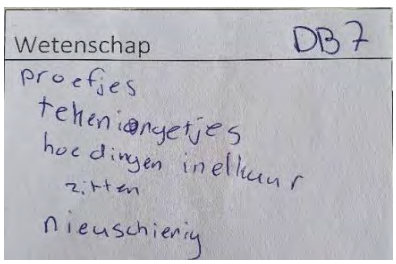



Photo-Elicitation Interview (PEI)	**The follow up interview based on the DAST**
"discovery of graphics" "Something difficult" "He wears a suit and looks weird" "original" "To keep the signs, he don't have to think so hard"	*"He makes remedies" "Monster world inside the portal" "mean people in the portal who want to kill the monsters"* *"she is making the chemicals for the mean people"*

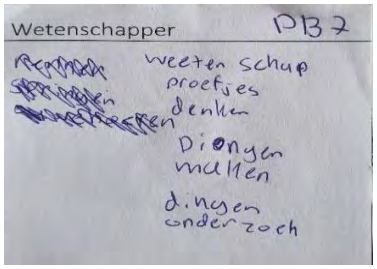
Table 10b. The Student-7's the Word Association Test (WAT)

Wetenschap | The student-7's original text



Dutch typed text	Translation
Wetenschap	Science
1. Proefjes	Experiments
2. Tekeningetjes	Small drawings
3. Hoe dingen in elkaar zitten	how things are put together
4. Nieuwschierig	Curiosity

Wetenschapper | The student-7's original text



Dutch typed text	Translation
Wetenschapper	Scientist
1. Wetenschap	Science
2. Proefjes	Experiments
3. Denken	To think
4. Dingen maken	To make things
5. Dingen onderzoeken	To find things

Word Association Test (WAT): The four words or sentences for "*science*" (Experiments, Small drawings, How things are put together and Curiosity) and five words or sentences for "*scientist"* (Science, Experiments, To think, To make things and To find things) (see Table 10b) were given by the student.

Attitude Questionnaire: The average of five questions of the scale "future participation in science'' was 2.4/5 (strongly agree) with the highest score of 3 *(I would like to become a scientist, I would like to study more science in the future, I would like to study science at university*) and the lowest score 1 (*I would like to become a science teacher*). The average of the "Importance of science'' was 3.4/5 (strongly agree) with the highest score of 4 (*Science and technology are important for society, There are many exciting things happening in science and technology*) and the lowest score of 3 (*Science and technology makes our lives easier and more comfortable, The benefits of science are greater than the harmful effects, Science and technology are helping the poor*). The student average score for both scales was 2.9/5 (strongly agree) (see Table 11).

Draw a scientist Test (DAST): The Student-7 drew a female scientist *(gender). The appearance* of this female scientist was with loose half-long blond hair and wore a blue t-shirt. *The location* of the story was the scientist's home. *The props* of science depicted in the drawing were laboratory equipment, chemicals and flasks. *The signs* of the drawing contained an indication of danger such as monsters and angry people. The drawing also included an indication of non-realistic elements, like a portal and monsters. The scientist's *activity* was to prepare a drink that could keep away these angry people in the portal and protect the monsters from the mean people inside the portal (from follow up DAST interview). *The specialisations* of the scientists depicted in the drawing are chemistry, biomedical science and engineering.

During the follow-up interview, the Student-7 described the portal where some kind of monsters and angry people were. She said that her scientist works with chemicals to defeat angry people (see Table 10a). In this view of science and scientist, she was noticeably different from the group in most of the assignments that contained such as monsters, mathematics and graphics which can be partially considerable in the frame of medicine, pharmacology and/or some psychiatric studies.

The below given second round of the results summaries the outcomes in the line of the research questions.

The first research question of this study searched an answer for *"What are young students' images and perceptions of scientists and their work?''*

As for the PEI, first measure, six students chose a photo of a male and one female student (Student-4) brought a female photograph. The age of the chosen scientist in these photos ranged from 20-30 (1 photo) to 60-70 years old (3 photos) and all dressed formally. The two scientists wore laboratory coats and all the chosen male scientist had the facial hair. The only female scientist in the photos was without make-up and her brown hair was wound up into a chignon. In the two of these photos a location was shown, one is in a laboratory and the other is in front of a lightboard. Of the students, four of them selected a famous scientist. Most chosen photo was Albert Einstein's photograph; three times and Nicola Tesla's photograph was chosen once. During the PEI, the students explained

their reasoning for selecting their photos and by that way, it was possible to catch a broad perspective on the child's perceptions of science and scientists and harmonize with the data from the WAT (see Appendix-A, B).

