Eva Lykkegaard conducted this work as part of her PhD study at Centre for Science Education at the University of Aarhus in Denmark. Her dissertation was a longitudinal study of STEM oriented upper secondary school students' ongoing educational choice processes. Using mixed methods her research focused on critical moments in students' choice processes, that changes their educational trajectories and in addition the students' perceived match between scientists and science students and their own identities.

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Role model and prototype matching: Upper-secondary school students' meetings with tertiary STEM students

Abstract

Previous research has found that young people's prototypes of science students and scientists affect their inclination to choose tertiary STEM programs (Science, Technology, Engineering and Mathematics). Consequently, many recruitment initiatives include role models to challenge these prototypes. The present study followed 15 STEM-oriented upper-secondary school students from university-distant backgrounds during and after their participation in an 18-months long university-based recruitment and outreach project involving tertiary STEM students as role models. The analysis focusses on how the students' meetings with the role models affected their thoughts concerning STEM students and attending university. The regular self-to-prototype matching process was shown in real-life role-models meetings to be extended to a more complex three-way matching process between students' self-perceptions, prototype images and situation-specific conceptions of role models. Furthermore, the study underlined the positive effect of prolonged role-model contact, the importance of using several role models and that traditional school subjects catered more resistant prototype images than unfamiliar ones did.

INTRODUCTION

The past couple of decades, concerns about the participation in science, technology, engineering and mathematics (STEM) have been endemic in the Western World (European Commission, 2004) and have sparked a substantial amount of research and development activities. This has led to an increased focus on the role that potential identities related to STEM disciplines play in students' choice of study and therefore also on how young people conceive what a science student is like (Archer et al.,

2010; Schreiner & Sjøberg, 2007). Students' choice processes and their conceptions of science students build on their prior experiences with the field of science as well as what they expect a possible future study and career in STEM to be like (Holmegaard, Madsen, & Ulriksen, 2014).

The students' experiences with science teaching affect their attitudes to science (Osborne, Simon, & Collins, 2003; Taconis & Kessels, 2009), and based on an analysis of the physics curriculum in the Danish upper-secondary school, Krogh (2006) points at the void between the values of the young people and the values expressed in the content of the curriculum as well as in the teaching and learning activities students are engaged in.

Students who do not have parents or other close relatives or acquaintances studying or working within STEM have to build their expectations about studying STEM and following a STEM career on culturally available ideas about what science and scientists are like. Previous studies have found that science tend to be conceived as gendered (being for men rather than for women (cf. Archer et al. (2012) for further references)), classed and racialized (being for whites and the middleclass (Archer, Dewitt, & Osborne, 2015; Carlone & Johnson, 2007)). When students consider which study to pursue they also consider what identities are available in a particular disciplinary culture and context, how these imaginable identities fit with their conceptions of who they are and who they wish to become, and whether pursuing this line of study proposes an attractive and realistic identity development (Holmegaard, 2015).

This identity focus as well as previous studies addressing how scientists are generally conceived (Andersen, Krogh, & Lykkegaard, 2014) has made targeted recruitment projects using STEM role models popular (Andree & Hansson, 2013; Henriksen, Jensen, & Sjaastad, 2014). The tacit assumption behind these recruitment projects is that interaction with role models will make students experience attractive STEM-related identities and thus make them more inclined to choosing a STEM program. For students from university-distant backgrounds role models offer an opportunity to form images about what STEM studies and careers could be. It is, however, limited to which extent it has been investigated how this 'meet, match and matriculate' sequence actually influences students' aspirations.

Using role models in relation to students about to choose a tertiary study program builds on the assumption that the impression the student gets of the model will affect his or her choice – and preferably make them choose STEM. The first impression of another person is formed within a split second (Willis & Todorov, 2006) and is affected by the situation in which the specific interaction occurs, by prior information about the person, as well as the person's identity display (Brewer, 1988).

A student in the process of forming an opinion about a role model will process all available identity indications and match them against his or her pre-established, situation-specific prototypes: "*A prototype describes just one person, who is considered as a particularly typical representative of the group in question (for example 'the typical teacher')*" (Hannover & Kessels, 2004, p. 53). The process of linking another person (e.g. a role model) to a prototype continues until a match appears satisfactory to the individual. Once an individual has linked another person to a particular prototype, this linkage is quite persistent. If new information about the other person does not fit the matched prototype, the individual will not search for a new general prototype but rather create an appropriate subdivision of the linked prototype that matches the new information (Brewer, 1988).

In order to evaluate the appropriateness of a specific study program, it has been proposed that students engage in self-to-prototype matching, which is "*the strategy of making situation choices on the basis of a rule of maximizing the similarity between the self and person-in-situation prototypes*" (Setterlund & Niedenthal, 1993, p. 770). In the educational choice process, students thus compare their conception of themselves with their prototypical images of students studying different

study programmes. Taconis and Kessels found that *“the actual choice of a specific academic profile could be predicted by students’ perceived similarity between their self and the respective prototypes”* (Taconis & Kessels, 2009, p. 1129).

