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Gifted students' experiences with participation in enrichment programs at talent centers in Norway

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ABSTRACT

Gifted students may be at risk of school disengagement due to lacking intellectual challenges. Four talent centers were established to offer makerspace enrichment programs, because makerspace activities promote engagement and science, mathematics, and technology learning. In the current study, we investigated gifted students' experiences with makerspace enrichment programs in Norway in terms of social aspects, learning aspects and teacher support aspects. We conducted semistructured interviews with 15 participants (15–16 years) from four different talent centers across the country. Findings suggested that the informants had an overall positive experience of participation and that most were more engaged at talent centers than at their home schools. In addition, the makerspace approaches seemed to suit gifted learners' need for more complex subject content and facilitate interaction with peers and teachers with similar content knowledge/interest. We concluded that makerspace activities at talent centers constitute an important supplement to ordinary school for gifted students.

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1. Introduction

Gifted students have needs that relate to frustration in learning situations, conflict with other students, and the risk of feeling socially isolated, as argued by Peterson (2009). According to Coleman and Cross (2021), vulnerability to these issues among gifted students is not an inherent feature but rather a consequence of accelerated development. Winsor and Mueller (2020) describe how this vulnerability of gifted students can be explained by the risks associated with being different. These risks are described as occurring when a student is “out of sync” with his or her own identity and with their immediate family or school environment.

Disengagement is a risk factor for both lower achievement than one's potential (i.e., underachievement) and school drop-out. Disengagement is exacerbated by feelings of alienation (Rumberger, 1987; Wehlage et al., 1989), which is among the more commonly described issues of gifted students, in addition to having a need for differentiated learning experiences. On the other hand, if students

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strongly identify with the school and their peers, they typically demonstrate a large degree of active involvement in both learning and social aspects of the school. Such student engagement is associated with greater achievement and retention in school (Finn & Zimmer, 2012; Moubayed et al., 2020; Piscitello et al., 2022).

As an initiative to meet the needs of gifted students, enrichment programs aim to promote a greater depth and breadth of creative individual learning experiences (Brigandi et al., 2018; Schiever & Maker, 2003). Kim (2016, p. 104) defines enrichment programs as follows: “[...] organized educational activities beyond regular class activities that (a) occur during the school year or summer, (b) are organized to serve gifted students, and (c) are supervised by adults”. Research has indicated that enrichment programs have a positive effect on academic outcomes and motivation for gifted students (Kim, 2016; Martin, 2005; Moon et al., 1994; Olszewski-Kubilius & Lee, 2004). A systematic review by Baccassino and Pinnelli (2023) indicated that enriched learning experiences are important for gifted students to counteract potential underachievement and school drop-out.

In Norway, attention to the needs of gifted students has increased during the last decade. An expert group described several areas for further development to meet gifted students’ needs. One of these areas of development was to provide more enrichment opportunities (Official Norwegian Report [NOU], 2016, p. 14). Furthermore, the committee noted that there were few to no enrichment opportunities in or outside Norwegian schools. In conclusion, the committee emphasized the need to provide gifted students with high-quality learning opportunities, develop an understanding of gifted students’ social and emotional needs and provide highly qualified teachers to help them manifest their abilities as achievements (NOU, 2016, p. 14). Based on this report, four talent centers in Norway were established in 2015. They were developed as an out-of-school opportunity offered during school hours for students with an interest in and talent for science and mathematics. The talent centers offer activities regarded as enrichment programs, according to Kim (2016).

The main goal of the talent centers is to further develop students’ motivation for and interest in science, mathematics and technology and provide them with the opportunity to meet other students with the same interests (Lødding et al., 2020). The talent centers are situated in four cities (Oslo, Bergen, Trondheim and Tromsø), and students from large areas gather 3–4 times per year for stays usually lasting two days. The educational background of teachers at talent centers differs somewhat from that of regular teachers because they are more focused on science, technology and mathematics. Most of the talent center teachers have a master’s or bachelor’s degree in science, technology, or mathematics, and/or have working experience from within those fields, in addition to (or integrated in) a teacher/pedagogical education. Student group size is reduced compared to ordinary school with an average of about 20 students per group (between 17 and 24) with one, or most often, two teachers.

To take part in the talent centers, the students sent a motivation letter to the talent centers. Additionally, the students, parents and teachers used a rating scale developed in Denmark to indicate giftedness (for details about the scale, see Nissen, 2019). Nissen’s (2019) assessment scales for teachers and parents are similar and tap into both student engagement and achievement. If there is a discrepancy between what parents can observe at home and what teachers can observe at school, it may indicate that the student is disengaged at school and at risk of achieving less than their potential. It is an explicit goal of talent centers to identify and include these students in their programs with the hope of increasing students’ engagement in school.