Along with the PEI, the students' drawings in the Draw a scientist Test (DAST) and their responses in the semi structured follow up DAST interviews were analysed based on the five categories in the DAST checklist (Emvalotis & Koutsianou, 2018; Lamminpää et al., 2020). The first category of this checklist, the scientists' gender, was clear in these drawings and in the follow up DAST interviews students named their scientist accordingly with the gender in their drawing. The four students drew a male scientist and three students drew a female scientist. So, the female scientist was drawn only by female students. The second category, the appearances of the scientists: Two of the students drew a scientist with a laboratory coat while the five students dressed the scientist with leisure clothes although the students chose the formally dressed scientist for their PEI. The location of the research, as the third category, was drawn as a laboratory by four students and two of them drew an office and in one drawing, scientist worked at home. One student drew multiple locations and workplaces in a big building. The fourth category is the props or other signs. As the science props, all students depicted the laboratory equipment, the chemicals (two students) and a microscope (one student). As signs, the indications of danger were found in all the drawings. The five of the students mentioned the illnesses in their drawing and two of them referred to a virus as a reason. The last category, the specialisations of the scientists in these drawings are chemistry (7/7) which is followed by the biomedical science (5/7) and engineering (2/7). Besides, one student added the specialisations of a doctor and archaeologist in the drawing with the multiple scientists in a workplace (Appendix C).

Second research question of the study was "*How do young students conceptualise science and scientist?*''. To answer this question, a Word Association Test (WAT) was approached with two stimulus words. The first, science, was performed by all the participants and "experiment'' and "discover'' were written by the three students in this test and words related with science were cleverness: being smart, studying or curiosity were written by five students. The second, scientist, was performed by five students. The words "experiment'' and "discover'' were shared by three and "microscope'', "white coat'' and "glasses'' were mentioned by two students. Similar to the first stimulus word, indications of cleverness: smart, or thinking were mentioned by three students. The indication of (world) improvements such as helping, finding or making the world a better place was stated by four students. To summarize, WAT gives insight into the participants' conceptualization of science and scientists and provides a frame to understand how each child associates these words in his/her way (Appendix B). Also, this can display the students' levels of conceptual understanding and a starting point for the further intervention studies.

The third question of this study explored the answer for "*What are young students' attitudes toward STEM careers and science involvements?*" For this purpose, the students' attitudes were measured based on two scales of attitude questionnaires (Kind et al. 2007) namely, the Future participation in science and the Importance of science. The descriptive statistics for the scales and items were calculated for the seven participants of this study (see Table 11).

As for future participation in science: the scale average was 2.9 with the highest item average of 3.9 (I would like

to study more science in the future) and the lowest item average of 2.4 (I would like to study science at university, I would like to become a science teacher). Generally speaking, the students did not show a strong tendency towards a STEM track and professions, such as being a science teacher but they were willing to study science. As for the importance of science: the scale average was 3.6 with the highest item average of 4.4 (Science and technology is important for society) and the lowest item average of 2.7 (The benefits of science are greater than the harmful effects). Thus, the participants found science and technology important for society even though some participants found science harmful as in the previous studies (Heitger & Milner, 2017). Additionally, keeping in mind the data was collected in the pandemic time, this period might have clout in the students' perspective (Han, 2022; Tabak & Dubovi, 2023). In summarizing, the average score of both scales was 3.2/5 (strongly agree) which showed that the students' attitudes are slightly on the positive side, and they are more convinced of the importance of science and technology for the society than choosing a STEAM carrier for themselves (see Table 11).