The influence of self-to-prototype match on students’ educational choice processes have been studied in relation to the students’ prototypical images of students who would have science and math as favourite subjects (Hannover & Kessels, 2004), science teachers (Kessels & Taconis, 2012), science peers (Taconis & Kessels, 2009) and scientists (Andersen et al., 2014). In this article the methodology is extended to explore the following research questions:

1. How do students match themselves to real life STEM role models? And
2. How is this matching process affected by the setup of the role-model meeting and by the students’ individual preferences concerning role models and experiences with the disciplines?

DESIGN AND METHODS

The role model project

The role model project was a STEM recruitment and outreach project at the University of Aarhus in Denmark lasting 18 months and including five visits at the university. The project ran in three iterations. In this paper, results will be presented from the 79 students participating in the first round.

The purpose of the project was to increase the STEM recruitment and to qualify upper-secondary school students’ tertiary educational choices, particularly for students from so-called ‘university-distant backgrounds’, that is, students whose socio-economic, cultural or geographic background could make them less inclined to pursue a tertiary education. Students were selected by teachers from the students’ schools based on written applications, the students’ university-distant backgrounds and their skills and interests in STEM. All students took advanced mathematics, which is mandatory for admission to university STEM education in Denmark.

Due to their family background, the students had no direct knowledge about what it means to attend university. A specific aim of the project was therefore to make the students able to picture themselves as university students at all. Through facilitated role model meetings the project made knowledge about what being a university student means more accessible to the participants. The students met two different types of STEM role models - mentors and match-making models.

Assigned mentors

The 79 upper-secondary school students were randomly divided into six groups, and each group was assigned two mentors. The students met with their mentors at the five all-day meetings at the university and chatted with them in-between using a specially-designed Facebook group.

The 12 mentors were second or third year STEM students at the University of Aarhus. Like the upper-secondary school students, they had university-distant backgrounds in order to enhance the possibility that the students would perceive an identity match with their mentors.

The mentors were paired in couples maximizing their joint coverage of the different STEM areas, for instance pairing up a mentor from physics with one from biology. Hence, the upper-secondary school students’ specific STEM interests were not necessarily represented by their two mentors, but the mentors offered insight into life as a university student for somebody with a family background similar to their own.

The mentors were trained before and during the role model project. It was stressed that the mentors’ job was not to recruit students for their specific STEM programs, but to offer as truthful a representation of university life as possible.

Self-chosen match-making models

During the third university visit, the upper-secondary school students met with three match-making models for 10 minutes each. The purpose of the match-making was to inform the students' educational choice processes by providing information about specific STEM programs their mentors might not be able to offer.

The match-making session consisted of two phases: 1) An informal exploration phase where the upper-secondary school students circulated among the 20 match-making models and their posters entitled 'Me and My Study Program'. 2) Three self-chosen meetings where match-making models gave a five-minute presentation followed by five minutes of questions from the upper-secondary school students.

In the first phase, the upper-secondary school students could select the role models they perceived to match based on study program, poster and/or the model's identity display. In the second phase, their interests and first impressions were supplemented through interaction with the match-making models.

Twelve of the twenty match-making models were also mentors, but eight additional match-making students were recruited in order to have all different STEM programs at the University of Aarhus represented during the match-making session.

Some upper-secondary school students visited their own mentor(s) in the match-making session if they presented a program of the student's interest, but frequently it would be the first meeting between the upper-secondary school students and the models and there would be no follow-up meeting later.

Prior to the match-making, all 20 match-making models were instructed to prepare a handmade poster and a five-minute talk. It was stressed that the posters should include information about the match-making models as persons and truthful presentations of the life as a student at their particular STEM programs. They were told not to act as student counsellors or to prepare a show for the students. Instead, they should give personal accounts of their background, living situations, future dream job, but also of their experiences with everyday study life, time schedules, teaching methods, books and exams at their particular STEM programs.

Sample

Sixteen focus students were selected from the 79 project participants on the basis of their applications for the role model project. The selection sought to capture as diverse a range of educational considerations as possible (Flyvbjerg, 2006). All sixteen students agreed to participate in the study, but one student did not respond to any requests after the first two interviews. Findings regarding the remaining 15 focus students are exemplified in-depth through three case students.

Methods

The 15 focus students were interviewed individually eight times during their final 18 months in upper-secondary school and additionally one and two years after their graduation. The interviews were semi-structured, and each interview followed the thread and theme from the previous interviews: emerging educational considerations, attitudes towards university studies in general and attitudes towards STEM programs and STEM students in particular.

