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ORIGINAL PAPER

Motivation style of K–12 students attending outreach activities in the STEM field: a person-based approach

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Abstract
This study focused on K–12 students attending outreach activities (i.e. activities from STEM-based industry emphasizing applications of STEM content in the STEM field), with the main objective being to motivate students for a future career in STEM. Outreach activities can be regarded as environments that extend the regular in-class learning environment and that differ from regular environments in terms of several dimensions, such as autonomy, relevance and learning resources. To date, little research has been conducted on these types of learning environments. We followed a person-centred approach in identifying students' motivational profiles and corresponding student groups in outreach activities, and in evaluating whether students with different profiles differ in their STEM-related attitudes and experience of outreach activities. Both quantitative and qualitative data were collected. Latent-profile analyses revealed four different motivational profiles: good-quality motivation, moderate-motivation, high-quantity motivation and low-quantity motivation. Students with a good-quality motivation reported significantly more favorable-attitudes towards a future career in STEM compared with the other groups, with content and personal relevance being key factors for students with this profile. This study provided support for adding outreach activities to the school learning environment.

Keywords Motivation profiles · Outreach · Person-centred · Secondary education · STEM

Introduction

As our society is getting more dependent on Science, Technology, Engineering and Mathematics (STEM), the workforce needs more STEM-specialized employees to ensure economic growth and innovation (OECD, 2008). Therefore, enhancing students' interest in learning STEM has been a focus in several studies for many decades (e.g. van Griethuijsen, 2015). A lack of interest in learning STEM has been attributed to an increasing gap between school science and the STEM-based world outside school (Waldrip & Prain, 2017). As a result and in an attempt to increase students' motivation for STEM and keep

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students motivated to pursue STEM-based careers, several initiatives have been launched (Hellgren & Lindberg, 2017; Waldrip & Prain, 2017). One promising way to increase students' motivation for STEM is the use of outreach activities (Vennix et al., 2017, 2018) in which guides (i.e. employees) from STEM-based industries connect the work context with STEM at school.

In our previous studies (Vennix et al., 2017, 2018), we focused on a variety of outreach activities developed in co-creation with secondary education and STEM-based industry to open the industrial STEM world for students. Our results showed significantly more-positive student perceptions of the outreach learning environment compared with perceptions of regular school science courses (Vennix et al., 2017). We connected the needs as proposed by Self-Determination Theory (SDT), namely, competence, autonomy and relatedness (Deci & Ryan, 2000), to perceptions of the learning environment. As outreach activities seemed to touch upon factors in the learning environment conducive to these needs, the first findings pointed in the direction of possible positive effects on motivation for STEM. Objectives such as new views of science and scientists and out-of-school components seemed important because these characteristics explained most of the variance in students' perceptions of the environment. Students' self-reported motivation scores were very high for autonomous motivation and low for controlled motivation (Vennix et al., 2018). Thus, students were intrinsically motivated for STEM after attending outreach activities. Activity characteristics such as out-of-school location, an objective to understand science, and workshops as teaching methods led to more-autonomous motivation. Also, self-reported attitudes showed high scores, especially with students' attitudes for career interest being positively associated with autonomous motivation and negatively with controlled motivation.

The results in the first two studies were obtained by using a *variable-centred* approach. However, students differ in various aspects such as their personal and STEM-related assets, and the nature and stage of their developing views about their futures. Concerning outreach, students' perceived motivation in a particular context is personal and results from the interaction between the experienced social context (i.e. outreach learning environment) and the person's need system. This interaction can either support or frustrate students' need fulfilment (Loukomies et al., 2013; Ryan & Deci, 2017). Therefore, motivational profiles can show different combinations of intrinsic and extrinsic elements in different contexts, even for the same person.

