

How do different factors influence secondary school students' motivation for STEM subjects?

A multiple case study from a self-determination perspective.

Ing. Tom van den Hoven

2452669

t.j.vandenhoven@students.uu.nl

First corrector

Dr. ir. R.F.G. Meulenbroeks

r.f.g.meulenbroeks@uu.nl

Second corrector

Dr. J.N.A. Boeve-de Pauw

j.n.a.boeve-depauw@uu.nl

Abstract

Societal need for capable Science, Technology, Engineering and Mathematics (STEM) workers continue to grow (Xue, 2014). For the Netherlands, this problem starts at the Subject Cluster Choice (SCC) students make in 9th grade of secondary education. Autonomously motivated choices for STEM-oriented subject clusters would increase the academic performance of students and their retention when in tertiary education (Ayub, 2010; Ryan & Deci, 1985; Vansteenkiste et al., 2009), thus the overall skills of STEM workers. In reality, there are determinants that influence a student's choice and motivation. Gaining insight into these determinants is crucial in increasing autonomous motivation among students in STEM. A longitudinal, multiple case study is employed to gain insight into the decision-making process, significant determinants and their influences on the process, and the type of motivation that is present in this process. Four Dutch 9th grade students were interviewed three times throughout the schoolyear. The interviews provided narratives, one for every student, which show that the decision-making process is continuous. Students' choices are influenced by parents, peers, the school and future career options. Students that show autonomous motivation base their choice on their career prospects, while controlled motivated students base it on a controlled parenting style. Parenting style and student motivation type can influence each other, often reaching an equilibrium when both are controlled or autonomous. Motivation type can be influenced by new information (either positively or negatively); however, autonomous motivation is more stable than controlled. Students showing autonomous motivation seem more perseverant.

Introduction

There is an increasing demand for skilled professionals in the Science, Technology, Engineering, and Mathematics (STEM) fields (Xue, 2014). Existing research demonstrates a growing disparity between the number of STEM professionals graduating from tertiary education and the actual demand in both public and private sectors in the EU (Berkhout et al., 2013; ROA, 2019). Many global issues with important technological implications that require capable STEM-workers. For example, the energy transition faces a problem called skill shortage, where there is a surplus of possible workers, however, there is a gap in the needed skills of these workers (Briggs et al., 2022; Zekaria & Chitchyan, 2019). This energy transition also brings forth another problem: availability. Currently, most renewable energy sources provide energy during the day or when there is wind. However, society is not set to utilizing these peaks and storing the energy is not efficient enough to be used on a large scale (de Jong, 2024; van Cappellen et al., 2023). Also, among others, wind turbines, solar panels electric cars and heat pumps overload the power grid, preventing large scale solar and wind turbine parks from being build, as well as impeding new companies from joining the power grid (de Jong, 2024; Dekker et al., 2022). Skilled STEM workers are needed to find solutions to these societal challenges.

The Netherlands might face the biggest challenge regarding the STEM worker shortage compared to other countries in the EU, as it currently has the lowest percentage of STEM graduates (OECD, 2017). This situation has been shown to be related to the gradual decline of students opting for STEM-related subjects in secondary school (TechniekPact, 2023), as students prefer other career options.

To become a skilled STEM worker, people have to make a series of choices favouring STEM-oriented subjects, studies and degrees. The first of these decisions are made around 14-16 years old. In the USA, Finland and the Netherlands students make a choice during their secondary school in what subjects they want to follow for the remainder of secondary school. It is possible for students to make a choose in the direction of STEM (KTPO, 2009; M&E Education, 2023; Ministerie van OCW, 2024a, 2024b). In China, on the other hand, there is no form of specialization until university (18

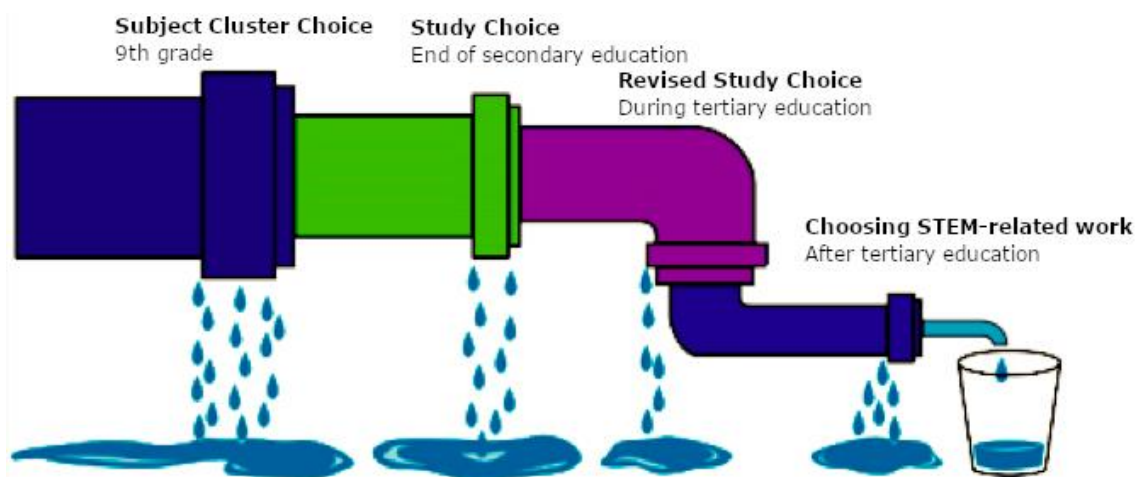
years old), besides vocational and academic education (Guo et al., 2019; Wang, 2003). After secondary education, students can a career in STEM after they finished a STEM-oriented degree.

This educational pathway is often referred to as the “STEM-pipeline” (Ahn et al., 2016). In this pathway there are several points where students might ‘leak’ out of the pipeline. Figure 1 illustrates the STEM-pipeline and its leakage points in the Dutch educational system.

In the Netherlands, the first leakage point occurs when students make a Subject Cluster Choice (SCC). By the end of 9th grade, students (approximately 15 years old) decide which subject cluster to pursue for the following 2-3 years. At the end of secondary education students take final exams in their subject cluster. (Ministerie van OCW, 2024a, 2024b).

The SCC is considered an important leakage point, as not all clusters allow a student to pursue a STEM-oriented degree. Admission to STEM-oriented tertiary education often necessitates completion of a STEM-oriented subject cluster or to have chosen STEM-oriented subjects in another cluster (123studiekeuze.nl, 2024a, 2024b, 2024c). Consequently, the first leakage point in the pipeline, the choice of subject cluster, assumes critical importance. It can shape the subsequent

Figure 1



The STEM education pipeline leakage. The figure depicts the four major dropout moments within the Dutch educational system. Adapted from “Motivating Students’ STEM Learning Using Biographical Information” by Ahn et al., 2016, International Journal of Designs for Learning 7(1), p. 2. Copyright 2016 by The Trustees of Indiana University.

educational and professional trajectory, since changing over to a different subject cluster later on is fraught with practical difficulties (Korpershoek, 2011). Addressing pipeline leakage requires a comprehensive understanding of the factors that influence educational choices, particularly concerning the SCC.

Even though the SCC plays a crucial part in increasing the amount of capable STEM workers, there is little research available on the SCC. Especially on why students choose a specific cluster, there is no information available. There is information on the influence of parents on what cluster students choose. However, this influence may be in a direction that does not align with the students' own preference. As research shows us that a feeling of autonomy improves well-being and performance in mathematics (Ayub, 2010; Froiland et al., 2012; Ryan & Deci, 1985), and leakage in tertiary education is highly affected by academic performance throughout the academic career (Casanova et al., 2021), an autonomy supportive parenting style can influence a student's academic success in STEM. Lastly, Vansteenkiste et al. show us that the quality of the motivation is more important than the quantity, hence a small amount of pressure that results in less autonomy, could already have a big impact (2009).

Thus, if students make an autonomous choice for STEM in their SCC, they are more likely to succeed in academics and more likely to continue in the pipeline for autonomous reasons (Messerer et al., 2023), resulting in more capable and possibly more STEM workers. Hence, this research focusses on different determinants that influence students' SCC and compare this to motivation types to gain insight into students' decision-making processes. With this information better support structures could be formed to aid in the SCC, and result in fewer students leaking out of the pipeline for reasons regarding controlled motivation.

To gain insight into these processes, the following research question is proposed:

What is the influence of different determinants on Dutch 9th grade students' decision-making process when selecting a Subject Cluster?

To structure this research a set of sub-questions is employed, which are as follows:

1. How do students describe their decision-making process regarding the SCC?
2. Which determinants do students consider significant regarding their SCC?
3. What do students report on the influence of parental pressure during the SCC decision making process?

These questions will be answered by conducting a longitudinal, multiple case study. Several students will be followed throughout one year, at the end of which, they will make their SCC.