Table 11. The Summary of Participants Responses to the Future Participation in Science and Importance of Science Scales (Kind et al. 2007)

	Grade 7				Grade 8			
	St-3F	St-4F	St-5F	St-6F	St-1M	St-2M	St-7F	
Attitude statement								
Future participation in science (5-item)								*Mean*
I would like to study more science in the future.	5	4	4	4	4	3	3	*3.9*
I would like to study science at university.	3	1	3	2	1	4	3	*2.4*
I would like to have a job working with science	4	3	2	4	2	3	2	*2.9*
I would like to become a science teacher.	1	1	2	5	3	4	1	*2.4*
I would like to become a scientist	3	1	5	3	1	3	3	*2.7*
Mean	*3.2*	*2*	*3.2*	*3.6*	*2.2*	*3.4*	*2.4*	*2.9*
Importance of science (5-item)								
Science and technology are important for society.	5	4	3	5	5	5	4	*4.4*
Science and technology make our lives easier and more comfortable.	5	5	2	4	3	5	3	*3.9*
The benefits of science are greater than the harmful effects.	3	1	3	3	2	4	3	*2.7*
Science and technology are helping the poor.	5	4	1	3	1	3	3	*2.9*
There are many exciting things happening in science and technology	5	4	5	4	4	3	4	*4.1*
Mean	*4.6*	*3.6*	*2.8*	*3.8*	*3*	*4*	*3.4*	*3.6*
Mean of both scales	*3.9*	*2.8*	*3*	*3.7*	*2.6*	*3.7*	*2.9*	*3.2*

5=*Strongly agree*, 4=*Agree,3=Neither agree nor disagree*, 2= "*Disagree*" = 2, and "*Strongly disagree*

Discussion and Conclusion

This research aims to examine the stereotypical images of science and scientists in the Dutch lower secondary school context and with this in mind examine the three research questions. The analysis, overall, showed that there are some common stereotypical images of science and scientists among the students with some variance as a function of the data collection task and gender. Generally, the students described scientist positively while adding they sometimes act differently. The environmental context and the pandemic period have influenced their perceptions, such as searching for a cure for a disease, virus. The students conceptualized science and scientists most of the time realistically and more than their school science experiences. As for example they showed more tendency to depict natural elements, such as plants or involved the plant base healings. Although they have a higher positive attitude towards science, they have less tendency towards the STEM career and science involvement in the future.

In this study the PEI was employed by selecting an existing photo via the internet which is the first time employed in such a study in our knowledge and adding the values and originality to the findings. It means also, the participants of this study had more time and opportunity to think about what a scientist looks like (Epstein, et al., 2006). Based on the result of this study, all the students substantiate their reasoning for their choices. Thus, choosing photos from the internet can be an option to work with the younger age students' perceptions of scientist and science. As noted in the results, except the one student (Student-4, female), all the students preferred the male scientist photos for their PEI and Albert Einstein was the most chosen scientist (Miele, 2014). Similar to the previous findings, only the female students depicted female scientist in the DAST (Bozzato, et al., 2021; Emvalotis & Koutsianou, 2018). Thus, the Student-4 was the only female student who choose the female scientist photo for the PEI and illustrated a female scientist in the DAST. Additionally, the scientists were named accordingly with the depicted scientist's gender in the interviews. Hence, in the gender aspect, the students showed the consistency across the measures and the variance in gender aspect across the measures shows the similarities with the existing literature. To conclude, these outcomes show that girls might still consider the scientific world consists only of men and not fully convinced about the female role (Carli, Alawa, Lee, Zhao & Kim, 2016; Danielsson et al., 2023; Miller, Slawinski Blessing & Schwartz, 2006; Toh & Watt, 2023). As it was suggested previously, girls' attitudes and skills appear need to be supported to foster their contribution in science and technology (Ruiz-Bartolomé & Greca, 2023).

Albert Einstein was a common image in both the PEI and the DAST. Students who selected a photo of Albert Einstein, also drew him in their DAST and named their scientist as Albert. Hence, the use of Einstein, which is a stereotypical image of the mad scientist is in line with previous studies (Rodari, 2007; Miele, 2014; Türkmen, 2008) and convergent across the measures with some unrealistic elements such his work on how to improve the environment or use his laptop. Connected to this, as it was previously suggested by the scholars, updating with the additional categories, such as Einsteinian Mythic Stereotype or operationalize the Mythic Stereotypes can be considered to reflect on the contemporary settings and deeply analyze students' drawings (Fergusson & Lezotte, 2020). The students who did not show any images of the mad scientist, showed a weaker connection between Einstein and science (Rodari, 2007). The students showed the previously reported stereotypes, such as all

participants illustrated the chemical laboratory equipment in their drawings as in the previous studies (Farland-Smith, 2017; Tintori, 2017), laboratory coats and glasses (Samaras, Bonoti & Chistidou 2012) while three of the students added decorative elements to their drawings, such as the frames.