For the present study, we were interested in a person-centred approach to student motivation in outreach activities in order to (1) gain insight into different motivational profiles and (2) understand how different elements of outreach learning environments match with motivation profiles of various subgroups of students. In addition, we wanted to understand the implication of these motivational profiles for students' attitudes towards a future STEM career and to determine what learning environment factors go together with the occurrence of these profiles. With the results of this study, future outreach activities might be customized for different groups of students. This might benefit a more-sustainable contribution of outreach activities to school learning environments, because outreach will become a contributor to the continuous development of positive attitudes towards STEM and motivation for STEM. The outcomes are especially valuable for outreach contributors, who have neither a main priority nor a focus on outreach, because it is a long-term investment with outcomes that are uncertain and difficult to prove. Therefore, understanding how the combination of different elements of outreach learning environments matches with students' motivation profiles and attitudes might help the STEM-based industry to structure and facilitate outreach activities effectively to differentiate between different groups of students or create separate sets of activities for different groups.

Our main research question for the present study was: *What motivational profiles of students are characteristic of students attending outreach activities and what factors of outreach activities are associated with students' motivational profiles?*

Theory

The development of students' attitude to and impression of STEM is a process that starts from early childhood and changes continuously thereafter (van Tuijl & van der Molen, 2016). During this process, different factors are influential, namely, person-related (interest, talent,…), family-driven (view on STEM, learning oriented or social), and education-related (Ker & Tomei, 2013; Mohtar et al., 2019). Outreach activities can contribute to the attitude development process (Vennix et al., 2018). When students attend outreach activities, it also implies that they will be at different stages of that process: some students did not make any career choice yet, other students might not have been in contact at all with STEM outside school, and others are still in the process of collecting information.

An outreach provider is not generally responsible for this process, but usually is interested to show and talk about STEM and the meaning of STEM. Even more, the provider's core business is not outreach, but mostly specific STEM-related research, development, or production. To optimize the contribution to students' individual career choice development, a clustering of students into groups based on motivation and attitude might, on the one hand, help schools and teachers to connect outreach activities for different groups of students to their needs, interest, and curriculum and, on the other hand, provide focus for outreach providers in their design of activities. This would help to create a sustainable set of outreach activities, with different foci of outreach activities tailored to different groups.

Within the perspective that students are in different stages in their process of connecting to STEM as they participate in outreach activities, this study was performed. It can be regarded as a first inventory of how outreach learning environment characteristics could be constructively aligned with student motivation types and interests. This is a largely uncharted territory. Hence, we do not (yet) focus on unravelling causality for the previously-mentioned factors.

Self-Determination Theory (SDT) (Deci & Ryan, 2000) was used as a lens to investigate the several factors of outreach activities that might positively contribute, for students of various motivation types, to both motivation and students' perceived attitude. In our theoretical framework, the outreach learning environment is assumed to be related to psychological basic-need fulfillment, controlled and autonomous motivation, and attitudes towards STEM (Vennix et al., 2018). In the next sections, motivational aspects are described using a person-oriented perspective and related to attitudinal outcomes and motives.

Motivational profiles

As argued by Deci and Ryan (2000), students' motivation can be autonomous and controlled at the same time, and present in various amounts. In their framework, four different *theoretical* combinations of autonomous and controlled motivation can be found: high controlled–high autonomous, high controlled–low autonomous, low controlled–high autonomous, and low controlled–low autonomous. Each profile is determined by a particular combination of motivation scores on the separate motivational dimensions. Taking a different (diagonal) perspective, these four combinations can be named meaningfully, using (a) the total amount of motivation (quantity) which is the *sum* of both controlled and autonomous motivation and (b) the *difference* between autonomous and controlled motivation can be defined as the quality of motivation. From this angle, *high-quantity* motivation is used to name the case of both high-controlled and autonomous motivation, *good-quality* motivation is used to indicate the combination of controlled and high-autonomous motivation as opposed to *poor-quality* (high-controlled and low-autonomous motivation) and *poor-quantity motivation* (both controlled and autonomous motivation are low) (Vansteenkiste et al., 2009). Within this perspective, the amount of external control is less for good-quality motivation and is personal.