The first interview, where the students' individual backgrounds and initial educational aspirations were probed, the fourth interview, conducted within two weeks of the match-making session and examining students' conceptions of the individual role models, and the eighth interview, where students

validated preliminary analyses of their educational choice process and conceptions of role models, all took place at the students' schools and lasted for about an hour each. The remaining five interviews lasted about 15 minutes each and were conducted by telephone while the students were at home. Either case provided students with a safe and familiar setting.

The first seven interviews were fully transcribed and condensed into a two-page vignette for each student presenting their background and their experiences with the project and the different role models, highlighting the influence on their educational choice processes. At the eighth interview, the 15 students read their own vignette and had the opportunity to correct misinterpretations. During this member-check (Guba & Lincoln, 2005), only a few students made minor adjustments to the educational choice narratives.

This article mainly draws on the fourth interview, although the analysis also includes the vignettes as well as the status upon completing upper-secondary school and the interviews after one and two years respectively.

The fourth interview, made shortly after the match-making sessions, was conducted in three sequences.

1. *Students' conception of individual role models:* Students were presented with pictures of their two mentors and of the match-making models they had visited and were asked to openly characterise each of them. They were then asked to compare the different role models by labelling respectively the *most* and *least* of different characteristics such as 'collaborative' and 'healthy' and students were asked to argue which of the role models they 'could learn the most and least from' and 'would rather and rather not be in a study group with'. Items were selected based on Andersen et al. (2014). Students were urged to reply to all labels to express their impression of the role models relative to each other, even if it meant that a role model could be labelled, for instance, least collaborative, while being considered collaborative by the respondent. The students were further asked to explain and justify their decisions and labelling.
2. *Students' perceived match between individual role models and their prototype images:* Students were asked to argue whether or not each of the role models fitted their image of someone in that particular study program.
3. *Students' perceived match between individual role models (and the model's study programs) and their self-conceptions:* Students were asked to argue 'which model they were most similar to' and 'whose study program they would rather and rather not pursue'.

Transcriptions of the interviews with each student were reviewed and sequences where students mentioned the mentors and match-making models were singled out. These sequences were then analysed with respect to how students experienced the role models, how they related their experiences with the role models, with the STEM disciplines, and with their self-conceptions, and finally whether this process of relating and balancing different elements became discernible in the students' reflections concerning the STEM programs and their educational choice processes. This was done for each interview and finally the results from the analysis of each individual student were compared and combined, and patterns across the individual responses were revealed.

The empirical data consists to a large extent of the students' own statements about how they experienced the mentors, the match-making models and related activities. However, these statements are not taken at face value. Analysis of the interviews largely followed the steps suggested by Kvale (1996). However, the second and third contexts of interpretation described by Kvale; the common sense understanding and the theoretical understanding (Kvale, 1996, p. 214) were merged into one. This means that the interpretation was based on a combination of a general textual analysis and an analysis guided more specifically by the theoretical framework of the present study.

Gender was not a focus of the project and gender issues were not prompted in interviews. As it were, there was nothing in the interviews that suggested this to be an issue of particular importance to the participating students. This does not mean that gender is without importance or relevance in students' choice of program, but we have decided not to address this issue in the present analysis.

Although the design has similarities with the studies by Kessels, Taconis and Hannover (Hannover & Kessels, 2004; Kessels & Taconis, 2012; Taconis & Kessels, 2009), there are some important differences. Firstly, we had the students replying to the items in a verbal interview as opposed to the written format in previous studies. This offers the opportunity to record the considerations of the students in the matching. Secondly, we asked students to relate prototypes to actual role models and relate themselves to the role models as opposed to comparing themselves to imagined prototypes only. Thirdly, we conducted qualitative analyses of the interviews rather than statistical analyses. Although this prevents an analysis of correlations, it allows for a nuanced discussion of the students' relation to STEM and stereotypes.

RESULTS AND DISCUSSIONS

This section is divided into two sections. The first subsection 'The matching process' presents and discusses results concerning research questions 1 and the subsequent subsection 'Elements affecting the students' matching processes' presents and discusses results in relation to research question 2.

The matching process

In order to answer research question one, we will give in-depth presentations of three case students and their matches with different STEM role models. Based on these cases and the patterns in the three students' matching processes, we propose a general model for the matching process. The model is derived from an analysis of interviews with all 15 focus students.

Mary

Mary is the kind of student which STEM recruitment projects using role models wish to target. She has a profound interest in mathematics, a high work ethic and a natural skill for STEM, but she cannot really see herself pursuing a math career. The following extracts from Mary's member-checked vignette illustrate her educational choice process prior to the role model project.