The talent centers aim to integrate mathematics, chemistry, biology and physics with technology and offer theoretical work as well as practical activities. This is done by using makerspace activities that connect the design and creation of a physical artifact to more theoretical concepts taken from science and mathematics. These artifacts often include electronic components and/or programmable devices (circuit cards). Some examples of such instructional designs are included in the appendix.

The relevance of makerspace activities for science is often emphasized in the makerspace literature (Sheffield et al., 2017), and some evidence of science learning has been identified. These include

learning regarding electric circuits (Litts et al., 2017; Pepler & Glosson, 2013) and improved grades in a science course in upper secondary education (Authors, *in review*). Moreover, a recent review revealed that making and makerspace activities increase engagement (Konstantinou et al., 2021), which is relevant for students at risk of disengagement. This seems to make makerspace activities especially relevant for the engagement of gifted students. However, little is known about the gifted students' perspectives regarding these activities. Thus, the current study aims to contribute to finding out more about the topic by capturing gifted students' experiences when participating in a makerspace-based enrichment program. Findings will be linked to engagement perspectives.

2. Theoretical perspectives – engagement and disengagement

Engagement is a multifactorial (Groccia, 2018) and developmental term (Finn & Zimmer, 2012) that involves the degree to which a student is involved in school, both socially and in a curricular manner. The three most common dimensions of engagement are behavioral, cognitive, and affective engagement (Fredricks et al., 2016; Salas-Pilco et al., 2022), which are described below:

- Behavioral engagement is defined by student participation, interaction, collaboration, skill development and the completion of learning activities.
- Cognitive engagement is related to, e.g., motivation and effort to learn, critical thinking and reflection.
- Affective engagement refers to students' attitudes, values, and feelings directed at teachers, peers, and courses.

Much of the engagement literature has shown a positive relation between student engagement and academic performance (Finn & Zimmer, 2012; Moubayed et al., 2020).

On the other hand, a lack of engagement, or disengagement, is connected to an increased risk of school drop-out (Finn & Zimmer, 2012; Piscitello et al., 2022). In previous research, the developmental trajectory of increasing disengagement has been highlighted due to the focus on how to turn negative development around to reduce dropout rates (Finn, 1989; Finn & Zimmer, 2012; Reschly & Christenson, 2006). Disengagement is connected to school dropout in such a way that a cycle of disengagement and alienation from school activities interact to worsen disengagement, which in turn increases the risk of school drop-out (Rumberger, 1987; Wehlage et al., 1989).

This developmental path is linked to gifted underachievement, as disengagement can be connected to lower achievement (Piscitello et al., 2022). Consistently attaining lower achievements than one can potentially reach is a way to define underachievement, and if students are caught in a disengagement and alienation spiral, an increased risk of school drop-out may develop. Therefore, identifying school disengagement in gifted students can be an important first step in avoiding more serious consequences further down the line. In the current study, the engagement/disengagement framework will be used to analyze gifted students' experiences of enrichment activities, which the students also compare to their ordinary schooling, because the identification of a connection between engagement/disengagement and either school or enrichment activities can inform how to break such a disengagement spiral.

3. Student aspects of participation

In the current study, we focus on three aspects of students' experiences with their participation in an enrichment program based on makerspace activities, namely, social aspects, learning aspects and teacher support aspects. These will be defined and elaborated upon in the following.

3.1. Social aspects

The social aspects of students' participation in enrichment activities include how and what kind of social interaction students prefer, what kind of social interactions students experience at enrichment activities and social behavioral issues (e.g., peer pressure or disruptive behavior).

Many gifted students need to meet other gifted students who mirror their interests and abilities (Neihart, 2021; Smedsrud, 2018) to decrease feelings of being different, which, in turn, increases the risk of disengagement (Rumberger, 1987; Wehlage et al., 1989). A study by Shernoff and Vandell (2007) indicated that participation in after-school programs had a positive effect on social competency for the general student population, and social benefits of enrichment activities have been reported for gifted students in particular (Moon et al., 1994; Olszewski-Kubilius & Lee, 2004). Moreover, Morgan (2007) showed that pull-out enrichment programs seemed to have social benefits for gifted students, as reported by both students and parents. A meta-study by Kim (2016) indicated that enrichment programs have a positive effect on academic outcomes for gifted students but that the relationship between pull-out programs and social development is not statistically significant. Adams-Byers et al. (2004) compared gifted students in homogeneous and heterogeneous groupings and concluded that the students perceived homogeneous grouping more positively in relation to academic outcomes; the group reported mixed experiences about which setting better met their social needs.

3.2. Learning aspects

The learning aspects of the students' participation in the enrichment activities include how satisfied the students are with what they learn, the difficulty level and depth of what they learn, and their learning tied to the makerspace activities (i.e., the specific enrichment activities).