In former studies using SDT, different motivational profiles have been found, varying between three and five profile solutions. Boiché and Stephan (2014), Hayenga and Corpus (2010), Ratelle et al. (2007) and Vansteenkiste et al. (2009) investigated motivation profiles for student learning. Work motivational profiles were studied by Jansen in de Wal et al. (2014) and Moran et al. (2012). All studies found a low-controlled and high-autonomous profile (i.e. good-quality motivation). In addition, most of the studies found a high-controlled and low-autonomous profile (i.e. poor-quality motivation). Furthermore, profiles with both moderately-controlled and autonomous motivation, labelled as moderate (Ratelle et al., 2007), and profiles with both high levels of controlled and autonomous motivation, labelled as high quantity (Ratelle et al., 2007; Vansteenkiste et al., 2009), have been reported.

In an educational context, because there is always an external factor involved, fully-intrinsic motivation cannot be measured. In outreach activities, which are open and largely separate from the formal curriculum and assessment system, there is no strict system that 'enforces' participants' activities. We therefore hypothesize that, when applied to such outreach learning environments, motivation profiles generally have a smaller 'controlled' component. Therefore, it might positively contribute to students' ongoing development towards career choice.

Attitudes as outcomes of motivation

Attitude as a construct has an affective component (feelings about…) and a cognition component (think about it, knowledge, and beliefs) (Kind et al., 2007; Reid, 2006, p4). Both knowledge about STEM and the possibilities of STEM are part of the cognition component. If students know more about STEM and the impact of STEM, they can see the social benefits and problems which accompany scientific progress (Welch, 2010). To identify with and feel confident to pursue STEM are part of the affective component. If students get to know more about various possible STEM careers, they can connect this to their feelings of confidence and value. All in all, the outcomes of outreach could be situated at two levels, namely, a level of societal awareness, appreciation and interest, and a personal level pertaining to possibly a career interest (Fraser, 1981).

In previous studies (Deci & Ryan, 2000; Vallerand & Ratelle, 2002), positive relations were found between autonomous motivated students and their future intention, persistence, and cognitive engagement. In addition, positive attitudes towards STEM courses were present more for autonomously-motivated students (Eccles, 1983; Meece, 1990). Furthermore, in a person-centred approach, it was shown that students with a good-quality profile displayed better learning outcomes such as effort and academic functioning compared with students with other motivational profiles (Vansteenkiste et al., 2009). Hayenga and Corpus (2010) found that students with a good-quality motivation profile received higher grades compared with their peers with a high-quantity profile. Because this was a longitudinal study, it showed that the percentage of students in the good-quality profile decreased over a course year. This intriguing shift might potentially be influenced by engaging students in, for example, a variety of outreach activities added over the course of a year to reduce this decline, because motivation can change overtime. In that perspective, we need to know first if outreach activities have the potential to do so.

In the present study, we assumed a relationship between students' motivational profile and their subject-related attitudes (e.g. affective and cognitive outcomes, interest). Van Griethuijsen et al., (2015) used a qualitative approach to 'profile' students by grouping them according to their interest in science. They found four groups which could be described by 'why' students were interested in science (including an 'uninterested-in-science' group). Interestingly, groups of students were interested in science for different reasons, with one group interested in science *content* and another group interested in science *activities.* Another group of students had a mixed interest in science, were uncertain about pursuing science, and were mainly driven by *external factors* such as money and fame; their interest depended on the *context* of the activity. Thus, for each group, different aspects were found relevant. Students with an interest in STEM-based jobs believed that scientists are creative people working in teams and believed that science can offer solutions to different problems in life. Uninterested students did not (Van Griethuijsen et al., 2015). In the study of Hall et al. (2011), students indicated that the most-important factor mentioned in considering a career in STEM was their personal interest in this field. This implies that an environment that accommodates different motives might increase students' interest or motivation for STEM.