Mary's parents fled during the Vietnam War. Before they fled, they both studied mathematics. In their home they have always kept books of math problems, and now that Mary is older, they also have several brainteasers. Mary's parents feel that they have fought hard to give her good opportunities and that she should not waste the chance to get a good education. Mathematics is Mary's absolute favourite subject, and therefore she also thought it would be "absolutely awesome to study [that at the university]". She likes fiddling around with math problems; she finds it fun to spend a long time making something add up, and when it does, it makes her happy. She gets that from her father. Lately, however, Mary has given up on the plan to study mathematics because she cannot see herself in the jobs it leads to - she does not really think she is "the scientist type". "I mean, I would really love to study mathematics, but I don't want to be any of the things you can become. I think that it is a bit of a waste that I am not going to use mathematics for anything anymore, because it is what I have always studied a lot, and it is what I have always preferred." Since Mary is also interested in the part of biology that involves the human body, and since she prefers working with people to working in an office, she has decided to become a physiotherapist.

During the role model project, Mary could not see what she was meant to use her mentors (Molly from biology and Michelle from mathematics) for. She did not talk a lot with them and had great trouble with seeing herself in them.

"I think they are nice and all, but it isn't really like I hang out with them. Or like they are the kind of people I hang out with."

Despite their mutual interest in mathematics, Mary did not see any similarities with Michelle whatsoever. Mary describes herself as being fun and into sports and American TV shows as opposed to Michelle, whom she sees as bone-dry and "scientific". Throughout the role model project, Mary's trajectory leads her still further away from pursuing her interest in mathematics.

Prior to the match-making, Mary was convinced that she would not pursue a math career. Instead, she decided to visit Reba who studied mathematics and economics "to see if that could be interesting instead." Mary was happy to meet Reba because she was not as geeky as Mary's prototypical image of a STEM student, and because Mary felt more similar to Reba than to her mentors: "We are quite similar personally. We have the same values and want to see life". Mary, however, did not attribute Reba's qualities to being a typical student of mathematics (and economics):

"She looks like someone who sells women's clothes, I really hadn't expected her to study maths [...] But maybe it's one of those things where since we were little, we have always thought that university was for geeks, those people who are much too clever compared to the rest of us."

Conversely, Michelle fitted Mary's image of a typical math-student much better.

Mary's meetings with the two math role models (Michelle and Reba) were not effective in making her reconsider studying mathematics. Instead, she decided to study to become a dentist right upon graduation. She had not mentioned this idea earlier, but explained that it was a trajectory her family and friends were very happy about.

Ewan

Ewan's educational choice process is an example of how the use of role models under the right circumstances can recruit students into STEM programs.

The following is a short extract from Ewan's member-checked vignette concerning his educational trajectory prior to the role model project.

There is no pressure on Ewan from home about him completing any specific study, although his parents have made his school a high priority ever since he was young. However, Ewan is a very committed student, both when it comes to classes and social events.

In general, Ewan is not interested in "old theories" but rather in more recent inventions, and hence he views theories as a "necessary evil" in many study programs. He does not care for "studying just for the sake of studying", especially not for several years. He would like a job in which he can both cooperate with others and have some management function. He imagines that at some point he will be made project manager and enjoy "a good salary and good working conditions with a relatively big amount of leisure time". At the same time he would like to "get out and experience the world and make an impression and make a difference to others."

Ewan wanted either to go to university to study science of some sort, or go to a school of engineering. The School of Engineering appealed to him the most since they mainly worked with practical projects. He had a feeling that the people in the science departments were less focused towards cooperation than the engineers (and Ewan) were.

Ewan liked the role model project “*where you sort of got a really nice insight into the university.*” He thought it was great to meet his mentors (Nadine from physics and Owen from molecular biology), and described them as “*a good guide*”, but he could not easily see himself in any of them. He thought they clearly signalled that they attended the university and were (too) invested in their studies. However, Ewan’s attitude towards tertiary STEM students changed a bit as a result of his interaction with his mentors:

“Nadine, who studies physics, I don’t know, she was very nice too... You can tell by looking at someone who studies physics that if they study anything, it will be physics. And maybe she is a bit the odd one out there, but then, there are a lot of people who study physics who do not look like complete nerds.”

At the match-making, Ewan heard about the geology program from Martin. In Martin, Ewan found one he felt very similar to: “*I don’t really think he is extreme in any aspect, and I’m not extreme*”, and Ewan also found geology to be a very attractive study program involving “*a bit more traveling, and there was a bit more practical work instead of just reading.*” He did not find it to be as dreary a subject as the other university programs. The brief meeting with Martin at the match-making motivated Ewan to seek more information about the geology program, and after the match-making, he chose to try out a one-week university internship at the geology study. After the internship, Ewan decided that this was what he wanted to study, and after a gap year, Ewan entered the geology study program.

Tabitha

Tabitha’s educational choice process illustrates that different role models may play different parts in the ongoing process of making an educational choice. Extracts from her vignette represents her educational choice process prior to the role model project.