Theoretical Background

This chapter will describe important theory. First, an explanation of the Dutch Subject Cluster Choice (SCC) will be provided, as this is the main focus point in this research. Secondly, the Self-Determination Theory (SDT) will be discussed, as this will be lens to look through when analysing the data. Then, parenting styles will be discussed, as this determinant is one of the main foci in this study. Lastly, influences and determinants of the SCC are described. Following this, all theoretical information is combined into a useful tool for analysing student and parental preference.

The SCC

The SCC is a choice between four clusters of subjects that focus on a certain group of subjects. Students will follow subjects for the last 2-3 years of secondary school partly within the cluster they chose. Standard subjects like Dutch, English and mathematics are mandatory. Within the cluster there are some mandatory and elective subjects, that differ per cluster. For example, one cluster focusses on economics, with mandatory cluster subjects: economics and history (SLO, 2023). All clusters are shown in Table 1. The N&T and N&G clusters are considered the STEM-oriented ones.

Table 1

The four subject clusters within secondary education in the Netherlands and their mandatory subjects (SLO, 2023)

Cluster Name	Mandatory Subjects
Nature & Technology (N&T)	Advanced mathematics, chemistry and physics*
Nature & Health (N&G)	Applied mathematics, chemistry and biology**
Economics & Society (E&M)	Applied mathematics, economics and history
Culture & Society (C&M)	Basic mathematics, modern second language and history

* Students can choose Biology as the extra subject to create a combined NT/NG cluster.

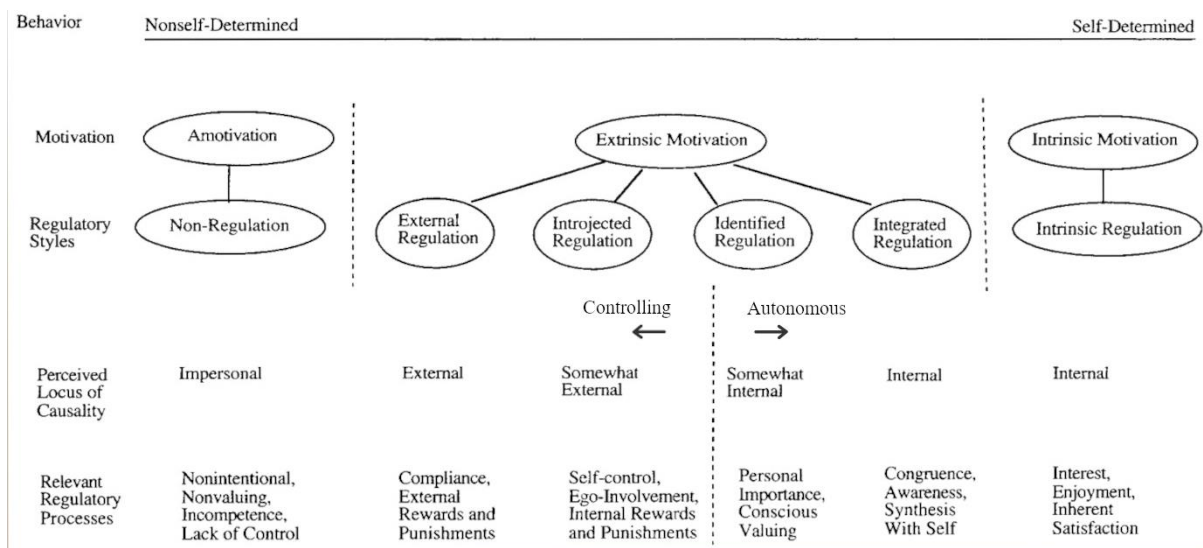
** Students can choose advanced instead of applied mathematics and physics as the extra subject to create a combined NT/NG cluster

Self-Determination Theory

The Self-Determination Theory (SDT) states that motivation can take various forms. It distinguishes between intrinsic, extrinsic and amotivation, which are placed along a spectrum ranging from self-determination to nonself-determination. Figure 2 illustrates this spectrum of behaviour, depicting the types of motivation and the associated regulatory styles.

The Perceived Locus of Causality (PLOC), depicted in Figure 2, recognized by operant theorists, categorizes motivation into three categories: Impersonal, External and Internal. In this study, a distinction is made between the External Perceived Locus of Causality (EPLOC) and Internal Perceived Locus of Causality (IPLOC). This division separates external motivators and ‘negative’ internal motivators (e.g. ego-involvement or avoidance of guilt or anxiety) on the controlling side, and ‘positive’ internal motivators on the autonomous side (deCharms, 1968; Skinner, 1965; Vansteenkiste et al., 2009). For this study, the IPLOC is related to autonomous motivation and EPLOC is related to controlled motivation.

Figure 2



A taxonomy of human motivation, dividing controlled and autonomous factors. Adapted from "Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being." By Ryan & Deci, 1965, American Psychologist, 55(1), p. 72. Copyright 1965 American Psychology Association.

Autonomously motivated behaviour can be characterized as doing an activity because the activity itself is interesting, enjoyable or inherently satisfactory, because the activity or behaviour is of personal importance or when the identified behaviour is assimilated to the self, resulting in alignment with personal values (deCharms, 1968; Ryan & Deci, 1985, 2000; Skinner, 1965).

Controlled behaviour, on the other hand, involves engaging in an activity due to external rewards or punishment or internal rewards or punishment. Controlled motivation may lead to amotivation, resulting in lack of engagement in the activity or understanding of the reasons for performing the activity (deCharms, 1968; Ryan & Deci, 1985, 2000; Skinner, 1965).

Consequently, choices made based on EPLOC are referred to as “controlled”, whereas choices based on IPLOC are referred to as “autonomous”.

Parenting Styles

Parenting styles range along a spectrum from controlling to autonomy supportive. A controlling style is characterized by parents’ pressure, intrusiveness, dominance and attempts to manage or control a child’s behaviour (Barber, 1996; Barber et al., 1994; Grolnick & Pomerantz, 2009). An autonomy-supportive style is characterized by parents’ encouragement to take initiative, independent problem-solving and taking the child’s perspective (Grolnick & Pomerantz, 2009).

For the purpose of this study only parental pressure regarding the SCC is taken into consideration. An overall controlling parenting style might have influence on the SCC, but this lies outside the scope of this research. Pressure to choose a specific cluster could be categorized as a controlling parenting style, as the characteristics bear similarities (dominance and manage or control a child’s behaviour).

Within this study, three categories of parental pressure are distinguished: autonomy supportive, pressure to choose STEM subjects, and pressure to choose non-STEM subjects. Throughout this research, if there is a reference to “parental pressure”, it represents “perceived parental pressure by the student, regarding the SCC”.

Determinants

Research shows that parents exert significant influence over their children's SCC (Korpershoek, 2011; Langen & Vierke, 2009; van den Hurk et al., 2019). First of all, Korpershoek tells us that students often make the SCC in socialization with their social environment (parents, peers, teachers, etc.). This limits the area of knowledge to what this environment knows, including the level and direction of education the parents have experienced (2011). Moreso, when comparing STEM candidates to non-STEM candidates, Korpershoek found that parents exert a greater social influence to choose STEM-related subjects (2011). Van Langen and Vierke explain that from the social environment of the student, the parents' have the biggest influence. The correlation between a student choosing a specific cluster and getting it recommended from their parents is up to twice as big as when it is recommended by peers or the school (2009). Lastly, van den Hurk et al. show us that the social environment also influences motivation, thus being of influence on why students choose a certain subject cluster and possibly academic performance (2019). This is supported by other research, showing that an autonomy-supportive parenting style positively affects motivation and academic performance (Froiland, 2015; Froiland et al., 2012).

Besides parents, van Langen and Vierke show us that peers and the school do have a significant influence on what subject cluster a student chooses (2009). Other research supports this as students themselves report their social environment being an important factor in making the SCC (Wietsma, 2023). Furthermore, the students report that they think it is important to make their own choice (Wietsma, 2023).

Pipeline leakage, perceived parental pressure and motivation in the SCC

Every student takes their own educational path. Some of these pathways lead to students entering STEM, some to alternatives and some paths might start in STEM but drop out for several reasons. Either way, in an ideal situation, students who are Autonomously Motivated (AM) for STEM choose a STEM-oriented cluster and students who are AM for an alternative choose an alternative cluster. However, parents may adopt a controlling parenting style and exert pressure on a student to choose

a subject cluster that does not align with their children’s autonomous motivation. If this is the case, the student is acting on controlled motivation. Further down the educational path, this might result in dropping out (either out of STEM or an alternative). This gives four types of ‘leakage’ out of the pipeline: direct autonomous, indirect autonomous, direct controlled and indirect controlled leakage.

Direct leakage happens at the SCC, indirect leakage happens at a later point in the educational path, where the student could potentially use up valuable educational resources. Controlled leakage occurs when students make choices based on controlled motivation, while they are autonomously motivated, possibly resulting in capable, future STEM-workers not ending up in the field.

Autonomous leakage occurs when students make an autonomously motivated choice for an alternative.

To help visualize the potential pathways a student can make, Table 2 compares the AM of the student to the perceived parenting style (controlled with pressure for STEM, controlled with pressure for alternative or autonomous supportive). Further on every category is explained in detail.