Costa (1995) identified different student categories based on the relationships between students' worlds of family and friends and their success in their science education. When students' interest was reinforced both inside and outside the classroom, they wanted to continue in science and were able to see the big picture and the connections between school courses and career options. So, connecting school science with STEM applications outside school might contribute to students' positive attitudes towards a future career in STEM.

Aims of the study

Exploring outreach activities in a person-centred approach might lead to additional understanding of associations between certain motivational profiles and students' STEM-related attitudes, as well as how students with different profiles experience a similar outreach activity. Also, students with particular profiles might be more-frequently involved in certain outreach activities than others, which might be an indication of the match between certain students and activities. Therefore, students might benefit from activities appropriate for their motivation profile. In addition, students' motivational profiles might help us to gain insight into what motivational profile has the most-positive attitude towards a possible career. Therefore, our research questions for this study were:

1. Which motivational profiles for STEM learning exist among students after attending outreach activities?

Table 1 Brief overview of different types of activities

Activity	Characteristics
Guest lessons	Content-based *or* introduction to a STEM-based industrial topic
	In-school (visit of an expert) *or* out-of-school (visit the company)
Workshops	Short (one-day) *or* spread over a couple of weeks
	In-school, out-of-school *or* combination of locations
Masterclasses	Students from different high schools work together
	Authentic assignments *or* an introduction to a certain way of working
	Out-of-school location

2. Do students with different motivational profiles differ in attitudes towards 'social implications of STEM' and 'a possible future career in STEM'?

Method

Sample

In the present article, we report results from a larger study. We used the same data for the analyses of the motivation profiles as in the study reported by Vennix et al. (2018). In the study, 702 students (grades 7–11) participated in 12 different outreach activities. Table 1 shows a brief overview of the different overarching types of outreach activities. Detailed descriptions can be found in Vennix et al. (2017).

Instrumentation

After participating in an outreach activity, students completed a questionnaire containing items about motivation (controlled and autonomous) and attitudes (social implications of STEM and career interest) (Vennix et al., 2018).[1] The questionnaire about motivation was based on the Academic Self-Regulation Questionnaire (SRQ-A, Deci & Ryan, 2000). The four subscales (extrinsic, introjected, identified, and intrinsic) were used to calculate controlled motivation (average of extrinsic and introjected subscale) and autonomous motivation (average of identified and intrinsic subscale). Questions were phrased as: "After attending this activity, I am motivated for STEM, because I want to learn new things"). For measuring STEM attitudes, two subscales of the Test Of Science Related Attitudes (TOSRA, Fraser, 1981) were used: career interest (feelings about pursuing a career in STEM, as an affective component) and the social implication of STEM (to be informed about the meaning of STEM), both with 7 items. As shown in our previous studies and in Table 2, the questionnaire was valid and internally consistent (Vennix et al., 2017, 2018). Table 2 was adapted from Vennix (2020). All items in the questionnaire used a five-point Likert scale ranging from (1) strongly disagree to (5) strongly agree. For all scales, we refer

[1] The full questionnaire can be obtained from the first author.

Table 2 Means, standard deviations, Cronbach's alpha reliability and sample items

		Number of items	M student level	SD student level	Cronbach's alpha	Sample items
Motivation	Controlled motivation	8	2.40	1.02	.85	I am motivated for STEM, because that is what others (parents, friends) expect me to do
	Autonomous motivation	8	3.66	.89	.93	I am motivated for STEM because I enjoy doing it
Attitude	Social implication	7	3.63	.68	.77	Science and technology can help to make the world a better place in the future
	Career interest	7	3.36	.86	.83	Working in a science laboratory of the high tech industry would be an interesting way for me to earn a living

Table 3 Results from Latent Profile Analyses with one to five profile solutions based on controlled and autonomous motivation as variables

Number of profile solutions	AIC	BIC	SBIC	LMRT	Entropy	Smallest profile (%)	−2LL
1	3824.04	3842.26	3829.55	–	1	100	1908.02
2	3774.12	3806.00	3783.77	53.214 (0.01)	.64	33.9	1880.06
3	3706.99	3752.52	3720.77	69.594 (0)	.76	13.7	1843.50
4	3647.81	3707.02	3665.74	62.017 (0.002)	.76	5.4	1810.91
5	3636.15	3709.01	3658.21	16.813(.0682)	.71	4.7	1810.91

to scores between 2.8 and 3.2 as moderate, scores below 2.8 as low, and scores above 3.2 as high.