To conclude, on one hand the students in this study showed the stereotypical elements of science and scientists in their choices and drawings but on the other hand generally they have a broader view of what scientists do. Working with PEI, DAST and the follow-up interview of DAST provide us to see this broader insight into the views of students towards science and scientist.

It is not common in DAST for the participants to draw about plants, nature or the environment improvement in their drawing (Ferguson & Lezotte, 2020; Miele, 2014; She, 1998). Different from most of the previous studies, the participants in this study showed more nature influence and often included plant-based research in their drawings. They illustrated the plants, environmental improvement and other environmental factors in their drawings and elaborated these in their interviews. One reason for this, the students in this study are from a very close neighborhood of the nature protection area and the farmlands. This might be the reason why nature and plants were commonly depicted in their drawings. Another reason, in the pandemic time, students might miss spending time in nature and engaging with outdoor activities (Alabdulkarim, Khomais, Hussain & Gahwaji, 2022). Moreover, according to recent findings, the COVID-19 pandemic period influenced the students' perception of science and scientists positively (Ofek-Geva, Vinker-Shuster, Yeshayahu & Fortus, 2022; Quílez-Cervero, Diez-Ojeda, López Gallego & Queiruga-Dios, 2021). In the data collection period of this study, the pandemic measures were still applied in the society and not surprisingly, the influence of the pandemic was clearly seen in most their drawings in line with other studies (Quílez-Cervero, et al. 2021) as for example scientists were busy fighting viruses and working on curing viruses related diseases which was not commonly reported previously or "*No time to grab his weird suit*", Student-1. This is interpreted that these students apparently carry more health concerns and heard more about biological science and cure.

From the point of WAT, the students associated the conception of science and scientist realistically, such as experiments, discoveries and curiosity (Chionas, & Anastassios, 2022). In their conceptualization of science and scientists, the stereotypes were seen but some of these are business as usual specifically for the natural science and scientist, such as the laboratory coat. Thus, it is an appropriate viewpoint for the natural scientists' interactions within society and their laboratory work. From this point of view further studies might discus to extend to categorize some of the students' perceptions "realistic'' (if the response expressed an appropriate view) as suggested by some scholar (Rubba & Harkness, 1993) or might require detailed instructions for further clarification to evaluate the students' perceptions deeply.

Based on the descriptive statistics, the students' attitudes toward science show that the students find science important for society with a careful concern of finding science could be harmful which is in the line of some research findings (Heitger & Milner, 2017). Nevertheless, the students have in general a positive attitude towards science and would like to study more science in the future although they are not planning a career in science as it is shared (DeWitt & Archer, 2015; DeWitt, Archer & Osborne, 2014; Scholes & Stahl, 2022). This highlights the

importance of intervention studies and contact with the young students earlier in this context.

The following limitations need to be taken in consideration for viewing the findings of this study. First, methodologically, it is a qualitative case study with a small sample size which means outcomes are not generalizable (Denscombe, 2021). Yet, the results can provide detailed information for the future studies, specifically its finding expected to be supportive for the intervention studies. Additionally, the DAST has many known limitations (Losh et al., 2008; Lamminpää et al., 2020) and this study applies multiple techniques to overcome these but still, each methodology applied in the study has its own shortcomings. Second, this study was completed with a small group of students following their STEM courses with their male science teacher for two years and worked closely. This might have been influenced and could be effective in some views considering the use of role models in the lessons and in the daily lives of the students is found important to the stereotypical images (Good et al., 2010; Frenzel, Daniels & Burić, 2021; Kerkhoven et al., 2016; Miller, et al., 2015; VHTO, 2016). This study did not count in these interactions and did not examine in the design since these are not the focus. Third, the time among the assignments could be longer and even the assignments could be spread over a few days although the students completed the assignments quicker than the planned time in this study. The time management could be relevant to the group of students' characteristics. It is highly suggested to revisit group and program differences with a note time between each assignment could have lowered the influence of each assignment on the other hand would probably have given broader results (Denscombe, 2021). Lastly, the participants were asked to search for the photos on the internet for their PEI. Searching on the internet involves some keywords and algorithms, for instance, words in Dutch for science (Wetenschap) and scientists (Wetenschapper) directed to the webpages where the students selected for their PEI photos. This might be another factor affecting the student's choice. To overcome this limitation, adding a prompt and/or some key words to the assignment instruction and encouraging an extended search in different search engines can be considered for the future studies.