Table 2

Autonomous motivation for STEM or an alternative vs. a controlling or autonomous parenting style.

	AM for STEM	AM for alternative
Direct parental pressure to choose STEM subjects	1: Might choose STEM related subjects, but lose AM later on	2: Might choose STEM subjects while not internally motivated to
Direct parental pressure to choose alternative	3: Might not choose STEM related subjects, while internally motivated to	4: Might not choose STEM related subjects
Autonomous supportive parenting style	5: Might choose STEM related subjects	6: Might not choose STEM related subjects

1. Autonomously motivated for STEM and pressured to do so.

Students who are autonomously motivated and are pressured to choose STEM subjects do not seem to contribute directly to the pipeline leakage at first. However, according to the SDT, increased controlled motivation decreases autonomous motivation (Ryan & Deci, 1985, 2000; Vansteenkiste et al., 2009). This parental pressure may continue or even increase over the following three years of secondary education, albeit in a different form. This potentially limits or decreases the initial autonomous motivation. Although parents' influence, and thus controlled motivation, tends to decrease after secondary education as students become more independent, autonomous motivation does not automatically increase. Consequently, it is hypothesized that students who were once autonomously motivated for STEM may lose motivation overall and eventually drop out, leading to indirect, controlled leakage.

2. Autonomously motivated for alternatives but pressured to choose STEM.

These students may initially choose STEM subjects due to parental pressure, but at a later stage in the pipeline decide to pursue their initial preference, leading to indirect leakage for autonomous reasons. Consequently, this could lead to a detour in their educational journey, consuming time and resources that could have been better utilized by students who are genuinely motivated to pursue STEM.

3. Autonomously motivated for STEM but pressured to choose an alternative.

If these students choose an alternative cluster, it may result in the loss of valuable STEM talent, as they are unlikely to enter the STEM field later on (Korpershoek, 2011), leading to direct, controlled leakage. For example, parents who expect their child to take over the family business may pressure them to choose business-related subjects instead of STEM.

4. Autonomously motivated to choose alternative and pressured to do so.

Students who are autonomously motivated to choose an alternative and are pressured to do so by their parents also do not add to the STEM pipeline leakage problem. They fit into the category of autonomous, direct leakage.

The remaining two categories are the proposed ideal situation:

5 + 6. Autonomously motivated for STEM or an alternative without parental pressure.

Students who autonomously choose STEM or an alternative cluster are not controlled or pressured by parents do not add to the proposed STEM pipeline leakage problem. The students who choose alternatives are considered direct, autonomous leakage, since they are not autonomously motivated to choose STEM.

In summary, the three most significant categories within the scope of this study, concerning pipeline leakage, are categories 1, 2 and 3. When parents pressure students to choose STEM (regardless of their autonomous motivation) or when parents pressure for an alternative when the student is autonomously motivated for STEM.

Methods

General approach

To address the proposed research question, a small sample longitudinal case study was conducted. A qualitative approach was selected due to the limited existing knowledge regarding the effects of influencing determinants on the decision-making processes of students concerning the SCC. This methodology allows for the collection of in-depth information and the identification of mechanisms.

Ideally, each of the six categories presented in table 2 are represented in the study. To achieve purposeful sampling, initial structured interviews were conducted, each lasting approximately five minutes. The purpose of these preliminary interviews was to categorize the students along the axes of table 2 and select six participants for further research.

The selected students were tracked throughout the academic year. Each student participated in three in-depth, exploratory semi-structured interviews. These interviews were designed to address the main research question and its sub-questions. It is possible that students categorized in one group on the basis of the preliminary interviews have to be reclassified over time, following these in-depth interviews. This limitation is inherent to the study design but do not undermine its validity. They may actually present an opportunity to explore intra-category differences among students.

Setting and timeline

The school is a medium-sized secondary institution situated in an urban area, characterized by a diverse student population, representing a wide range of cultural backgrounds. The population is considered “super-diverse” (Crul et al., 2013; Vertovec, 2007). Upon enrolment, parents sign a consent clause allowing their children to participate in research aimed at improving educational practices, covering the research in this study.

Due to time and logistical constraints, one 9th-grade pre-university (vwo) class was selected.

Throughout the school year, the study counsellor organizes several events to disseminate

information about the SCC to both students and their parents. The interviews are scheduled around these events. The interview planning is depicted in Figure 2.

Participant selection

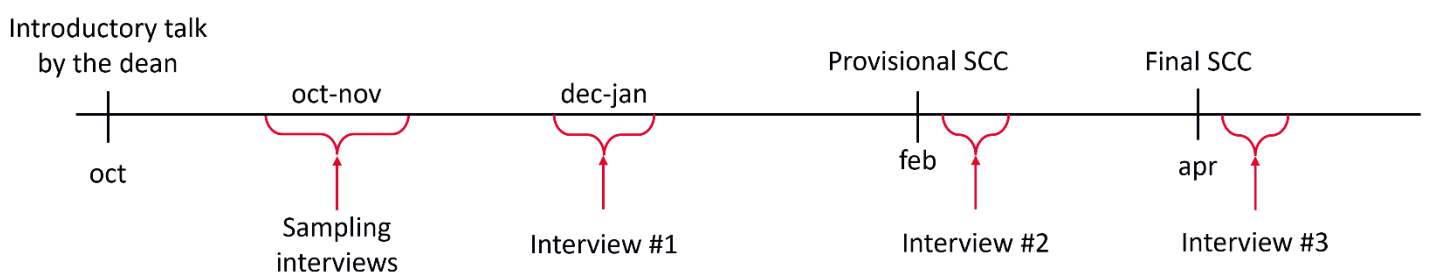
To maximize the likelihood of representing all six categories in this study, preliminary interviews were conducted with all students in the selected class. The primary objective of these interviews was to categorize each student and derive a representative sample. The data collected was pseudonymized and kept confidential.

Preliminary interviews were chosen over questionnaire surveys for several reasons. First, interviews mitigate the risk of students providing brief or nonsensical responses and allow students to contemplate their answers without the pressure to quickly proceed to the next question. Second, the critical data for categorization derive from "why" questions, which are more prone to brief and uninformative responses in questionnaires.

Prior to the preliminary interviews, students received information about the research during their mentor classes to increase participation willingness and provide essential details about the study. The preliminary interviews were conducted during these lessons over a three-week period. In order to be as unintrusive as possible, the interviews were not recorded; instead, responses were documented in key words.

Figure 2

The SCC schedule and conducted interviews' schedule.



The interview questions were developed in collaboration with a second researcher and were based on the Self-Regulation Questionnaire (SRQ-A; Kröner et al., 2017) and the Children’s Report on Parental Behaviour Inventory (CRPBI; Schaefer, 1965). To minimize miscommunication, the questions were translated into Dutch. The interview protocol was reviewed and tested with several other researchers and piloted on several students outside of the sample, but in the same age group.

The questions aimed to determine which subject the student is most autonomously motivated in and whether there is perceived parental pressure regarding the SCC. The question on parental preference sought to identify subjects where the student feels pressured, if any. Given the possibility that autonomously supportive parents may not exhibit a preference, students were allowed to respond with "I do not know." The preliminary interview questions are provided in Table, the full interview scheme is provided in Appendix A (p. 39).

Based on the collected data, a selection of students (ideally from each category) was invited to participate in the remainder of the study. They were informed about the study's schedule, time commitment, and potential impact on their free time and schoolwork, ensuring they could make an informed decision.

Table 3

Preliminary interview questions.

#	Question
1	What subjects do you find enjoyable/interesting?
2	Which subject do you enjoy the most? Why?
3	What subjects do you deem important to your future?
4	What subjects do your parents think are important?
5	Do you think you’ll choose [subject Q2] in your subject cluster? If not, why?

Categorization

To ensure fair categorization, a second independent researcher assisted in coding the responses from the preliminary interviews. For each student, the researchers considered the following questions:

1. Is the student autonomously motivated for STEM or alternative subjects? (Q1-4)
2. Does the student report any form of parental pressure (e.g., to choose or perform well in a subject)? (Q2, Q4, Q5)
3. If there is reported pressure, is it for STEM subjects or alternative subjects? (Q5)

To answer the first question, responses to Q2, Q4, Q3, and Q1 from the questionnaire (in order of importance) were considered. According to Ryan and Deci (1985, 2000), autonomous motivation is indicated by interest, enjoyment, congruence, and personal importance. If different subjects were mentioned, the answer to Q2 was considered the most indicative of autonomous motivation.

To address the second question, responses to Q5, Q2, and Q4 (in order of importance) were examined. If the answer to Q5 was "none" or no obvious reason was provided for parental importance, it was assumed there was no perceived pressure. If a reason was provided and appeared genuine, it was assumed there was perceived pressure. Any discrepancy between responses to Q2, Q4, and Q6 was recorded as indicative of perceived pressure.

To answer the third question, Q5 was primarily used. If multiple subjects from both categories (STEM or alternative) were mentioned, the quantity and order of the subjects were considered.