To gain some additional insight into the interpretation and meaning of our findings, we informally observed during the activities and spoke to some students about their experiences.

Analyses

To answer the research questions, several analyses were performed. To answer the first research question, we performed a latent profile analysis (LPA) conducted with Mplus 7.31 (Muthén & Muthén, 2012) in several steps. LPA is a person-centred analysis technique that can identify subgroups of individuals who have a corresponding pattern of responses regarding key variables (i.e. indicators: controlled and autonomous motivation). In the LPA model, estimates were made of the means and (co)variances of the indicators, the proportion of the total sample for each profile and the probability of each case belonging to a particular profile. In the LPA, the mean scores for autonomous and controlled motivation were modelled as an indicator for a latent variable (i.e. the number of profiles). We explored solutions with one to five profiles. To assess the fit of the LPA solutions, several statistical tests were used. The Akaike Information Criterion (AIC; Akaike, 1974), Bayesian Information Criterion (BIC; Schwarz, 1978), and Sample size Adjusted BIC (SBIC; Sclove, 1987) were used; lower values for these tests indicated a better model. The Lo-Mendel-Rubin Likelihood Ratio Test (LMRT) was used to compare the solution with a solution with one less profile. When a solution with more profiles is a better fit than a solution with one profile less, this is shown by a significant *p*-value (Nylund et al., 2007). A high value for the entropy indicates an optimal fit. The −2*loglikelihood (−2LL) was computed to indicate the distance between model and data (Embretson & Reise, 2000). A significant decrease in −2LL for a model with more profiles indicates a better fit. All these test results were used to find the optimal profile solution, by checking if most tests showed a significantly better result, taking into account the most realistic solution.

To answer research questions two, we examined for each group whether the groups had different scores for the perceptions of their learning environment and their attitudes

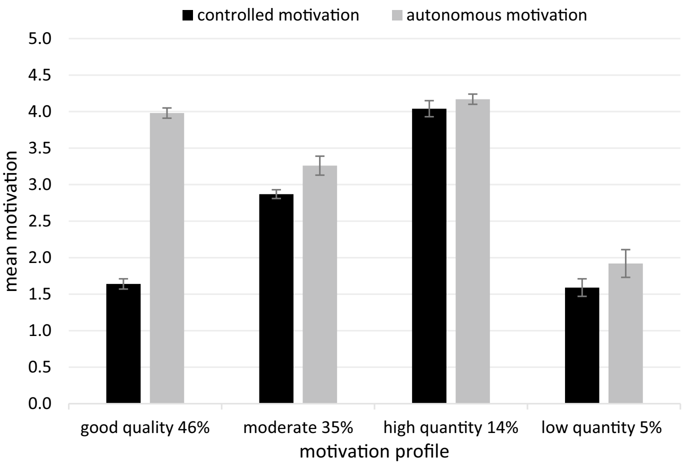

Fig. 1 Mean scores and standard deviations of both controlled and autonomous motivation for each motivation profile found

towards the social implication of STEM or a career in STEM across different activities using an ANOVA and a post-hoc Scheffé test.

Results

Which motivation profiles regarding experiencing STEM exist among students after attending outreach activities?

Table 3 shows the results of the latent profile analyses. The four-profile solution was the preferred solution as shown by most fit indices. The entropy statistic dropped for a five-profile solution. The fifth profile did not add a unique profile, but a similar profile compared with one of the other profiles emerged. Although the entropy did not increase, the other fit indices dropped for the fourth profile. Therefore, the four-profile solution was considered the most valid solution.