Recommendations

To contribute to the existing literature, multiple measurement tools were employed in this study and results showed that the students are not consistent across the measures. Some stereotypical elements recurred more often, but also some new elements appeared in each assignment. In the end, the responses to the measures are supportive of each other and helpful to understand to clarify the students' perspective. Overall, this study suggests working with multiple measures specifically with the young age students to grasp a broader perspective and understanding of a student's image of science and scientists deeply.

The findings also suggest that the students aged 10-13 in this sample have the commonly documented stereotypical image of science and scientists and their attitudes towards science shows that they have some reservation to becoming scientists themselves which is in line with the previous research. These stereotypical images and the students' attitude can influence their choice of becoming a STEM professional (Kerkhoven, et al., 2016). Thus, considering the track choice earlier in the Dutch education, focusing on this age group students with science activities and conducting interventions would be supportive for their future STEM perspective.

It is remarkable to state that the students did not mention a well-known scientist, such as Ben Feringa, from their own area. Besides, none of the students mentioned current famous scientists of the Netherlands, such as André Kuipers (an astronaut) or Freek Vonk (a tv-biologist) which is different from Tan, Jocz & Zhai, (2017) results suggesting importance of popular media play. Furthermore, no influence was shown of their STEM program Lego Legeau (https://firstlegoleague.nl/), in which the students are building a robot at school in an early age induction and intervention program. They might interpret the scientist as a user rather than creators or symbol of technology for the students (Fergusson & Lezotte, 2020). Therefore, to improve the current image and the attitude toward science, it is recommended that interventions aiming to support the development of sophisticated views about science and scientists include not only students actively but also share the contemporary and social aspects and how scientists work. In this frame, the practice can benefit from the joint scholarship of both science education and communication (Baram-Tsabari & Osborne, 2015). To conclude, this study provides novel information that could be used as input for the design of curriculum materials aiming to support the low middle school students' perspective in developing a more sophisticated understanding of the nature of science and the work of scientists and the findings deliver useful insights that would be beneficial for the further (intervention) studies.

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Appendix A. The Description of the Chosen Photos for the Photo-Elicitation Interview (PEI) per Participant

	Grade 7				Grade 8		
Description of photo	St-3F	St-4F	St-5F	St-6F	St-1M	St-2M	St-7F
Gender	Male	Female	Male	Male	Male	Male	Male
Age	20-30	30-40	60-70	60-70	60-70	40-50	40-50
Outfit	Lab. coat, latex gloves, safety glasses and suit with tie	Clean black shirt	Blouse	Blouse	Blouse	Suit with blouse	Lab. coat, suit with tie, tick round glasses
Appearances	Short neat hair, beard	dark long hair in a bun, earrings	Moustache, messy grey hair	Moustache, messy grey hair	Moustache, messy grey hair	Moustache, short neat hair	Messy grey hair, beard
Location	In a laboratory	x	x	x	x	x	Before a lightboard
Famous or not	Non famous	Non famous	Albert Einstein	Albert Einstein	Albert Einstein	Nicola Tesla	Non famous
Interview quotations or remarks:	"Testing things out in a lab". "Looks like a scientist with: gloves, goggles, lab coat and microscope"	"She is doing weird experiments" "She looks like a scientist"	"I already knew he was a scientist"	"I saw a lot of videos of him" "His hair" "discoveries"	"Only famous scientist I know" "He discovered a lot of things, which I think is interesting"	"He is a very famous man, smart man and he has achieved many things in life." "He invented the light"	"discovery of graphics" "looks weird" "original" "To keep the signs, he don't have to think so hard"