Several studies have addressed gifted students' need for differentiated learning instruction (Hoth et al., 2017; Mellroth et al., 2021; Renzulli, 2022) and the opportunity to develop their interests in a subject through adapted and enriched learning activities (Renzulli & Reis, 2014). The findings indicate that learning opportunities are one of the most important factors in meeting gifted students' needs (Lubinski & Benbow, 2006) and that a lack of learning opportunities may lead to underachievement (Montgomery, 2009). A recent study found that differentiation strategies and materials for gifted students was underused (VanTassel-Baska et al., 2021), and gifted students need more open-ended tasks and the opportunity to discuss alternative or multiple solutions (Nadjafikhah et al., 2012). Lenvik et al. (2021) describe how gifted students benefit from grouping by level. These findings are in line with those of Steenbergen-Hu et al. (2016), who also found that special groupings might be beneficial for gifted students, but even within these ability groupings, gifted students need differentiated instruction and support to be truly engaged (Authors, [in review](#)).

3.3. Teacher support aspects

The teacher support aspects of the students' participation in the enrichment activities include how often the students ask for support, what kind of support they receive, the student-teacher relationship and teacher competence as perceived by students.

Both social and learning outcomes are affected by the student-teacher relationship and how much support students receive from their teachers (McGrath & Van Bergen, 2015; Sivan & Chan, 2014; Wubbels et al., 2016). For a general student population, the quality of the teacher-student relationship longitudinally predicts both the affective and behavioral engagement of the students (Thornberg et al., 2022). Furthermore, teacher involvement was positively associated with high-quality motivation in gifted students in their ordinary classrooms (Hornstra et al., 2020). Moreover, research has indicated that a lack of motivation (a central part of cognitive engagement, often referred to as a predecessor to behavioral engagement) is one of the main reasons for

underachievement among gifted students (McCoach & Siegle, 2003; Reis & McCoach, 2000; Snyder et al., 2021; Whitmore, 1981). Such supportive teacher involvement depends on teachers knowing and recognizing the need for support from gifted students; however, teachers need further education on the differentiation needs of gifted students (Laine & Tirri, 2016; Lenvik et al., 2022; Szabo, 2017). This lack of knowledge may lead to a lack of high-quality student-teacher relationships and essential support with concept learning (authors, *in review*), which may increase student disengagement.

4. Research questions and methods

Overall engagement is linked to the chosen three aspects of student participation, namely social aspects, learning aspects and teacher support aspects, as argued above. How the underlying dimensions of behavioral, cognitive and affective engagement can be connected to these aspects, however, has yet to be explored. Thus, the current study addresses the following research question:

- How do participants at talent centers experience social aspects, learning aspects and teacher support aspects of participation, and how can these findings be connected to behavioral, cognitive and affective engagement perspectives?

This is in line with what (Yin, 2004) describes as a “grand tour question”. The study was conducted by means of interviews with 15 students aged 15–16 years who participated at four different talent centers around the country. The study was approved by the Norwegian Agency for Shared Services in Education and Research (SIKT), which includes the former Norwegian Center for Research Data). This means that the current study was conducted in line with SIKT’s ethical guidelines regarding the participation in research and the related data collection, confidentiality, and safe storage, and particularly groups such as children. Thus, all participants provided informed and oral consent, and the data were saved to secure discs on the internal server of the institute handling the data.

Ten individual interviews and one group interview with 5 students were conducted. We used a group interview at one of the four talent centers due to time constraints, and the students were familiar with each other and preferred group interviews over individual interviews. The first and second authors conducted the interviews. The first author conducted the individual interviews, and the second author conducted the group interviews using the same protocol. All interviews were conducted in the participants’ native language (Norwegian), and the results were audio recorded. The interviews were transcribed, and all personally identifiable information was deleted. Most of the informants were selected for participation by their teacher at the talent center. In some cases, the parents were the driving force behind participation. For the study, the students participated of their own free will by sending a written request before the researchers met up. The interviews were semistructured, employing open-ended questions to explore the students’ individual experiences at the talent centers, while some questions were asked of all the students. The individual interviews lasted between 45 min and 1 h. One individual interview lasted one hour and 20 min, and the group interview lasted one hour and 35 min. The interviews were analyzed in NVivo version 11TM (Castleberry, 2014). Some examples of the open-ended questions asked are as follows:

- Could you tell us about your overall experience with school?
- Is there a difference in how you learn at the talent center compared with your home school?
 - If so, how would you describe the difference?
- What factors are important for you to thrive at school or here at the talent center?
- Could you describe your relationship with your teachers at your home school?
 - Which characteristics do you feel are important to a teacher?

- Do you experience any difference between the teachers at your home school and those at the talent center?