Variances for both motivations were fixed to obtain a stable solution. A graphical representation of the means, standard errors, and percentages of occurrence of the four profiles solutions is shown in Fig. 1. The naming of the profiles was taken from the literature (Vansteenkiste et al., 2009). The profile with the label 'good quality' is considered better than the high-quantity profile in an educational context. The high-quantity profile (i.e. both autonomous and controlled motivation are present) has a high degree of controlled motivation, which can make learners dependent on these external factors. The good-quality profile does have autonomous motivation, but not that external dependence. Thus, a good-quality profile is different from a high-quantity profile and considered to be of higher quality.

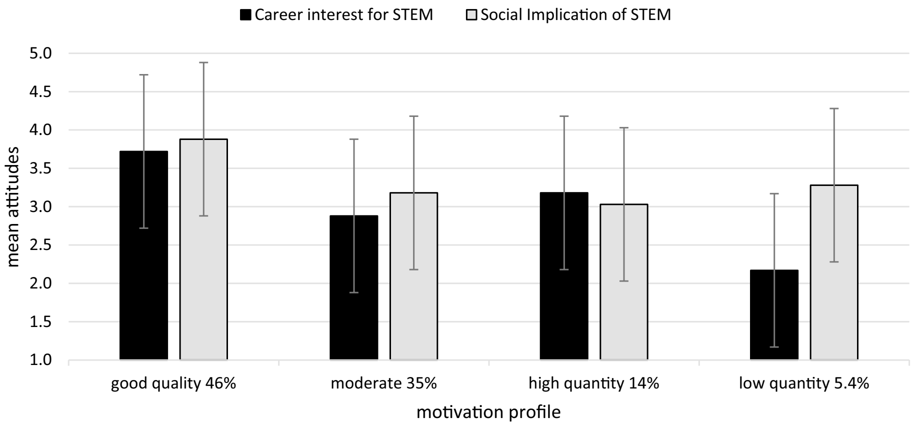

Fig. 2 Mean scores and standard deviations of students' attitudes for each motivation profile

No motivation profile with high controlled and low autonomous motivation (poor quality) was found. The *good-quality* profile (low controlled and high autonomous motivation) was the most common profile (46%). Students in this profile were intrinsically motivated to learn for STEM.

Students with a *moderate motivation* profile (35%) had moderate (neutral) scores for controlled and slightly high scores for autonomous motivation. Thus, students were motivated, but felt that external factors were important for their motivation as well.

Students with very high scores for both autonomous and controlled motivation had a *high quantity* motivation profile (14%). Although these students were very intrinsically motivated, they experienced also external factors to be important for them.

Much less students (5.4%) showed a *low quantity and low-quality* motivation profile (low scores for controlled and autonomous motivation).

Do students with different motivation profiles differ in attitudes towards social implications of STEM and a possible future career in STEM?

Figure 2 gives a graphical representation of the average scores of students' perceived attitudes for each motivation profile. All profiles were characterized by an equal distribution of both boys and girls.

ANOVA showed that students with *good-quality motivation* had statistically-significantly the most positive attitudes towards both social implications ($F(3,698) = 14.91$, $p = 0.00$, $\eta^2 = 0.060$) and career interest ($F(3,698) = 30.77$, $p = 0.00$, $\eta^2 = 0.117$) compared with students in the other profiles using the Scheffé-test for post-hoc comparisons. Although the effect sizes were relatively small, the differences were statistically significant. Students in the other profiles had no significant differences in attitudes towards the social implication of STEM. Thus, no statistically-significant difference could be found for attitude towards the social implication of STEM between the moderate, high-quantity and low-quantity profiles. Attitude towards the social implications of STEM was perceived to be moderate to high in these groups. Students with low-quantity and moderate motivation reported an average or neutral attitude towards a possible future career and were not statistically-significantly different from each other. Students' attitude towards the social implications with high-quantity motivation was moderate and these were the only students with a slightly-higher attitude towards future career intentions compared with the social implications attitude.