Selection

Following categorization, not all categories appeared to be represented. No student fit into category 4 (autonomous motivation for alternative subjects, pressure for alternative subjects). Students from the other five categories were initially invited to participate, with four agreeing. The results of the categorization of the students on the basis of preliminary interviews is presented in Table 4.

Table 4

Categorization of the participating students.

	AM for STEM	AM for alternative
Direct parental pressure to choose STEM subjects	Student B	Student A
Direct parental pressure to choose alternative	Student C	
Autonomous supportive parenting style	Student D	

Main interviews

The in-depth interviews are conducted individually at the school. Interview protocols were developed in advance, drawing upon existing literature on motivation and parenting styles. Two distinct interview protocols were designed: one for the period preceding the final SCC decision and another for the period following the final SCC decision. The complete interview protocols are detailed in Appendix B (p. 40). The most important questions are listed in Table 5.

The interviews were held at three key points during the academic year, strategically selected to coincide with significant moments in the students' decision-making process. The first interview occurred around the Christmas break, by which time students were aware of the forthcoming SCC decision due to communications from the school study counsellor. The second interview was conducted following the provisional SCC decision as reported by the student in February. The final interview was conducted shortly after the final SCC decision.

To ensure the validity of the interview protocols, a pilot interview was conducted with a student from the class who was not included in the subsequent study phases. This pilot interview used the same questions to gauge student reactions and assess the interview's accuracy. The pilot interview was not recorded, with responses documented through key points. After the pilot interview, the interview scheme was deemed valid.

Table 5

Most important questions from the main interview.

#	Question
1	<p>What have you done up to this point to make the SCC? Why did you do this?</p> <p><i>This question should give insight to what processes the student has gone through or is going through at this point. It's possible to ask about their parents' role (this does come back later)</i></p>
2	<p>What are you planning on doing in the coming two months regarding your SCC? Why? Can you give an example?</p> <p><i>This question should give insight to what the student is planning to do.</i></p>
3	<p>Who do you talk with about your SCC? Can you give an example?</p> <p><i>This should give insight into influences.</i></p>
4	<p>Do you talk with your parents about your SCC?</p> <p><i>If in the last question parents aren't mentioned.</i></p> <p><i>Follow-up with "What do you talk about?" If possible, follow up with "Do your parents want you to choose a specific cluster?" This can be a sensitive question, pay attention to body language. To comfort the student a question could be asked about other influences: "Do your friends think you should choose a specific cluster?"</i></p>

Data management

Before the start of the first interview, participants are provided with an information letter, provided through communication channels used by the school, detailing the interview schedule, participation guidelines, data handling procedures, and contact information for a third party they can approach to discuss any concerns related to the research or the researcher.

The data collected during both the in-depth and preliminary interviews is pseudonymized before being securely stored on servers located in the Netherlands.

Data analysis

To analyse the data, a slight variation of the Qualitative Analysis Guide of Leuven (QUAGOL, Dierckx de Casterle et al., 2012) was employed.

First, the interviews were transcribed. To enhance readability without altering the students' message and voice, filler words and repetitive wording or phrasing were removed. Throughout the analysis, the actual transcripts were continuously referenced to ensure the distilled data remained faithful to the student's voice.

After transcribing and anonymizing, the interviews were summarized with the assistance of a second researcher. Categories that were deemed important or recurring were proposed, based on these summaries. Following the completion of all interviews, a narrative was developed for each student, outlining their SCC decision-making process.

These narratives were then used to construct categories in collaboration with a second researcher, focusing on recurring themes and the research objectives. This process resulted in the codebook shown in Table 6. There is a distinction between 'Events' and Motivation. Events being reported experiences (Pc, Pa, If, li, F) and motivation being a motivated preference (Aut, Con).

Subsequently, the transcripts were re-read, and significant quotes were highlighted. Representative quotes for the codebook were selected, and the remaining quotes were coded according to the established codebook. During and after this process, the codes were reviewed to ensure they still aligned with the narrative and were adjusted as necessary.

Finally, the constructed narratives were compared with the transcripts and quotes to verify that the intended messages were preserved throughout the analysis.

To validate the coding process, a researcher not connected to this study coded 40 of the 205 total quotes. An intercoder reliability test was conducted, resulting in a 63% agreement with a Cohen's Kappa of $\kappa = 0,62$, indicating acceptable agreement (Institute of Educational Sciences, 2017).

Table 6

The constructed codebook. There is a distinction between 'Events' and Motivation. Events being reported experiences (Pc, Pa, If, li, F) and motivation being a motivated preference (Aut, Con).

Category	Abbreviation	Description	Typical Quote
Parents control	Pc	Quotes that refer to pressure from parents regarding the SCC.	"Because I don't do much at the moment and my grades are quite good, my parents actually want me to choose Wiskunde B anyway."
Parents autonomy supportive	Pa	Quotes that refer to autonomy-supportive behaviour of parents regarding the SCC.	"Well, my parents and I just talk about it sometimes and yes, I don't really know, I'm free in my choice, but if I have difficulty with something or have doubts about something, then we can talk about that. "
Formal information	If	Quotes that refer to mandatory or non-mandatory information provision from a school regarding the SCC.	"Yesterday, [the dean] came by. They explained in detail about the SCC."
Informal information	li	Quotes that refer to the information provision outside the school, regarding the SCC.	"I looked up what you can become with nutritional sciences or 'bewegingswetenschappen.' Then I saw [those studies] and I thought yes, that seems nice."
Influence friends	F	Quotes that refer to influence on the SCC by friends.	"I heard from a friend that they are also choosing [computer science] and they also said that it was a good choice."
Autonomous preference	Aut	Quotes that refer to an autonomous (intrinsic or identified) preference for a profile, study or job.	"Computer science, how to set up your own website and such. I think that it would be nice to be able to choose."
Controlled preference	Con	Quotes that refer to a controlled (introjected or extrinsic) preference for a profile, study or job.	"[I want that other subject cluster] because I think chemistry and physics are both quite boring subjects."
Other	Oth	Other neutral quotes that are relevant for drafting a narrative. Other neutral quotes that are relevant to the research. Other relevant quotes about the SCC.	"[I talk about the SCC] with my parents and sometimes with friends." "[I prefer the 'vwo'], because I think I can do it, but don't show it now." "I chose N&T at this school. I hope I can transfer to another school where I have registered and there, I've chosen a different subject cluster. "

Results

In this chapter, all constructed narratives are discussed and substantiated with quotes. For each student, a timeline is created to visualize the narrative, as shown in Figure 3. The timeline depicts reported events and motivation, categorized as either controlled or autonomous, based on the corresponding quotes.

The events (circles with code category abbreviation) refer to experiences students discussed during the interviews, which may have influenced their motivation.

Additionally, events where information was provided (li or lf) or gathered could either broaden or limit the available options for students. For example, hearing that grades aren't sufficient to choose the preferred subject cluster is a limiting event. On the other hand, searching on the internet and finding new interesting jobs is a broadening event. These distinctions are shown in the timeline by a plus (+) for broadening and a minus (-) for limiting.

Alongside the timeline, the constructed narratives are provided. These are underpinned with quotes, provided in a Quotebox.

Student A

At first, this student experienced pressure from their parents to choose an N&T cluster, while they were not autonomously motivated to choose it. Their parents said that if their grades are good enough, and they do not know what to choose, they should go for N&T, since that gives the most possibilities in the future. The student seems to agree but shows mostly controlled motivation for this cluster. (Quotebox A1)

After the first interview, student A realized their friends probably will not continue to the next grade, because of their academic performance.

Student A started looking for alternatives and found a school where other

A1

"Because I don't do much right now and still get good grades, my parents want me to choose Wiskunde B"

"Because I rarely study [for tests] and still get good grades it is wasteful to choose Wiskunde A."

A2

"Because all my friends are leaving the class. At [another school] I have other friends, whose class I'll join."

"It was mostly because I wanted to look into other schools. My mom told me to look into what cluster I would want there."

friends go to. At that point, the student's parents tell them to choose a subject cluster for that school if they want to transfer. (Quotebox A2)

This school offers a wider range of subjects, including computer science and business economics. These subjects were found to be more interesting. At this point autonomous motivation became the most present type of motivation in the student. Also, a more autonomy supportive parenting style was reported, possibly because the student made a thought-out decision. (Quotebox A3)

A3

"Just look on their website at the subject clusters and just look through the options."

"Yes, I like the cluster in the other school way better. And that is something that I think I will use in my future. "

After the second interview, the father of the student offered to start a company together after they finish their higher education. This seemed to stabilize the autonomous motivation more. (Quotebox A4)

A4

"[My father] wants to start a new company with me in the future. That's why I've chosen business economics, because you'll know about that stuff."

Student B

At an early age, student B had an experience where they could look in the airplane's cockpit while flying. This led to them wanting to become a pilot. To be able to start the training for pilots you need physics in high school. At the current school it is mandatory to take Wiskunde B (science-oriented math) if you take physics. However, student B does not want to take Wiskunde B as they think it is too difficult for them. (Quotebox B1)

B1

"On the way back [from holiday] to the Netherlands, I was allowed into the cockpit with my mother and [the pilot] was Dutch, and they spent two hours telling me about the cockpit and everything and that's where my interest came from. I liked it."