Tabitha’s mum died when she was little. Her father has not quite gotten the education he had wanted, and consequently it is very important to him that Tabitha completes a long tertiary education and gets as good opportunities as possible. Tabitha herself also enjoys school and especially likes being one of the best students in school. Furthermore, Tabitha is very concerned with “creating balance in her life” when it comes to her social life, her classes, and her everyday life, in which she does not care to deal with “thinking topics” all the time. Tabitha is highly interested in biology. This interest may stem from her grandmother, who from when Tabitha was a young girl used to take her to feed ducks, explain things to her, and take her to different museums. As a child she wanted to be an animal attendant, but now she plans to study “rubber boots biology” – she likes the “tangible” and more “natural” biology. Tabitha’s alternatives to the biology program are psychology or English. She finds both fields to be extremely interesting, but she cannot picture herself working in them.

Like Mary, Tabitha’s mentors were Molly from biology and Michelle from mathematics. Tabitha was pleased with her mentors and especially Molly, with whom she could identify to a high degree:

“She wants a lot of experiences and wants to travel, in a way that you get to thinking that she has a lot of the qualifications I also feel I have, and on the other hand she is just really geeky [...] if I am interested in something, I can also become a bit nerdy about it.”

In this way, Molly has played an important part in the formation of Tabitha’s new image of the university student as knowledge seeking and social as well.

Tabitha had an old interest in geology, and she had visited the geology study when in lower secondary, “... and it was one of the worst things I have ever experienced; it was simply a struggle to stay awake.” During the match-making, Tabitha decided to visit Martin from geology, but this meeting did not leave her with a good impression of the geology program either. Tabitha perceived Martin as a lively and outgoing guy, but she got the impression that,

“His study program is a bit of a ‘slacker’ study program where you can calmly cruise through it [...] but maybe it is just my prejudices that get out of hand here [...] Again, it is because he seems less serious. Whereas I am quite determined and not so good at tolerating people who show up unprepared.”

Tabitha’s meeting with Martin and geology once again suppressed geology as a suitable study program for her – although she eventually filed geology as her second option in her university application.

At the match-making, Tabitha also visited Mike who was studying chemistry. She was very surprised at how he was:

“You sit there thinking that you were that cool guy in upper-secondary school, weren’t you? That guy who was smart, but cool at the same time [...] I was really expecting to meet a geek.”

She was quite impressed by Mike, and after the meeting she was convinced that it would be “cooler” to study chemistry than biology. At this point, chemistry was what she wanted to study the most. After the match-making, Tabitha therefore chose a one-week university internship at chemistry to investigate her new chemistry interest.

“During that, I found out that it wasn’t that I couldn’t keep up, and it wasn’t that the topics weren’t interesting enough, I just don’t think I can entertain myself with this [chemistry] for five years [...] biology comes more naturally to me than chemistry.”

Tabitha’s perceived attractiveness of the chemistry study program was thus not reinforced after the match-making meeting with Mike.

Tabitha’s reiterated meetings with Molly throughout the role-model project confirmed her belief that she should study biology. Biology would allow her to become immersed in her studies and still remain socially active. After she graduated upper-secondary school, she started studying biology.

From a two-way to a three-way matching process

The three case students’ matching processes suggest that the ‘self to real-life role model’ matching process of the students in this study is more complex than the self-to-prototype matching process described in previous research. Instead of making a two-way comparison between role models and

Figure 1: The three-way matching process involved when students meet role models.

selves, the three case students engaged in a three-way matching process, as illustrated in Figure 1. In this process they evaluated: 1) The match between role model and self. 2) The match between self and prototype, and finally, 3) The match between role model and prototype.

Each of the three matching stages in Figure 1 involves academic, social and professional comparisons. Students' self-conception and conception of the role models involves information about subject preferences and abilities; work ethics; social needs, skills and statuses; cultural background; current and future family lives as well as spare time activities and dreams for the future. Students' conception of STEM student prototypes, on the other hand, primarily involves information about study methods; (lack of) spare time and cooperation; study work load; and future job possibilities and working conditions.

Exposing the students to real-life role models also changes the setup of the students' way of engaging with prototypes in the matching process. In self-to-prototype matching studies of Kessels and Taconi's, the students were asked to relate a person to the stereotype of a particular discipline (e.g., physics). As such, the matching object is methodically controlled. This is not the case when students meet role models in real life. In a real-life context we cannot control to which prototype the students match the role models. The upper-secondary school students in this study could match the role models with prototypes of university students in general, prototypes of STEM students in general or with prototypes of specific subgroups of STEM students, such as the prototypical math student, biology student etc. However, they could also match the role models according to a host of other situation-specific prototypes based on the role models' identity displays (ethnicity, job aspirations, socioeconomics, gender etc.). No matter if the role models were selected to represent a particular discipline, the real-life role models presented themselves as individuals and it could not be controlled how the upper-secondary school students related to them and to what extent the meetings made them revise their prototype images.