4.1. Data analysis

We applied thematic analysis when coding the data, and one of the benefits of such analysis is its flexibility (Braun & Clarke, 2006). The analysis was based on the three themes presented in the research question, namely, social aspects, learning aspects and teacher support aspects. This analytical process can be described as exploring and coding material with a focus on meaning and the interpretation of meaning (Miles et al., 2018). The process of developing themes and coding the material also involved continuously questioning the material, codes and interpretation of meaning (Brinkmann, 2014) and cross-checking the interpretations with coauthors or intercoder agreements (Sahlin, 2022). To ensure a common understanding of the material at hand, the coauthors discussed the themes and interpretations of meaning and compared them with theory and their own preconceptions during the analytical process. The latter is often described as triangulation (Maxwell, 2008) and can improve the validity of a study (Golafshani, 2003). The term “theory” is used to indicate whether our findings diverged from those of other similar studies (e.g., Landis & Reschly, 2013) or were seemingly in line with other findings and how other researchers understood the concept (e.g., Salas-Pilco et al., 2022). According to Golafshani (2003), if the findings seem to contradict the more general understanding of the concept, the reliability of a study should be questioned.

In thematic analysis, researchers play an active role in developing themes based on their knowledge, interest and understanding of the concepts at hand (Braun & Clarke, 2006), which represents both a strength and a possible weakness in overlooking important themes in the material or a misinterpretation of statements. Thus, thematic analysis is also a matter of reliability, as themes do not reside “within the material”; rather, they reside within a researcher’s mind (Braun & Clarke, 2006). The subjective nature implies that themes, in most cases and in this study, are developed inductively.

The first and second authors coded the interviews separately and discussed the themes afterward. The initial coding of the material ended with a relatively long list of codes. We grouped the codes that we again related to interesting topics, subthemes, and possible overarching themes. Moreover, we related the subthemes to the three overarching themes presented above. The initial codes were both phrases and sentences. For example, the initial codes “guidance”, “mentors not teachers” and “relationship with mentors vs. teachers” were related to the subthemes “relationship with the teachers/mentors/guides” (the first two codes) and “difference between home school and the talent center” (the third code), and all three codes to the overarching theme “teacher support aspects”. The codes “focus on learning, not achievement”, “supporting each other”, “no social noise at the talent center”, and “feeling different at the home school” were related to the subthemes “shared interest and social experience” (the first code), “social support or academic support” (the second and third codes) and “comparison with others” (the last code) and all four codes to the overarching theme “social aspects”. Codes like “from abstract to specific”, “not to high level” and “different methods” were related to the subtheme “Descriptions of their own learning” “learning challenges (high/low)” and to the overarching theme “Learning aspects”.

A relatively small but interesting subtheme described in the Results section is whether the students described themselves as social or not at the talent centers or in general. The codes that we saw as indicating self-identification as social were as follows: “I am a social person”; “I would like there to be more social activities”; and “I am mainly here to meet new friends”. One informant simply answered “no” when asked if he was a social person, while another described how he “was mainly at the talent center to learn, not to get new friends”. These descriptions might also be interpreted as a description of what they wanted out of their participation.

After the thematic analysis, the findings based on the social, learning and teacher support aspect themes were analyzed further using the engagement/disengagement framework. The first and last

authors identified key words or phrases from the extracts indicating engagement or disengagement (e.g., enjoy, like, interest, motivated/unmotivated, friends, satisfied, work in groups, friends, not interesting). These key words or phrases were then used to assign which engagement dimension (s) the extracts belonged to, to be able to say something about potential links between the social, learning and teacher support aspect and the behavioral, cognitive and affective engagement dimensions.

The quotations from the informants were translated from Norwegian (Bokmål) to English. There is always a risk of losing meaning when translating text from one language to another (Hammersley, 2010), especially local expressions or metaphors. We tried to avoid using quotations with words or expressions that we deem to have special meaning in Norwegian or that are not easily translated. One example is that one of the students used the Norwegian term “huttiheita”¹ when describing his geographical placement compared to the placement of the talent center. Even though English is a richer language than Norwegian is, there is no direct translation.

5. Results

5.1. Social aspects

The interviews indicated that the participants at the talent centers formed a heterogeneous group. Six participants described themselves as social, five described themselves as “not social”, and the rest did not express an opinion. The students described whether they “liked” social settings or not. For example, seven of the students participated in many activities outside school, while eight of the participants described how they spent most of their time on their computers or with a few friends. Commonly, the informants tended to cultivate their interest in science outside school and in their own free time. This demonstrates the connection between behavioral engagement (i.e., participation, interaction and collaboration) and non-school activities for the talent center participants. This connection holds even for school subject content, when not participating in the talent center enrichment program, which can be considered part of the gifted students’ formal schooling.

When asked how they would describe their social experience at the talent centers, they all responded positively. However, they focused on somewhat different aspects of the experience.