Conclusion and discussion

In the present study, we explored students' motivations for STEM after attending outreach activities using a person-centred approach. In our view, the findings have given some interesting insights into the processes underlying the motivation of students. This might be of general value for enhancing the number of students studying STEM and considering pursuing a career in STEM.

First, we explored motivational profiles for students attending outreach activities using latent profile analyses. We found the best fit for four different profiles, based on combinations of controlled and autonomous motivation scores: a good-quality motivational profile (46%), a moderate motivational profile (35%), a high-quantity motivational profile (14%), and a low-quantity motivational profile (5.4%). Compared with studies in regular school situations (Hayenga & Corpus, 2010; Ratelle et al., 2007; Vansteenkiste et al., 2009), no profile with high-controlled and low-autonomous motivation was found. As argued below, the distribution over the different profiles differed from most other studies in that almost all students were motivated (no low-quantity motivation) after attending an outreach activity, and that those students with a predominantly controlled motivation seemed to experience the outreach learning environment as contributing to some intrinsic motivation as became clear from the informal interviews.

Informal observations and conversations with students – not reported in this manuscript – confirmed the distinctness of the profiles and indicated the existence of no other profiles. Although limited, this additional information suggests that these profiles could well align with typologies of students' attitudes towards science as found by Costa (1995) and others.

Almost half of the students had a good-quality profile (high autonomous motivation, low controlled motivation). As Ratelle et al. (2007) did not find this good-quality profile at all among high-school students, they suggested that the high-school environment was possibly not the environment that successfully fostered students' good-quality motivation. When they found a good-quality profile among college students, they explained this in terms of the college environment having more opportunities in terms of choice. Compared with our study, this might indicate the potential strength of outreach activities in terms of motivation and a possible interest in a future career in STEM. On the other hand, most (although not all) students already choose science courses in high school because of an initial preference for STEM. In line with their motivational profile, students with a good-quality profile had statistically-significantly the most positive attitudes towards the social implication of STEM and towards pursuing a future career in STEM.

The second common profile (35%) that we found was a moderate motivation profile. Jansen in de Wal et al. (2014) found a similar moderate profile, but with less occurrence, for teachers' motivation. Vansteenkiste et al. (2009) did not find this profile and Ratelle et al. (2007) did find an even higher percentage of high-school students with this profile. As proposed in the literature (Ratelle et al., 2007), students with a moderate motivational profile (or combined) can adjust their motivation, as shown by realizing students' feelings of competence, when some controlling factors, such as connection with peers and personal relevance, are eliminated.

Students in the high-quantity motivation profile (14%) had extremely high scores for both controlled and autonomous motivation. Both Vansteenkiste et al. (2009) and Ratelle et al. (2007) found much larger percentages for these high-quantity motivation profiles. The low percentages of students having a high score for controlled motivation might be an indication that the lack of grading in outreach and voluntary participation generally contributed to this ratio, because students probably felt more autonomy and competence. Students with this motivation profile felt some internal conflicts and were most sensitive to learning environmental factors, such as connection to their peers and way of working. Their attitude towards the social implication of STEM was lowest compared with students with other profiles. Because students' controlled motivation was highest in this motivation profile, this indicates a negative association between the attitude towards social implications and controlled motivation. This is in line with the findings in our prior study (Vennix et al., 2018).

Only 5.4% of students were found with a low-quantity profile (low controlled and autonomous motivation). Both Vansteenkiste et al. (2009) and Hayenga and Corpus (2010) found almost 30% of the students with this profile. The results indicate in our view that, in an outreach learning environment, students with this profile might be an artefact, because a large percentage of the students in our sample was selected and those who were not selected found the outreach activities interesting.

Overall, the attitude towards the social implications of STEM was high, possibly because of the general emphasis on applications and impact of STEM during outreach activities. Students highlighted different examples for the same activity, because they found different content valuable and personal relevant. A possible conclusion is that emphasizing the social implication of STEM is important and should be achieved in different ways.