Revisiting the three case students focusing on prototype revisions

The stories of Mary, Ewan and Tabitha offer insights into prototype images that are revisable and prototype images that are not.

Mary evaluated Michelle and Reba's identity displays according to a math student prototype, see Figure 2A and B.

Mary had a rather negative math student prototype that did not match her cooler self-image. She assumed the prototypical math student to be geeky and "*much too clever*". She perceived Michelle to match and reinforce this prototype image.

Conversely, Mary did not think Reba matched the math prototype, but this did not make her revise her prototypical image. Therefore, Mary's perceived personal match with Reba was not enough to make her consider a mathematics (and economics) study.

Figure 2: Mary's matches with the two math role models

Ewan's overall conception of science students was that they were not that focused towards cooperation. His prototype of the subdivision of physics students conceived them as quite geeky, but his meeting with his mentor Nadine made him revise this image a bit, "*there are a lot of people who study physics who do not look like complete nerds.*"

Ewan's meeting with Martin made him create another subdivision of the STEM student prototype - that of a geology student. Prior to the meeting with Martin, Ewan did not have any information about geology and he had not formed a prototype of a geology student. Therefore, not surprisingly, Ewan perceived Martin to match the geology student prototype (since the prototype, so to speak, was based on Martin!), see Figure 3A. Even though Ewan did not think he matched his general prototypical image of a science student, he did believe he matched the subdivision of the prototypical geology student.

Figure 3: Ewan's and Tabitha's matches with different role models

Tabitha's perceived matches with Martin, Mike and Molly are presented in Figures 3B-D. Tabitha had a rather sloppy prototype image of a geology student that did not match her more serious self-image. She perceived Martin to match this prototype image and therefore she did not need to revise that prototype.

Mike neither matched Tabitha's prototype of a chemistry student nor her self-conception; she perceived him as cooler than both. At the same time, she perceived chemistry as a more difficult and (therefore) prestigious discipline than biology, which had been her preferred discipline. Meeting Mike, who challenged the chemistry student prototype, opened chemistry as an option and made her revise her prototype image. However, her experience during the internship tarnished the image of chemistry as a cool and attractive discipline and even the presence of students as cool as Mike was not sufficient to make her apply. Hence, the lack of match which Tabitha experienced between the cool Mike and her chemistry prototype initially made her revise her ideas about chemistry and allowed her to picture herself studying chemistry. However, this change was not strong enough to subdue the sense of chemistry as 'unentertaining' she got from the internship, and she eventually decided that chemistry was not for her.

Tabitha's meeting with Molly made her revise her prototypical image of a tertiary (biology) student, allowing her to combine being hardworking, geeky and socially competent in one person. After this revision Tabitha had no problems seeing herself pursuing tertiary biology.

Summing up, the students engaged in a three-way matching process where they related role models to themselves, the role models to their prototypes and the prototypes to themselves. Apparently, the personal match between student and role model was frequently the one that the students immediately related to, rather than to the role models as representatives of a discipline. The match between students and prototypes only became central if the student had no clear impression of the model.

The match between role model and prototype in some cases challenged the students' prototypes. We cannot conclude in what circumstances the prototype was maintained by revising existing prototype or by creating a sub-division (like Ewan did after meeting Nadine) and in what circumstances it was challenged (as Tabitha was after meeting Mike). What we can say is that 'self-to-real-life role model' matching is complex, context-specific and involves more than the two components in the self-to-prototype matching.

Elements affecting the students' matching processes

The case-based exposition of students' meetings with different role models highlighted three elements that influenced the matching processes. These results will be unfolded one by one in the following and subsequently summarised in order to answer the second research question.

Different set-ups for role model meetings

The two types of role models (mentors and match-making models) influenced the upper-secondary school students differently: the mentors primarily made the students reconstruct their general prototypical images of university students, while the match-making models rather made the students reflect on program-specific prototypes. A new focus student, Peter, is introduced to illustrate this dual role model effect. Peter used different prototypes when matching with the match-making student John (from physics, see Figure 4A) and his mentor (Sophia, from biology, see Figure 4B).

Figure 4: Peter's matches with two role models and the situation-specific prototype linkages

Peter perceived a high degree of match with both John and Sophia. He had an interest in physics and matched John according to a physics student prototype. Peter felt he could identify with John, for instance in their shared commitment to physics. He also appreciated John's way of explaining and defining things:

"I like it when people use relevant terminology and firmly support the notion that when you discuss a subject, you use the terminology related to that subject."

Peter matched Sophia according to a 'student coming from a university-distant background' prototype:

“Sophia is a person who outside of school is quite similar to me. She is from the countryside, and in many ways I can identify with her. The way she views things. [...] She has been a good counsellor when it comes to understanding the level at university [...] She has not influenced my educational choice directly since she is a biologist and therefore does not know much about physics. She has, however, helped make me more certain that the university was a place for me to be.”