I think it is very exciting because I can talk about the subjects with the other students in a different way than at my home school. Here, all the students seem motivated in a different way. This might be because there are more students at the same level than in my regular classes. (I. 1)

This student focused on the aspect of motivation and the level of competence that the participants seemed to share, while another student highlighted her shared interest in general when asked the same question:

First, we all share the same interest or the same field of interest. In addition, when we share the same interest, we talk in a different way. I am sure that if every participant here was in my class at school, we would be friends. In that way, I have met many potential friends here. (I. 3)

These two extracts illustrate that cognitive engagement (i.e., motivation) is connected to students being at the same knowledge level for these students, and that affective engagement (i.e., attitudes and feelings towards their peers) is connected to students sharing interest. Therefore, sharing both knowledge level and interest level is relevant to gifted students’ engagement levels.

When asked about their experiences at the talent center and how it compared to their home school, they described different social experiences. For example, that all the students in the

¹Huttiheita means something similar to the slang term “the boondocks” or “far away from people” and living in a “rural area”. In this particular setting, the informant used the term to describe how interested he was in participating and how he was not that kind of “social” butterfly: “Jeg er jo veldig interessert i å delta, jeg lever jo langt oppi huttiheita og det er heller ikke lett å være sosial der, det er også veldig langt å reise”. (e.g., Norwegian).

enrichment program were there to learn and that there was less of what they described as “social noise”. Social noise was described by the informant as an environment that can include bullying or disruptive behavior: “I can be with every one of them at any time; no one has bad behavior or bullies anybody” (I. 5). Based on the preceding excerpt, this informant seemed to have had some experience with bullying at the home school; thus, the talent center represented a positive break from the regular classroom setting.

The participants were all asked about social support and well-being at the talent center. Six informants highlighted the lack of social pressure at the talent centers. This pressure could be related to dress code, the code of conduct or responsibility in group work, as described by one informant:

I am not sure if the social conduct is better or not. However, it is different. For example, there is no pressure about what clothes you wear among the participants. At my home school, there is lots of pressure about clothes”. (I. 7)

As the informant noted, it was not clear whether the lack of pressure to wear certain clothes was good; however, this social conduct was different from the social conduct at their home school. The reason that there was no pressure at the talent center was not mentioned but may stem from the strong focus on learning and that the interest in learning at the talent centers eliminated any focus on other activities not related to learning. As another informant described, “Here, it feels like we are working; everyone is here to help each other. At my home school, it feels more like we are in kindergarten” (I. 9). These extracts underline that the student’s shared learning purpose instilled a sense of belonging (i.e., affective engagement) which was connected to less social pressures and social noise.

5.2. Learning aspects

In general, all the participants had a positive experience attending talent centers in relation to their learning experiences. An example from the interviews is as following:

For me, the level of learning is high enough and fits me very well. I feel I understand everything and can start to work fast after the instructions are given. At the same time, it is exciting because I learn new things, such as how to build a drone. (I. 8)

Additionally, ten other participants were also satisfied with the level of learning (challenges) participating. However, three students also seemed to describe lack of challenges: “I don’t feel that the tasks are that challenging. For me, the level could be much higher than what it is right now” (I. 10). This illustrates that the students at the talent centers are not a homogenous group. This also indicates a need for differentiated instructions and the individual adaptation of the learning material at talent centers. This adaptation seems central to the students’ affective engagement (i.e., excitement towards course content) because this engagement is closely linked to the feeling that they can learn something new.

When we asked the informants about why they felt they learned more and how the learning experience at the talent center was different from that at their regular schools, the students gave diverse responses. Five students described that they were able to research a topic more deeply at talent centers than at their regular schools:

In a way, we go more in-depth into the topics. We learn more than what we would have in school, more about the different themes. At school, we only learn exactly what we need for a certain test; here, we learn what we think is interesting. It is hard to describe, but it is a totally different experience than at school. (I. 13)

This extract illustrates the connection between being able to go deeper into the course content to cognitive engagement (i.e., motivation) as finding content interesting depends on the students being allowed to dig deeper.

Three students also focused on how the group work at talent centers was somewhat different than that at their home schools:

I think it is very nice here because you can choose whether you work in groups. Everyone in the group works; if you understand what I mean and if you want to work on your own, that is also totally fine. (I. 14)

Here, a connection between choosing to collaborate (i.e., an indicator of behavioral engagement) and that all students in the group contribute, is emphasized.

Another experience that all students except one seemed to relate to learning was the combination of theory and practical tasks:

I think the way we learn here is different. We can do many of the tasks individually, but not everything. Here, we can test what we learn. As an example, we are building a bridge and then will see if what we calculate (such as the weight and height) works. Here, it feels like we learn how to make the things you read about; at school, I feel like it's all about memorizing what you hear in the class. (I. 15)

The students were theoretically strong, but they appreciated the practical work and especially how it was combined with theory. They highlighted that they enjoyed moving from ideas to theory to construction, and if their calculations did not work, they identified weak points. Their affective engagement, (i.e., enjoyment) was therefore connected to the instructional design of the makerspace activities. The students seemed to reap the benefits of open-ended tasks in which they engaged in a creative thinking phase before beginning to work.