At this point student B looks for alternatives and finds a school where physics and Wiskunde A (economics-oriented math) can be chosen together. Also, the student reports that there are more friends in that school and that they think the test system (the number of tests and intervals between them) is better. At first their parents tell them they do not think it is a clever idea to go to that school, because there will be too many friends. (Quotebox B2)

B2

"My mother doesn't think it's a smart idea for me to go to that other school. She says because you have few friends here and things are going so badly, it doesn't seem wise to go there, because there you have even more friends, you know everyone and you will have an even more fun time."

Later in the year, student B realizes their grades are not good enough to continue to the next grade. At this point their motivation changes from identified to externally regulated. Their outlook on their future changes drastically and there is little to no mention of their dream to become a pilot anymore. They even downplayed the job, mentioning the pay will not be as good and it will be less fun since everything will be automated in the future and listing these external factors as reasons not to pursue their dream anymore. (Quotebox B3)

B3

"[I may not want to be a pilot anymore, because] it's all being automated now. So, either it is no longer necessary or you will earn less."

Between the second and third interview student B had another experience. This time through a subject where they had to look for sponsors. Student B enjoyed this because they are good at it. They decided to want to go into sales, making choices based on this, like choosing German over French because more trade is with Germany than France. (Quotebox B4)

B4

"[We had to] get sponsors. And I was pretty good at it."

"I chose German because I might want to do something in sales and then you don't often go to France but more to Germany and Austria. Yeah, I thought this is a smart thing to have."

Student C

Student C demonstrates strong autonomous motivation. Before the first interview, they looked up career perspectives and selected the one they liked the most. They report selecting certain subjects for the sole reason to become a paediatrician, hence the autonomous motivation. (Quotebox C1)

C1

"[I became a pediatrician because] I had looked up what professions there were and then which ones I liked best."

"The profession I want to do requires medicine and that is why I want to do [medicine], because I would like to become a pediatrician."

Later the student reports that their parents want them to be happy and have a good future. Even though through school they find out that this cluster will bring a lot of stress with it, their motivation does not change, and their intrinsic motivation even becomes more apparent. They also look up information on what cluster is needed for the study they want to do. (Quotebox C2)

C2

"[The career guidance software] says that if you choose [N&T], you have to deal with stress well."

In the third interview the student reported that they had heard from two sources that the cluster they want to do will be stressful. One source is through 10th grade students, saying that it is stressful, but worth it. The other source is social media (TikTok), where it is said the cluster is too stressful and one should not choose it. Still, the type of motivation this student shows does not change: intrinsic and identified motivation are still most prevalent. The student said that even though they take this stress factor into account, they would not want to make a decision they would regret later: in this case not choosing the N&T/N&G combined cluster. (Quotebox C3)

C3

"People in the fourth year say [that it's tough], but [doable]. Not that they say I shouldn't do it, because I won't regret it."

"[On TikTok] they said, don't do it and you're really going to regret it and all that."

"I think if I didn't do [N&T] I would regret it."

After this, the student reported having an enriching experience. They got a concussion and had to go to the hospital. They said they like going to the hospital and enjoy being there. They also report they like helping children. (Quotebox C4)

C4

"I'm just very clumsy and that means I end up in the emergency room very often. I quite enjoy being there. Two weeks ago, I had a concussion, I was also in the hospital, I just really enjoyed being there. And I also want to help children"

Student D

Student D's parents are very autonomy supportive, allowing them to choose freely, but also helping them make their decision when there is doubt and bringing the SCC up in conversation. The student shows identified motivation, which is still stable even though the grades at the start of the year are not sufficient to make it to the next year. They want to study something in healthcare because they are interested in biology. (Quotebox D1)

D1

"Well, my parents and I just talk about it sometimes and yes, I don't know so much, I'm just free in my choice, but if I have a problem with something or if I have doubts about something then, sort of, we can talk about that."

Even though the parents support autonomy, they do advise their child to not choose the N&G cluster if their grades are bad, which is said in such a manner it is believed to be pressuring the student. However,

D2

"If I were to stand all fours and so or fives, then yes, [my parents] would probably say: yes, you know, not very useful [to choose N&G]."

"I just looked up a bit on Google of things that I currently have in mind, what profession can you become if you choose this, and then see if that seemed fun to me."

their grades have improved. Also, the student has looked up information on what study they could do after secondary school. (Quotebox D2)

This student also reported that they are afraid of stress since they are a high performing athlete. They are still doubting their choice since they do not know how intense the next years of secondary school will be. They are considering the possibility that they will have to stop with their sport to focus on school, which they do not want. (Quotebox D3)

In the third interview the student reports that their parents will support their decision no matter what they choose. (Quotebox D4)

D3

"I don't want the pressure to be too high. [That pressure comes from] school and sports, but I don't want to stop playing sports."

"[I'm unsure about the choice] because [I think] N&G is going to be a challenge. I don't necessarily find chemistry super easy and I think biology is also a lot of material to learn."

D4

"Yes [my parents] would also support it if I did E&M, or whatever, if I want to do it then I can do it."

Categorization

The categorization of three of the four students was revised later based on the results from the interviews and shown in table 7. Note that these changes can either be due to new information that is learned in the interviews that contradict findings from the preliminary interviews or because the situation of the student has changed (longitudinal information). They are not necessarily an indication of the validity of the preliminary interviews. This is briefly explained below.

Student A has reported parental pressure for STEM in the preliminary interviews, which was confirmed in the main interviews, however, this pressure has changed to a more autonomously supportive perceived parental style. Student B experiences parental pressure to choose for STEM through several occasions. At the end of the year, they explain they maybe want to become a dentist, because their father is one. This is denoted as pressure. Student C reported pressure for alternatives, but throughout the interviews this perceived pressure did not seem to be present (anymore).

Student D was categorized correctly in the preliminary interviews.

Table 7

Revised categorization of the participating students.

	AM for STEM	AM for alternative
Direct parental pressure to choose STEM subjects	Student B	Student B Student A
Direct parental pressure to choose alternative	Student C	
Autonomous supportive parenting style	Student C Student D	Student A

Quantification

Even though the research is qualitative, the number of quotes in each category was counted to gain insight into what students talk about most. Table 8 shows the categories and the total amount of quotes in the corresponding category.

As can be seen, autonomous motivation is fairly present in the interviewed students, which is underpinned by the quotes and timeline presented in the results. Still, there is controlled motivation present. The size of the categories are similar, with a notably larger amount of informal information quotes (25% larger than mean Event categories). Lastly, the ‘Other’ category contains 21% of all quotes.