John fit well into Peter’s physics student prototype, while Sophia made Peter more confident that students with the university-distant background they shared could indeed enter university. The meeting with Sophia thus made Peter revise his university student prototype.

Students’ perceived matches with role models more often affected their conception of the general university student than their conception of more program-specific prototypes. Thus, several students said that getting to know the role models had convinced them that entering university was an option for young people with university-distant background. Fewer students reported that they had changed their orientation towards specific STEM programs. However, the match-making session facilitated students to engage in the three-way matching process and estimate how well the match-making models matched subject-specific prototypes and thus for many students, like Ewan, served as make-or-break points regarding considerations about the models’ specific study programs.

Students’ different role model preferences

Students obviously had different self-conceptions and also different prototype images. Moreover, they experienced and interpreted the individual role models they met differently. One example is Mary and Tabitha’s different descriptions of their mentors Molly and Michelle.

Mary described Molly as being *“friendly and pedagogical”* and Michelle as *“bone-dry”* whereas Tabitha perceived Michelle as *“one of the pedagogical ones”* and Molly *“a bit more like a geek”*. Another disagreement in the girls’ description of Michelle was that Mary picked her to be the *least* collaborative of the role models she had met:

“I just think that mathematicians are a lot like that... because I myself like working like that, because you sit by yourself and think and so on, and you can work at your own pace and stuff like that, because it is difficult to find someone who is at the exact same level as yourself. Either it is someone better or someone worse.”

Tabitha, however, considered Michelle as the *most* collaborative of the role models:

“It’s probably the ‘teacher thing’ again that influences it, she is good at explaining what she does herself, and at the same time good at understanding others when you have to talk to her.”

Here it becomes evident that Mary and Tabitha match Michelle according to different prototypes. Mary matches Michelle to a math student prototype. Tabitha, on the other hand, knows that Michelle has an aspiration of becoming an upper-secondary school teacher and matches her to this profession prototype, but also argues based on her personal experience with Michelle. The different conceptions are based on differences in the students’ conception of the individual as well as in which prototype they apply.

Another obvious diversity in role model conception is Ewan’s and Tabitha’s characterisations of the geology role model Martin. Tabitha disapproved of his laid back style: *“He seemed like it wasn’t that his studies were horribly difficult, and that actually suited him rather well.”* Ewan viewed that as an attractive attribute. He found Martin to be the role model he could learn the *most* from because *“he seemed nice”*. Conversely, Tabitha believed he was the one she could learn the *least* from:

"because, again, I think the topic is one of the easier ones, but maybe it is just my own prejudices that go into overdrive here, and then in real life it's just a hundred times harder than biology."

Ewan could easily see himself in a study group with Martin because he perceived him as *"very relaxed and easy, and someone who knows what he's doing,"* whereas Tabitha selected Martin as the role model she preferred not to be in a study group with: *"Again, it is because he seems less serious."*

Ewan's argumentation relies on his immediate impression of Martin (remember, he did not prior to the meeting have a prototypical image of a geology student), whereas Tabitha's argumentations are based on her prototypical and negative image of a geology student and of geology as a discipline. Interestingly, Tabitha herself comments that she bases her answers on a prototypical image *"my prejudices"*.

Students' different discipline familiarity

When students were asked to label role models the *most* and *least* collaborative etc., they generally answered based on their personal impression of the role model. The students only turned to prototypical labelling when they had nothing else to base their answers on (Tabitha, for instance, labelled Michelle the least healthy because *"The canteen at mathematics has huge pieces of cake"*) or when they had particular strong prototype images.

It turned out that students' strong prototype images (e.g. Mary's prototypical math student image and Tabitha's prototypical geology student image) were particularly related to school subjects. The students did not have robust prototypical images of subjects they did not know from primary or secondary school. As Ewan said: *"I don't really know if I have any specific ideas about who studies molecular biology."*

This means that role models representing study programs which the students have not previously heard about, will usually create new prototypes (like Ewan creates a geology prototype), whereas role models representing traditional study programs will be judged according to existing prototypes and will probably only be able to slightly revise the prototype (e.g. Mary's robust math prototype).

Summing up:

- The set-up of the role model meeting affects the matching process:
Mentors and match-making models affected students differently. The mentors influenced the students' conceptions of whether studying at university was a viable opportunity considering their social backgrounds. The match-making models mainly affected the students' views of the study programs. Since the majority of the match-making models were indeed the mentors, this elucidates how the role models presented themselves (or were conceived) differently in the two different set-ups. The difference is not surprising, as the mentors and the match-making models were instructed differently in the two set-ups, and moreover, only match-making models shared the same specific subject interests as the upper-secondary school students. However, it emphasizes how role model set-ups affect student outcomes.
- The students' individual role model preferences affect the matching process:
Students have different self-conceptions, different prototype images and thus experienced and interpreted role models differently.
- The students' familiarity with specific study programs affects the matching process:
The interrelation and hierarchies of prototypical discipline images are complex. Role models from unfamiliar disciplines are, for good and bad, much more influential on students' prototype images because they may define the prototype, while role models from traditional disciplines will be compared to established prototypes.