5.3. Teacher support aspects

In our view, the informants provided interesting descriptions about motivation, the pedagogical approach and social adjustment in relation to the personnel at the centers. Five of the informants seemed to describe the pedagogical personnel in a different way than their schoolteachers and more like role models. One informant described that she did not truly perceive the teachers as teachers but rather as discussion partners or role models:

I don't really know. They do not even feel like teachers. They help you in a way, but it's different. It is more like a discussion of the subject. It might be because this is not ordinary school; however, it is different, and I lack the words to describe it. (I. 4)

This student's description indicates a master-apprentice relationship rather than a more traditional teacher-student relationship. Another informant described the relationship in the following way:

Coming here and talking to actual professionals within their field, and at the same time, they are very engaged and like to have conversations with us; it is special. Some teachers do not care that much about the subject. Here, I get inspired and meet people who work within the field (e.g., physics, math, chemistry or engineering). (I. 1)

This student appreciated meeting experts in science and mathematics and discussing themes of interest with them. That the talent center teachers' engagement in their subject content is viewed as inspiring (i.e., an indicator of both cognitive and affective engagement) suggests a certain infectiousness of high engagement. From the informants' view, the teachers, and other experts they met seemed to be less like teachers and more like mentors in their endeavors at the centers. The fact that teachers could draw from their practical experiences within their respective fields also enabled the teachers to make connections between theoretical and practical approaches to problem solving. Overall, the informants described the teachers at talent centers as passionate and inspiring. Moreover, they noted the social aspect of how they related to the pedagogues. In the same way that the gifted students adapted to their peers and classroom environments, they also seemed to adapt their behavior to the teachers. Here is an example from one informant's description of this phenomenon:

In a way, you adjust yourself to the teacher who teaches you. When you ask a question, you know what kind of answer you will receive. You ask the question if you know you will get a good answer. And if you know you will not get an interesting or good answer, you do not ask the question. (I. 6)

Importantly, this informant felt there was a point in asking questions when participating in the program. However, she did not always feel this way at her home school. The informants described that

they did not ask questions in class at their home schools because they would not always receive a fruitful answer. Moreover, one student explained that they refrained from asking questions to not put the teacher in a difficult situation: “At school, I don’t really ask questions because the teacher gets insecure. So, I am not really used to asking questions in class; however, here I ask them sometimes” (I. 3). Another student expressed that she had confidence in the teacher’s expertise but that she understood that the teacher must spend more time helping weaker students; thus, she avoided asking questions. Hence, for diverse reasons, the students seem to be less behaviorally engaged (i.e., less participation by avoiding asking questions) in class at their home schools but not because they did not want to be engaged.

As reported by some of the participants, some of their schoolteachers acted disengaged towards the gifted students by not giving thorough answers to their questions causing the students to stop asking such questions. This indicated that a teacher acting disengaged towards the gifted students (whether due to lack of conceptual knowledge or insecurity about their knowledge) can lead to disengagement (i.e., lack of participation in asking questions) for the gifted students. Namely, that disengagement can be viewed as infectious in a similar manner to how engagement can be infectious. Some gifted students also scrutinized their teachers’ competencies and stated that their perceptions of their teachers’ subject knowledge curbed their enthusiasm, which in turn affected their interpersonal relationships with their teachers.

The aspect of relating to both the teachers and the other participants at the talent centers was often described as “speaking the same language” by the informants, as they used somewhat different descriptions of this, for ten participants, this seemed to refer to knowledge and enthusiasm. The participants noted how the teachers could explain and explore certain topics while also discussing creative solutions to the tasks at hand. This aspect seemed to be overlooked or to be considered too time-consuming in their regular schools. The tasks of exploring, discussing, and developing multiple solutions to a task support enrichment. In this way, teachers at talent centers can be understood as personnel who inherently use enrichment strategies to meet gifted students’ needs.

6. Discussion

Whether gifted students have different social needs than regular students has been discussed in several publications (Coleman & Cross, 2000; Cross, 2002; Peterson, 2009). In this study, the students seemed to thrive socially while participating at the talent centers. In line with the findings of a previous study (Smedsrud, 2018), the students related to the interests of the other students at the talent centers and expressed excitement for the academic challenges and learning content. This shared experience seems to be important for positive social experiences in learning situations and might explain the lack of such experiences at students’ home schools. Furthermore, group work in regular classes might be challenging for gifted students because they may experience loss of control or lack of participation by other members of the group (Smedsrud, 2018), as indicated by some of our participants. Nevertheless, at the talent centers, most of the students enjoyed group work; they felt that the other students had the same energy, interest and enjoyment as they did.