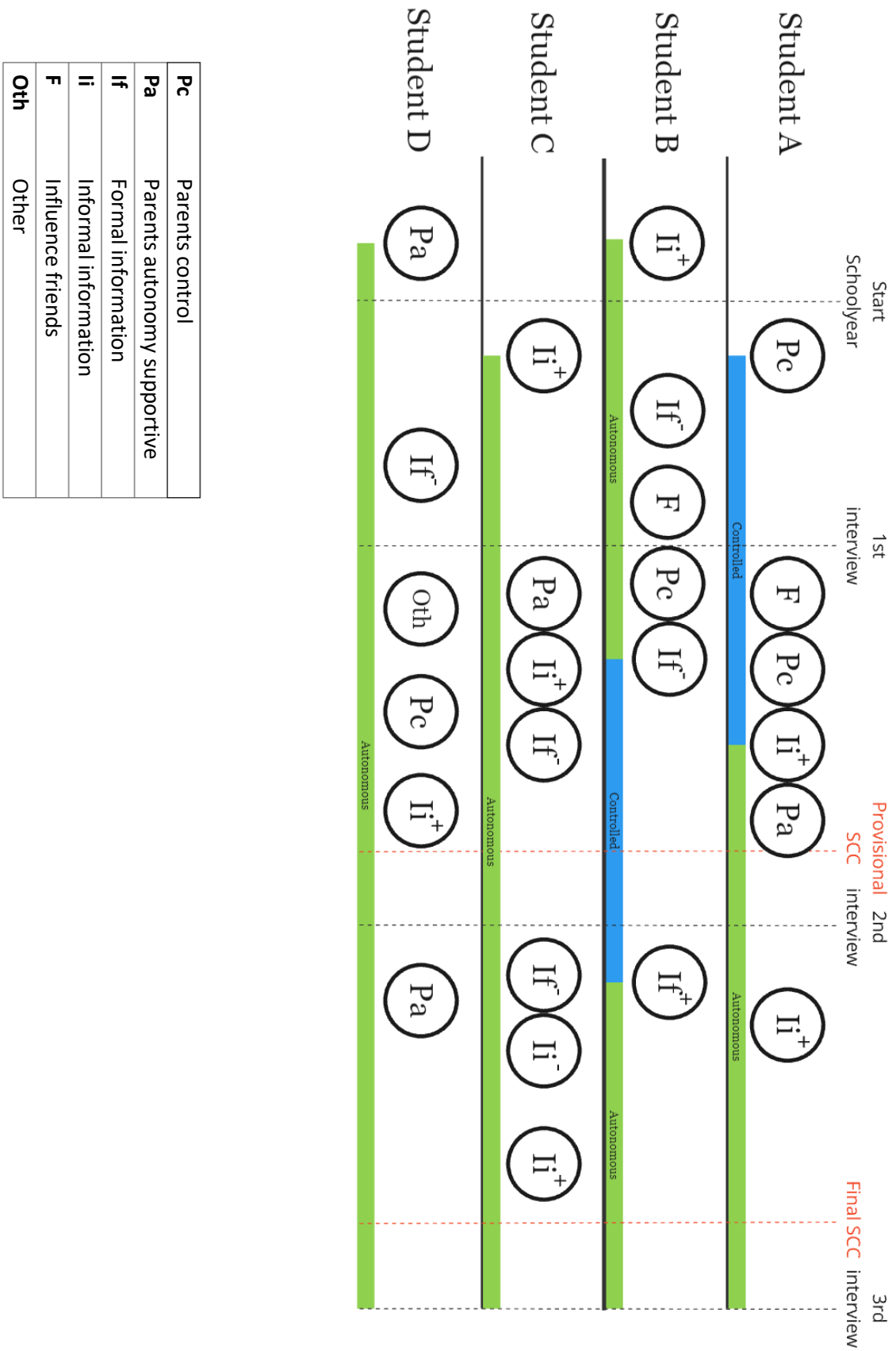
Table 5

Most important questions from the main interview.

Category	Number of quotes
Parents control	13
Parents autonomy supportive	13
Formal information	13
Informal information	18
Influence friends	15
Autonomous preference	64
Controlled preference	26
Other	43
<i>Total</i>	205

Figure 3

Timelines of the SCC process of all students showing events (circles) and motivation type: controlled (blue) or autonomous (green). The abbreviations are explained in the legend.



Pc	Parents control
Pa	Parents autonomy supportive
If	Formal information
Ii	Informal information
F	Influence friends
Oth	Other

Discussion and conclusions

This chapter will discuss the research questions in detail, answering them as completely as possible.

Furthermore, limitations in this study, possible future research, main conclusions and recommendations are addressed.

The previously posed research questions are as follows:

- SQ1: How do students describe their decision-making process regarding the SCC?
- SQ2: Which determinants do students consider significant regarding their SCC?
- SQ3: What do students report on the influence of parental pressure during the SCC decision-making process?
- RQ: What is the influence of different determinants on Dutch 9th grade students' decision-making process when selecting a Subject Cluster?

The process

Students report mainly to talk about the SCC with their social environment, from which mainly parents are avid discussion partners. Often, students talk with parents about what they should choose, engaging in discussions about what they would find interesting, what possibilities there are with certain subject clusters and what future careers could be interesting. Peers are important to the decision-making process to a lesser extent, as the discussions stay more superficial.

If a student is autonomously motivated, they come to a decision by focussing on the future career and working their way back to what subject cluster is needed for that career. When controlled motivation is present, the student does not look at future careers.

Interestingly, the students' decision-making process seems to be an ongoing process. Even when students reported having made a choice on what subject cluster they wish to choose, they still engage in their social environment about the SCC. All of them also continued to look up information on their own accord to either change or strengthen their choice.

Determinants

From research it is known that parents, peers and the school are important determinants in a student's SCC, which is also seen in the results of this study. However, not all three are present in a similar fashion or magnitude. Besides these three, students reported future career possibilities to be important to determining their preferred subject cluster.

Parents are reported to be of importance in all four students, as the students seem to want to choose something their parents will be proud of. Still, this could be autonomy-supportive or controlled. Even when parents weren't as present during the SCC (student C), they do report the one instance where their parents were present in the process.

Peers are not direct influences on the SCC, as all students reported not choosing a subject cluster because of what friends choose. However, two out of four students report wanting to still share some subjects with friends. One even reports wanting to change schools so they could be with friends. These choices can have an indirect influence on the SCC; hence they are deemed significant determinants.

The school is not reported by students to be a big determinant. There is little guidance or counselling provided besides the general introductory talk. However, there is use of a career guidance software, but the impact seems small as three out of four students did not complete it, filled in nonsensical answers or did not agree with the results. This lack of motivation might be due to a lessened personal engagement. Students report spending more time on the SCC by talking to their social environment than any other way of gathering information.

Furthermore, most school-organized information events were constraining ones, for example informing a student of their insufficient grades. This was not directly reported as a big determinant, but through data analysis it can be concluded limiting events did have influence on possible future career paths and motivation, which influences the SCC and this considered a significant determinant. Nevertheless, this is probably different per school and might not be the usual manner of operation

for schools (empirically it can be said this school does not provide many possibly broadening information events).

Lastly, it is crucial to mention that all students that display autonomous motivation for a certain subject cluster, at some point reported choosing that cluster because it was important for their intended future job.

Parental Pressure

Three out of four students in this study report, at some point in the process, parental pressure to choose a certain cluster. It is likely that any student, somewhere in their process, experiences a kind of pressure from their parents. It is important to note however, that this is reported pressure from the students. So, it might be possible that some parents do not realise that their child is perceiving their helpfulness as pressure.

Students reported the parenting style changing after their own displayed motivation had changed. It seems likely that the perceived parenting style correlates with the shown motivation type of the child. This could either be because the student experiences the same 'pressure' differently, or because the parents changed their manner of acting. One student did report on their parents' involvement, describing it with two different wordings, showing that, for at least this student, the latter is true.

Moreover, it seems that a perceived controlling parenting style can put a student in a more passive state where they are less motivated to look for possibilities regarding their SCC. Hence creating a stalemate where the student is less likely to find new information, so their motivation does not change and the perceived parenting style not changing as well. This is an unideal situation as more autonomous motivation increases well-being and academic performance (Ayub, 2010).

Influence of determinants

Most interestingly, motivation seems to change when students are given or find new information about their SCC or related (for example their grades). The results show that if a student displays

controlled motivation, an option broadening information event is likely to allow the student to adopt a more autonomous form of motivation. This is not necessarily true the other way around, an autonomous form of motivation is shown to be more stable than controlled motivation, which improves academic performance and well-being over a longer period of time. However, as seen with student B, a larger number of limiting information events can alter motivation from autonomous to controlled. Furthermore, students displaying more autonomous motivation seem to have more perseverance than students displaying a controlled motivation.

Parents and students have an interesting interaction when it comes to motivation and parenting styles. Autonomous motivation from the student seems to go hand in hand with an autonomous parenting style and vice-versa: controlled motivation is apparent at the same time as a controlling parenting style. Either parents control the students' motivation type by their parenting style, or parents adapt their parenting style according to the most prevalent type of motivation.

Peers do not influence the SCC directly, but two out of four students at some point reported making a decision to change schools because they would have classes with friends. One student (student A) found out other subjects were available at the other school. These subjects seemed more interesting to the student and resulted in a change of motivation to more autonomous and reported future career prospects after this information event (which they did not mention before).

Limitations

This study has been conducted with only four students, greatly limiting the extent to which the results can be compared to a larger group. The results should not be taken as truth, rather as a direction for further research. By only interviewing four students an in-depth analysis of individual student's thought process could be conducted, giving insight into the mechanisms at play in an important choice in a student's life, on which topic there is still little research available.

Also, this study has been conducted in a school in an urban area of the Netherlands, known for being super-diverse. This means there might be cultural or socio-economic differences between the four

students, which can affect their perception of parental pressure, importance of status or wealth, and importance of educational success. These did not lie in the scope of this research and have not been considered in the data collection, however, they may introduce confounding variables.

Additionally, by joining the research, students are provided with more moments in time where they discuss their SCC. This might have influenced their decision-making process. In other words: the interviews may have constituted an intervention. However, the students indicated discussing the SCC with many other people, so the impact of this intervention may be limited.

Finally, this research has been conducted at the school where the researcher works as a teacher. The researcher does not teach the 9th grade but does teach the 10th. Even though it was stated in every interview that the results would not influence any future interactions, it might be possible that some socially desirable answers were given.

Further research

These results give a baseline for future research. Now that it has become more clear how students think about the SCC and how their decision-making process works, more directed research can be conducted with a more concise direction. It would be interesting to know how the determinants can influence the motivation type that is most present in the student. Also, this study could be upscaled now that more directly aimed questions can be formed based on this research.

Furthermore, parental pressure during the SCC could be delved into more. Researching how to recognize it quickly in the context of the SCC could help deans motivating students to make choices based on their autonomous motivation.

Lastly, it would be interesting to dig deeper into the effect of these information events. How they change students' motivation when they do or do not and why it changes.

Main conclusions

Decision-making process

The decision-making process of the students included in the study is continuous, even when students reported to have decided. Students reach this decision by gathering information about what subject cluster is needed for a certain job, talking with parents about their decision and to lesser extent talking with peers. With peers, conversations are mostly focussed on what they want to choose, compared to parents, with whom they talk about how to make the choice.