CONCLUSIONS

This paper studies the interaction of upper-secondary students with role models in a recruitment and information project at tertiary level. We found that the students engaged in a three-way matching process where they matched (1) their impression of the role model with their self-image, (2) their impression of the role model with their discipline-related prototype, and (3) the prototype with their self-image. We also found that the students frequently related to the role models as university students in general and at an individual level rather than as representing disciplines.

These findings correspond with the understanding of young people's choice processes when deciding which line of study to pursue. When the students relate to the role models as individuals and university students in general while also matching them with their discipline prototypes, it reflects the students' need to find a study path that not only matches their interests, but offers an identity that is viable and obtainable. Similarly, Holmegaard, Ulriksen, and Madsen (2014) found that students' choice processes included a continuous match between the identities they believed to be available when choosing one line of study compared to another, and considerations concerning how these identities fit with what the students experienced as attractive and viable identities.

Our findings are also in line with the studies by Archer and colleagues who emphasise that class and gender affect the process of identifying recognizable and attractive identities (Archer & DeWitt, 2015; Archer et al., 2015). The matching process thereby evaluates the available identities as well as how interesting the discipline appears to be. Further, it suggests that the individual identity and the discipline-related identity should concur.

These findings add to the understanding of the self-to-prototype studies. Previous studies have analysed the matching of prototypes to self, to peers, to teachers or to researchers and revealed the ideas the students hold of particular disciplines when they are not exposed to real-world representatives (Andersen et al., 2014; Hannover & Kessels, 2004; Kessels & Taconis, 2012; Taconis & Kessels, 2009). The methods used by Kessels and colleagues include written surveys with closed answers, while Andersen and colleagues combine written surveys with coding of qualitative, oral interviews. Our study suggests that these different methodological approaches to some extent limit what can be implied from the mentioned studies.

Comparing the findings by Kessels and Taconis (2012) with the study by Andersen et al. (2014), indicates a difference between the written and the oral interview. While the written survey imposes particular prototypes and requires the students to take a stance concerning these, the oral interviews allow the students to reflect on and modify their conceptions of the prototypes and of themselves. In the present study, the prototypes are further challenged and reflected on through the three-way matching process. A further methodological difference between some of the studies is that while Taconis and Kessels (2009) exclude students with low self-clarity from their analysis, the lack of clarity and fixed self-perception among the students is a point in its own right in the study by Andersen et al. as it is in the present paper.

These differences can be expected to also affect the range of conclusions drawn from the studies. Studies in which students are responding to fixed prototypes without the opportunity to challenge them and before having been exposed to real-life exponents of the prototypes, will first of all reveal the prejudices existing at an early stage and at one point in time. If students in this context express that they experience science prototypes as alien and unattractive, this could prevent the students from pursuing additional knowledge or insights into what possibilities pursuing a STEM path would open. The prototypes can be expected to act in the first steps of students' decision processes.

The study by Andersen et al. suggests that the rather rigid prototype conception could be challenged if students are asked to reflect on it. The present paper has investigated a more complex matching process involving real-life role models which allows for the role model to interact with the student on

a personal as well as a discipline-related level, and this can be expected to make the prototype less prominent in the students' evaluation of different opportunities. Our findings emphasize that the students' decision processes do involve considering prototypes, but the students do not only consider the discipline or science in general. They relate to the role models as whole persons with identities that relate to being a university student, to studying science, but, importantly, also to other aspects of life. Prototypes, in other words, are only one component in a more full conception of identity. Further, as argued by Holmegaard (2015), the process of choosing is a negotiation process occurring over time and including a lot of uncertainty and doubts. In order to understand the role of prototypes, role models and other classed and gendered experiences and conceptions, it is important to apply methodologies that allow for that kind of complexity.

Future research could further explore this difference in young people's relating to and being affected by prototypes and real-life role models to clarify in what way the prototypes affect the students' choice processes at different stages of the decision process.

Implications

The study finally suggests some practical implications for future role model projects. It seems that role model projects should have some duration in time to present the students with different set-ups and because prolonged contact is the most effective for challenging prototypes. Further, the students should have the opportunity to meet different role models, since individual students perceive role models differently. Finally, it should be considered that role models representing traditional and non-traditional subjects have different opportunities and challenges for influencing students. It appears that students should not meet role models from familiar and unfamiliar, but related disciplines (e.g. biology and molecular biology) at the same time, because there is the danger that students create a subdivision of the familiar discipline for the unfamiliar discipline, thus reducing the opportunity to experience the new discipline as an independent opportunity.

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