The fact that gifted students enjoyed group work is an important point because of the prevailing notion that gifted students prefer to work alone (Rinn, 2018). However, in this study, it seemed that the students preferred to work with other compatible peers. For some students who have had negative experiences at their home schools, it might be especially important to experience such positive collaboration to avoid potential disengagement. The enjoyment of collaborating (behavioral engagement) with other gifted students has its roots in both cognitive and affective engagement. Several students list the level of content knowledge (cognitive) and shared interest and enthusiasm (affective) as reasons for this enjoyment and the lack of a corresponding community at their home schools, i.e., that they have less in common with their peers back at school. Such alienation may decrease behavioral engagement, resulting in behaviors such as less interaction with peers/teachers

and hesitancy to collaborate with other students, which may be behind the common perception that gifted students are less social than other students.

It has been suggested that meetings with highly trained and competent teachers have a positive effect on both the academic and social needs of gifted individuals (Dai & Rinn, 2008; Hattie, 2002; Preckel & Brüll, 2010). In the current study, teachers seemed to be an important factor that differentiated talent centers from regular classrooms. Mills (2003) indicated that teachers who are best suited to teaching gifted students are those who are similar to their students. The fact that the educational background of the talent center teachers in this study is largely connected to science and mathematics subjects to a greater degree than that of the teachers at the gifted students' schools may increase this similarity, as content knowledge and interest in science and mathematics will be greater for teachers at talent centers. Accordingly, a study by Hoth et al. (2017) indicated that the general population of teachers may have little content knowledge.

The informants described the teachers at talent centers as similar to themselves, as Mills (2003) emphasized. Another factor influencing the ability to teach gifted students is whether teachers are confident in this task and know how to identify these students (Laine et al., 2019). A study by Brevik et al. (2018) indicated that teachers in Norway have knowledge about the characteristics of gifted students. However, they also feel insecure about adapting their teaching strategies for gifted students (Lenvik et al., 2022) and that it is a challenge to take care of these students in the ordinary mathematics classroom (Szabo, 2017).

When teachers are insecure, either regarding the identification of gifted students or their own level of content knowledge, they may withdraw from interactions with these students. This teacher insecurity may be picked up by gifted students, and students may withdraw from such interactions, decreasing their behavioral engagement. Either way, the loss of potential teacher-mediated cognitive and affective engagement increase may lead to student disengagement. This highlights the importance of teacher knowledge and confidence regarding both gifted students and content knowledge.

In the current study, the students felt that they learned more and in a different way at the talent centers than at their home schools. However, some students expressed that they could have been challenged at an even higher level. The latter underlines the importance of not treating gifted students as a homogeneous group. It is important to challenge gifted students so that they are motivated (Phillips & Lindsay, 2006). This finding is also in line with the finding that differentiation in a gifted enrichment makerspace program is important for student engagement (Authors, *in review*).

Second, gifted students seem to enjoy open-ended tasks instead of deductive learning experiences (Sousa, 2009). This also seemed to be true for the students participating in this study. The participants enjoyed working on projects from the "drawing board" all the way to constructing the specific object or machinery. In this way, they moved from the idea and creative brainstorming process to practical construction, where they could see if their calculations would work in real life. Moreover, these tasks seemed to be something that the informants noted as absent from their regular classrooms. They described their regular education as more deductive and focused on test preparation rather than complexity or nuance and connections between disciplines. The latter is in line with a previous qualitative Norwegian study in which the informants expressed a lack of practical approaches, especially in mathematics (Smedsrud, 2018).

In this makerspace context, practical does not mean "easy"; rather, it means connecting different subjects and using mathematics, physics, chemistry, biology, etc., to explain something or exemplify. This may be more challenging than only focusing on abstract science concepts, as one must connect two very different forms of representations to each other, which has been identified as complex (Stieff et al., 2016), but the high complexity may facilitate the students' ability to use what they have learned in many other situations in a more flexible manner.

Finally, we summarize the important insights that the current research provided into the connections between the three aspects of students' experiences of participation in a makerspace

enrichment program regarding their engagement. The gifted students were socially and behaviorally engaged through content knowledge, both with peers and with teachers. The entanglement of cognitive and affective engagement was found in students' differentiation needs, including using makerspace activities to enable them to delve deeper into content knowledge. In the differentiation and makerspace context, this entanglement meant that when subject content was appropriately cognitively challenging, students experienced increased cognitive engagement (e.g., motivation and effort to learn) and affective engagement (e.g., enjoyment of activities and positive feelings toward teachers and peers). Thus, we see that content knowledge at a similar level is central for gifted students' engagement and that grouping (both teachers and students) according to content knowledge/content interest may be beneficial for preventing the development of disengagement and alienation and, in turn, underachievement and even increasing drop-out risk.