Appendix B. Summary for the Word Association Test (WAT) per Participant

	Grade 7					Grade 8		
Words	St-3F	St-4F	St-5F	St-6F		St-1M	St-2M	**St-7F**
Science (n=7)								
1	Experiments	Experiments	Chemical	To discover		Discovery of things	Smart	Experiments
2	Laboratory	Microscope	Explosion	Drinks		Medicines	Reading	Small drawings
3	Being precise	Chemicals	Robots	Smart		How things work	Learning	how things are put together
4	Studying					To discover	To discover	Curiosity
5	School					Being smart	Famous	
Scientist (n=5)								
1	Laboratory	Doing crazy experiments	**Not completed**	**Not completed**		To discover	Smart	Science
2	Microscope	White coat				To invent	Important	Experiments
3	Safety glasses	Microscope				To discover new things	Famous	To think
4	You make the world a better place	Experiment tube				Helping people	Rich	To make things
5	A white coat	Glasses of a scientist				Being smart for it	Kind	To find things

Appendix C. The DAST Evaluation based on the Checklist (Emvalotis & Koutsianou, 2018; Lamminpää et al., 2020), with the Follow-up DAST Interview Remarks

		Grade 7				Grade 8		
Category	Characteristics	St-3-F	St-4-F	St-5-F	St-6-F	St-1-M	St-2-M	St-7-F
(1) The gender of the scientist								
Drawings or written elements about the gender of the main character(s)	Female	Female	Female					Female
	Male			Male	Male	Male	Males	
Remarks during the interview		Female: Jolanda	Female: Nora	Male: Albert Einstein	Male: Albert Einstein	Male: Albert	Multiple males	Female and male: Named after her mother
(2) The appearance of the scientist								
Drawings or written elements about the appearance of the main character(s)	Labcoat	labcoat						
	Eyeglasses			Eyeglasses				
	outfit	Work pants	Leisure clothes	Leisure clothes	Leisure clothes	Leisure clothes		Leisure clothes
	facial-hair			Moustache				
	age	30-40	30-40			20-30		30-40
Remarks during the interview		Doesn't need glasses because the experiment is not dangerous			Umbrella and jacket for the rain	No time to grab the weird suit		
(3) The location of the research/story								
Drawings or written elements about the location of the story	lab	x	x	x		x	x	
	Office				x		x	
	Field						x	
	Home							x
Remarks during the interview		Added some decorations: paintings	Colourful scientist space	Broken lamp, not cleaned, spiders	Added some decorations: Paintings	In a building	In a very large building in which a lot of people are doing all kinds of things	Added some decorations: posters Inside a portal

		Grade 7				Grade 8		
Category	Characteristics	St-3-F	St-4-F	St-5-F	St-6-F	St-1-M	St-2-M	St-7-F
(4) The specialisation								
Drawings or written elements about the specialisation of the scientists	Physics							
	Chemistry	x	x	x	x	x	x	x
	Biomedical science	x	x		x	x		
	Astronomy							
	Earth science							
	mathematics							
	Engineering /technology					x		x
	Space science							
	Other					Doctor, archaeologist		
(5) The props or other signs								
Drawings or written elements about the props or other signs	laboratory equipment	Microscope	Chemicals	Lab eq.	Lab eq.	Lab eq.	Lab eq.	Chemicals
	flasks	x	x	x	x	x	x	x
	Computers				x		x	
	rockets							
	robots							
	Indication of danger		virus	Smoke, poison, explosion & illness	illness	Virus	illness	monsters and angry males
	secrecy							
	non-realistic			x				Portal
	other			World improvement	Recipe book			
Remarks during the interview		Working with plants: whether grass heals well against burns on your hand.	Looking at bacteria and small animals through a microscope	A Desk at which he is working, looking at environmental improvement	Receipt book for drinks, laptop, small jars	Virus, antidote, flasks of glass with on the inside ingredients	Researching bacteria; discovering new plants, fish and animals; looking at nature;	Working with chemicals to defeat the angry males in the portal, portal with monsters