Determinants

Students report parents and future career prospects to be of significant influence on the SCC. Parents are important, because of the guidance they offer. To lesser extent friends are significant, with some reports on choosing subjects to follow with friends, as well as deciding to change schools to be in a class with friends, become an indirect influence on the SCC. The school environment is reported to be less significant. This is possibly due to the type of guidance (or lack thereof) this particular school offers.

Parental pressure

Most students report some form of parental pressure during the process; however, the extent of this perceived pressure can differ between students. In this study this ranged from parents advising to not choose a specific cluster based on grades to parents telling a student to pick a specific cluster because the student does not know what to choose.

Influence of determinants

Parenting styles align with students' motivation type; autonomous motivation correlates with an autonomy-supportive parenting style, and controlled motivation correlates with a controlling parenting style.

Motivation type seems to influence the students' decision-making process, as a student showing controlled motivation seems less interested in finding new information, staying in a passive state.

New information, gathered through school or otherwise, can broaden or limit the options a student has (e.g. insufficient grades, finding an interesting career prospective online). These events can influence the type of motivation a student shows, limiting events causing more controlled motivation and broadening events causing more autonomous motivation. However, autonomous motivation seems to be more stable than controlled motivation, wavering less when an AM student is met with limiting events, compared to a CM student who is met with broadening events. This is underpinned by Vansteenkiste et al., reporting that framing intrinsic goals increased perseverance (2004).

Recommendations

After conducting this research, I would recommend schools and parents to stay diligent about their influence on students in their SCC-process as this is an important moment in students' lives, which can influence the rest of their lives. A more autonomous choice process can be reached if parents are aware of their potentially pressuring behaviour, even when they do not mean to, as well as schools keeping involved in the process. It is shown that broadening information events (expanding the options or perceived options) help nurture autonomous motivation in students, so it would be desirable if these moments are introduced by the school, preferably in other ways than study guidance software. A personal touch seems to work well with students, as a big part of the process is talking about the SCC with their parents and friends.

If it is not possible to achieve this with all students, an advice would be to avoid "limiting information events" (events where students' options are being limited) and provide accompanying broadening information events if limiting events are insurmountable. For example, if a student's grades are insufficient, discussing this with the student and look for other possibilities or to make a plan on how to increase the grades to still be able to choose a specific cluster, while trying to keep the autonomous motivation most present in the student.

References

- 123studiekeuze.nl. (2024a). *Van profiel naar studie havo-hbo*. <https://www.studiekeuze123.nl/van-profiel-naar-studie/pdf?priorEducation=Havo&type=Hbo&occupation=Voltijd>
- 123studiekeuze.nl. (2024b). *Van profiel naar studie vwo-hbo*. <https://www.studiekeuze123.nl/van-profiel-naar-studie/pdf?priorEducation=Vwo&type=Hbo&occupation=Voltijd>
- 123studiekeuze.nl. (2024c). *Van profiel naar studie vwo-wo*. <https://www.studiekeuze123.nl/van-profiel-naar-studie/pdf?priorEducation=Vwo&type=Wo&occupation=Voltijd>
- Ahn, J. N., Luna-Lucero, M., Lamnina, M., Nightingale, M., Novak, D., & Lin-Siegler, X. (2016). Motivating Students' STEM Learning Using Biographical Information. *International Journal of Designs for Learning*, 7(1). <https://doi.org/10.14434/ijdl.v7i1.19409>
- Ayub, N. (2010). Effect of Intrinsic and Extrinsic Motivation on Academic Performance. *Pakistan Business Review*, 12, 363–372.
- Barber, B. K. (1996). Parental Psychological Control: Revisiting a Neglected Construct. *Child Development*, 67(6), 3296–3319. <https://doi.org/10.2307/1131780>
- Barber, B. K., Olsen, J. E., & Shagle, S. C. (1994). Associations between Parental Psychological and Behavioral Control and Youth Internalized and Externalized Behaviors. *Child Development*, 65(4), 1120–1136. <https://doi.org/10.2307/1131309>
- Berkhout, E., Volkerink, M., & Bisschop, P. (2013). *Technici: mobiel en toch honkvast - The outflow of employees from the engineering and technology sector*. <https://dare.uva.nl>
- Briggs, C., Atherton, A., Gill, J., Langdon, R., Rutovitz, J., & Nagrath, K. (2022). Building a 'Fair and Fast' energy transition? Renewable energy employment, skill shortages and social license in regional areas. *Renewable and Sustainable Energy Transition*, 2, 100039. <https://doi.org/10.1016/J.RSET.2022.100039>
- Casanova, J. R., Vasconcelos, R., Bernardo, A. B., & Almeida, L. S. (2021). University dropout in engineering: Motives and student trajectories. *Psicothema*, 33(4), 595–601. <https://doi.org/10.7334/psicothema2020.363>
- Crul, M., Schneider, Jens., Lelie, Frans., & Gerritsen, R. (2013). *Superdiversiteit : een nieuwe visie op integratie*.
- de Jong, P. (2024, February 7). *Goed nieuws: het stroomnet is vol?! Natuur & Milieu*. <https://natuurenmilieu.nl/themas/energie/energietransitie/goed-nieuws-het-stroomnet-is-vol/>
- deCharms, R. (1968). *Personal Causation: The internal affective determinants of behavior*. Academic Press.
- Dekker, R., Masson, E., de Jong, R., & Van Est, R. (2022). *Stroom van Data*.
- Dierckx de Casterle, B., Gastmans, C., Bryon, E., & Denier, Y. (2012). QUAGOL: A guide for qualitative data analysis. *International Journal of Nursing Studies*, 49(3), 360–371. <https://doi.org/10.1016/j.ijnurstu.2011.09.012>
- Froiland, J. M. (2015). Parents' Weekly Descriptions of Autonomy Supportive Communication: Promoting Children's Motivation to Learn and Positive Emotions. *Journal of Child and Family Studies*, 24(1), 117–126. <https://doi.org/10.1007/s10826-013-9819-x>

- Froiland, J. M., Oros, E., Smith, L., & Hirchert, T. (2012). *Intrinsic Motivation to Learn: The Nexus between Psychological Health and Academic Success*.
<https://doi.org/10.1007/BF03340978>
- Grolnick, W. S., & Pomerantz, E. M. (2009). Issues and Challenges in Studying Parental Control: Toward a New Conceptualization. *Child Development Perspectives*, 3, 165–170.
<https://doi.org/10.1111/j.1750-8606.2009.00099.x>
- Guo, L., Huang, J., & Zhang, Y. (2019). Education Development in China: Education Return, Quality, and Equity. *Sustainability 2019*, Vol. 11, Page 3750, 11(13), 3750.
<https://doi.org/10.3390/SU11133750>
- Institute of Educational Sciences. (2017). *Reviewer Guidance for Use with the Procedures Handbook (version 4.0) and Standards Handbooks (version 4.0)*.
https://ies.ed.gov/ncee/WWC/Docs/ReferenceResources/wwc_reviewer_guidance_103017.pdf
- Korpershoek, H. (Hanke). (2011). *Search for science talent in the Netherlands*. University of Groningen.
- Kröner, J., Goussios, C., Schaitz, C., Streb, J., & Sosic-Vasic, Z. (2017). The construct validity of the German academic Self-Regulation Questionnaire (SRQ-A) within primary and secondary school children. *Frontiers in Psychology*, 8(JUN). <https://doi.org/10.3389/fpsyg.2017.01032>
- KTPO. (2009). *[Increasing 1,250 student places in basic vocational education for organizing permits starting on 1 January 2010]*.
- Langen, A. van, & Vierke, H. (2009). *Wat bepaalt de keuze voor een natuurprofiel?* ITS.
- M&E Education. (2023). *Required and elective subjects in U.S. high schools*. M&E Education.
<https://maeducationusa.com/en/required-and-elective-subjects-in-u-s-high-schools/#:~:text=One%20of%20the%20major%20attractions,during%20their%20after%20school%20hours.>
- Messerer, L. A. S., Karst, K., & Janke, S. (2023). Choose wisely: intrinsic motivation for enrollment is associated with ongoing intrinsic learning motivation, study success and dropout. *Studies in Higher Education*, 48(1), 137–150. <https://doi.org/10.1080/03075079.2022.2121814>
- Ministerie van OCW. (2024a). *Hoe zit de havo in elkaar?* Rijksoverheid.
<https://www.rijksoverheid.nl/onderwerpen/voortgezet-onderwijs/vraag-en-antwoord/hoe-zit-de-havo-in-elkaar>
- Ministerie van OCW. (2024b). *Hoe zit het vwo in elkaar?* Rijksoverheid.
<https://www.rijksoverheid.nl/onderwerpen/voortgezet-onderwijs/vraag-en-antwoord/hoe-zit-het-vwo-in-elkaar>
- OECD. (2017). *Skills Strategy Diagnostic Report Netherlands*. www.oecd.org/edu/educationtoday
- ROA. (2019). *De arbeidsmarkt naar opleiding en beroep tot 2024*.
- Ryan, R. M., & Deci, E. L. (1985). Self-Determination Theory and the Facilitation of Intrinsic Motivation, Social Development, and Well-Being Self-Determination Theory. *American Psychologist*, 55(1), 68–78. <https://doi.org/10.1037//0003-066X.55.1.68>