Content is an important factor in motivation, because all students experienced personal relevance of the subjects when content was in line with their personal interests. In addition, motivation is also dependent on the bias of former experiences, namely, activities related to STEM or the content of STEM, and therefore is subject sensitive. Even when an activity is short in duration, this still can make a difference. Also, stepping into a relatively-unknown world can even support feelings of competence and relatedness and give students a direction in possible career options. The content external experts from the industry can add to the students' knowledge about STEM and possibilities in STEM via outreach, and is of great value for students when their personal needs are fulfilled. This is in line with the work of Hellgren and Lindberg (2017) who claim that motivations of students did not decline over time, but stayed the same due to their intervention. Thus, adding outreach activities to the curriculum might also reduce a possible decline in motivation over time.

Limitations

Although we undertook a multiple case study with a wide variety of activities, our sample might have missed certain important characteristics, such as online learning environments. As a result, we are not able to generalize the results. Second, most students questioned in this study volunteered to participate in an outreach activity and, because of possible former positive experiences, they participated more than once. In addition, most students were already enrolled in a natural science cluster. This might result in perceived motivations and attitudes being more positive. We did not control for these initial motivations and attitudes and earlier activity experiences. Third, we interviewed students for just one activity. More interviews with students with different profiles attending other activities might have revealed even more insight into students' self-reported motivation, because other activities emphasize other characteristics. Repeating interviews with the same students after a certain period might give some extra information about the stability of motivation profiles. Fourth, although students were interviewed directly after the activity, it is difficult to form conclusions about causality. Last, we did not include observations of student–student and student–guide interactions during an activity. This might have added some extra information about processes during an activity influencing student motivation and insight into the congruence between school science and the STEM-world.

Implications

The results of this study suggest that, by adding outreach activities to the curriculum, students might be better prepared and informed about possible STEM careers. We showed in our exploratory study that, after attending an outreach activity, students had different motivation profiles for STEM and that, for each profile, different external factors seemed to be important. These findings stress the importance of customizing outreach environments to students' needs. By doing so, outreach providers can use the activities effectively to positively develop students' attitude towards STEM and a possible career in STEM. For example, if students do not have a specific interest in STEM, more emphasis can be given to the more-societal aspects and the impact on daily life. In addition, career options related to STEM might be given. Students with specific content interest in STEM might benefit from content-based hands-on activities that go into more detail. STEM-based companies can choose the specific factors on which they want to focus, and schools (teachers and counselors) can add these to better customize activities to their curriculum. This might also be applied to fields outside STEM. As this study was exploratory, further research, more testing research and longitudinal research are needed.

The group of students with a moderate motivational profile was the second-largest group in our study. These students often did not know into what profession they wanted to enter, and their motivation was also adaptive (Ratelle et al., 2007). Thus, this moderate-motivated student group is important because these students might be potential scientists if they are informed and approached according to their interests.

Therefore, it is highly recommended to add a variety of outreach activities to the curriculum to support as many as students as possible and to expose them to multiple outreach activities during their high-school careers.

The outreach learning environment showed a variety of aspects that can be linked, on the one hand, to structured informal learning environments and, on the other hand, to context-based learning environments. Instruments used for regular school learning environments proved to be useful in our person-based approach in this study.

In addition, the person-centred approach used in this study might complement approaches that attempt to characterize the learning environment based on, for example, perceptions of and reactions to the learning environment for the entire student group. A person-centred approach could provide insight into how possible subgroups of students have internally consistent but different perceptions and experiences. Hence, they also might respond to it differently. In our study, tools for analyzing regular school learning environments also proved useful for our person-centred approach to school learning environments, and we were able to gain an initial idea of the possible relationships between aspects of the school learning environment and the experiences of students from different subgroups. This supports the idea that a person-centred approach can enrich learning environments research and could provide a basis for optimizing the learning environment to meet the needs of such subgroups (den Brok et al., 2010).

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