- Ryan, R. M., & Deci, E. L. (2000). Intrinsic and Extrinsic Motivations: Classic Definitions and New Directions. *Contemporary Educational Psychology*, 25(1), 54–67. <https://doi.org/10.1006/ceps.1999.1020>
- Schaefer, E. S. (1965). Children's Reports of Parental Behavior: An Inventory. *Child Development*, 36(2), 413–424.
- Skinner, B. F. (1965). *Science and human behaviour* (92904th ed.). Simon and Schuster.
- SLO. (2023). *havo/vwo Profielen*. <https://www.slo.nl/sectoren/havo-vwo/profielen/>
- TechniekPact. (2023). *Monitor Techniekpact*. <https://www.techniekpact.nl/monitor-techniekpact/monitor/havovwo>
- van Cappellen, L., Groenewegen, H., & Nauta, M. (2023). *Thuisbatterijen in de energietransitie*. https://ce.nl/wp-content/uploads/2023/11/CE_Delft_220408_Thuisbatterijen-in-de-energietransitie_Def.pdf
- van den Hurk, A., Meelissen, M., & van Langen, A. (2019). Interventions in education to prevent STEM pipeline leakage. *International Journal of Science Education*, 41(2), 150–164. <https://doi.org/10.1080/09500693.2018.1540897>
- Vansteenkiste, M., Sierens, E., Soenens, B., Luyckx, K., & Lens, W. (2009). Motivational Profiles From a Self-Determination Perspective: The Quality of Motivation Matters. *Journal of Educational Psychology*, 101(3), 671–688. <https://doi.org/10.1037/a0015083>
- Vansteenkiste, M., Simons, J., Soenens, B., & Lens, W. (2004). How to become a persevering exerciser? Providing a clear, future intrinsic goal in an autonomy-supportive way. *Journal of Sport and Exercise Psychology*, 26(2), 232–249. <https://doi.org/10.1123/jsep.26.2.232>
- Vertovec, S. (2007). Super-diversity and its implications. *Ethnic and Racial Studies*, 30(6), 1024–1054. <https://doi.org/10.1080/01419870701599465>
- Wang, X. (2003). *Education in China Since 1976* (1st ed.). McFarland & Company Inc. https://books.google.nl/books?hl=en&lr=&id=8qd7pask21IC&oi=fnd&pg=PP11&dq=china+educational+system&ots=ZVQfi7t-Yt&sig=Ou-PAYfjMThF5MiUotCd-NGm_cw#v=onepage&q=china%20educational%20system&f=false
- Wietsma, T. (2023). *De Profielkeuze van Vmbo-tl leerlingen* [Master thesis, Rijksuniversiteit Groningen]. <https://gmwpublic.studenttheses.ub.rug.nl/2024/1/Definitieve%20thesis%20profielkeuze%20vmbo-tl%20leerlingen%20-%20Tjarda%20Wietsma%20-%20S2550199.pdf>
- Xue, Y. (2014). *STEM Crisis or STEM Surplus?* MIT.
- Zekaria, Y., & Chitchyan, R. (2019). Exploring future skills shortage in the transition to localized and low-carbon energy systems. *CEUR Workshop Proceedings*, 2382.

Appendix A – Preliminary interview scheme

Introduction

In case you have forgotten: my name is [interviewer's name]. What is yours? And the first two letters of your last name?

I'm writing down the first two letters of your first and last name, so that I might retrace these answers to you, if I'd want to ask you to continue the study. The answers to these questions will only be read by the research team and not be shared with anyone in- or outside the school. I pseudonymize your name, so in case any data leaks, it will not be traced back to you. Any answers you give will not influence any further interactions we might have in the future. After I have gotten the people needed for the interviews, all your info will be redacted.

If you don't feel comfortable answering a question, you are free to not answer it. Lastly, if after this interview you are reconsidering participating, you can let me, or your mentor know, and I'll delete all info and answers.

Questions

1. What subjects do you find enjoyable/interesting?
2. Which subject do you enjoy the most? Why?
3. What subjects do you deem important for your future?
4. What subjects do your parents think are important?
5. Do you think you'll choose [subject question 2] in your subject cluster? If not, why?

Appendix B – Main interview scheme

Before final SCC

Time	Questions and area of interest	Type
0' – 1' (1')	<p>“Do you agree with this interview being recorded?”</p> <p>“First of all, thank you for making time for this. Everything you say during this interview will not be shared with anyone in- or outside the school, without your name and other info being anonymized before. This interview will not have influence on any future interactions we might have, for example if I become your teacher next year. If during the interview you do not want to answer a question, you are free to do so. Lastly, if during this interview or any future point during the research process you reconsider your participation, you can tell me or your mentor and all your data will be deleted.”</p>	Introduction
1' – 2' (1')	<p>Introducing the research</p> <p>“As you might remember, I’m doing research on how students make their subject cluster choice and what influences play a part in that. Today we will discuss for about 15 minutes about your SCC.”</p>	Introduction/warm-up
2' – 4' (2')	<p>How is it going with your SCC?</p> <p>Have you made a decision already?</p> <p><i>The answer should give insight to where in the process the student is.</i></p>	Warm-up
4' – 6' (2')	<p>What have you done up to this point to make the SCC?</p> <p>Why did you do this?</p> <p><i>This question should give insight to what processes the student has gone through or is going through at this point.</i></p> <p><i>It's possible to ask about their parents' role (this does come back later)</i></p>	Key question
6' – 8' (2')	<p>What are you planning on doing in the coming two months regarding your SCC?</p> <p>Why?</p> <p>Can you give an example?</p> <p><i>This question should give insight to what the student is planning to do.</i></p>	Key question
8' – 11' (3')	<p>Who do you talk with about your SCC?</p> <p>Can you give an example?</p> <p><i>This should give insight into influences.</i></p>	Key question

11' – 14' (3')	<p>Do you talk with your parents about your SCC?</p> <p><i>If in the last question parents aren't mentioned.</i></p> <p><i>Follow-up with <u>"What do you talk about?"</u></i></p> <p><i>If possible, follow up with <u>"Do your parents want you to choose a specific cluster?"</u></i></p> <p><i>This can be a sensitive question, pay attention to body language. To comfort the student a question could be asked about other influences: <u>"Do your friends think you should choose a specific cluster?"</u></i></p>	Key question
14' – 15' (1')	<p>Is there anything else you would like to mention?</p> <p><i>Within the recording.</i></p>	Debrief
15' – 16' (1')	<p>"Thanks again for making time for this. For repetition, information will not be shared without being anonymized first. And if you wish to stop participation, you can always tell me or your mentor.</p> <p>Outside of recording: "Is there anything you would like to share outside of the recording?"</p>	Debrief

After final SCC

Time	Questions and area of interest	Type
0' – 1' (1')	<p>"Do you agree with this interview being recorded?"</p> <p>"First of all, thank you for making time for this. Everything you say during this interview will not be shared with anyone in- or outside the school, without your name and other info being anonymized before. This interview will not have influence on any future interactions we might have, for example if I become your teacher next year. If during the interview you do not want to answer a question, you are free to do so. Lastly, if during this interview or any future point during the research process you reconsider your participation, you can tell me or your mentor and all your data will be deleted."</p>	Introduction
1' – 2' (1')	<p>Introducing the research</p> <p>"As you might remember, I'm doing research on how students make their subject cluster choice and what influences play a part in that. Today we will discuss for about 15 minutes about your SCC."</p>	Introduction/warm-up
2' – 4' (2')	<p>How is it going with your SCC?</p> <p>Have you made a decision already?</p> <p><i>The answer should give insight to where in the process the student is.</i></p>	Warm-up

4' – 6' (2')	<p>What have you done up to this point to make the SCC? Why did you do this?</p> <p><i>This question should give insight to what processes the student has gone through or is going through at this point. It's possible to ask about their parents' role (this does come back later)</i></p>	Key question
6' – 8' (2')	<p>Who have you talked with about your SCC?</p> <p><i>Ask <u>why/why not</u>.</i></p>	Key question
8' – 11' (3')	<p>What do the people around you think about your SCC?</p>	Key question
11' – 14' (3')	<p>What do your parents think about your SCC?</p> <p><i>If in the last question parents are not mentioned, ask this question. Ask why.</i></p> <p><i>Caution: could be a sensitive question.</i></p>	Key question
14' – 15' (1')	<p>Is there anything else you would like to mention?</p> <p><i>Within the recording.</i></p>	Debrief
15' – 16' (1')	<p>“Thanks again for making time for this. For repetition, information will not be shared without being anonymized first. And if you wish to stop participation, you can always tell me or your mentor.</p> <p>Outside of recording: “Is there anything you would like to share outside of the recording?”</p>	Debrief