In Table one, there is a summary of the connections between social, learning and teacher support aspects of participation in the makerspace enrichment program for gifted students and the behavioral, cognitive and affective engagement dimensions. At present, the talent centers seem to meet the gifted students' needs very well regarding the social and teacher support aspects through all engagement dimensions. However, there still seems to be room for improvement in terms of differentiation efforts, as some gifted students still report that the subject content is not demanding enough (Table 1).

That we did not identify any explicit instances of cognitive engagement being linked to learning aspects may seem contradictory but does not mean that they are not linked. The boundaries between cognitive and affective engagement are not clear-cut. For instance, when students express excitement and enjoyment (affective) towards subject content, they are also generally motivated (cognitive) towards the subject content. Here, we have taken expressions of feelings such as excitement and enjoyment as indicators of affective engagement (attitudes and feelings) rather than cognitive engagement (motivation and effort) because the former is a more explicit connection, as the feelings are stated directly in the extracts. Thus, this result is a consequence of the operationalization of the analytical framework which can be reconsidered in future work, for instance by combining affective and cognitive engagement dimensions.

6.1. Limitations

The current study has several limitations that should be addressed. First, the study was limited by the small and specific population of informants. The data might have been richer and captured

Table 1. An overview of connections between social, learning and teacher support aspects of participation in the makerspace enrichment program for gifted students and behavioral, cognitive and affective engagement dimensions.

| Engagement dimension | Social aspects | Learning aspects | Teacher support aspects |
|----------------------|--|---|---|
| Behavioral | Student participation, collaboration and interaction was more common in their spare time or at the makerspace enrichment program than at their regular schools. | Choosing to collaborate is linked to all students contributing to solve a task. | Student participation (asking questions) is linked to perceived teacher engagement and subject knowledge level. |
| Cognitive | Motivation is linked to a common knowledge level for the gifted students. | – | Student inspiration is linked to teacher subject content engagement. |
| Affective | Positive attitudes and feelings towards their peers and a sense of belonging is linked to common interests and a shared purpose of learning for the gifted students. | Excitement and enjoyment towards course content is linked to individual differentiation and the instructional design of the makerspace activities | Students' appreciation and inspiration is linked to teacher subject content engagement and expertise. |

more of the participants' experiences if the interviews were longer and if we had met with the informants several times. Moreover, we might not have captured the in-depth experiences of the participants in such a short interview. We know little about the long-term effect of the programs in which they participated, and it might be that they would have rated their participation differently after the programs were finished. We did not differentiate between the students who were talented or interested in mathematics and students who were talented and interested in science. This differentiation might have made the data richer, and there might be group differences connected to their interest. The identification method used by the talent centers was validated in a Danish study. However, the cultural influence on the concept of giftedness might influence the validity of this method in the Norwegian context (Smedsrud, 2020). The identification method made it possible to identify underachievers who would participate in the program; however, based on the data, it seems that few underachieving students were represented. Furthermore, recruitment to talent centers is largely dependent on the population of students surrounding larger cities in Norway (Oslo, Bergen, Trondheim and Tromsø). Therefore, the population in this study might have been small and skewed in comparison to the large population in Norway that lives in rural areas and might not have had the possibility of participating. As mentioned in the Discussion section, the study involved relatively few physical meetings; therefore, the long-term effects on the students might be difficult to determine. If the students had been interviewed at a later stage, we might have received different information. As students sometimes experience school as boring or unmotivating, the students' descriptions of the excitement of participating at talent centers might have been exaggerated. In general, the teaching methods used at talent centers are difficult to provide in schools due to the need for necessary materials and personnel. Nonetheless, there is no evidence indicating that few students would benefit from this approach to learning. Therefore, such provisions could be offered to all students. Interviews can be limited by an interviewer's capacity to ask good questions and make the informants feel relaxed in the interview setting. Open-ended interviews often lead to the collection of a large amount of information, and some important themes might have been overlooked in reporting this study. Importantly, we combined group interviews with individual interviews. As the majority of the interviews were individual, there are still issues related to combining the two. Group interviews can affect students' ability to share their personal experience and offer no anonymity (within the group), and informants might adapt to the situation. However, in this case, the group interviews enabled us to observe interesting discussions among the informants. Finally, we used the term *gifted* in the current study, and we could have used the terms "highly motivated" or the Norwegian adaptation of "students with high or extraordinary learning potential". However, gifted individuals were chosen based on how giftedness is perceived in the relevant literature, in line with the research field tradition.

7. Conclusion

The results showed that the informants in this study enjoyed participating in makerspace activities at talent centers. Even if they gave different answers, all the students pointed to the social and learning aspects of the experience and the teacher support aspects at the talent center as important for their benefit. The social environment and support from the teachers seemed to contribute to their positive experiences. The informants experienced the teachers as different and as having more in common with them than with their regular classroom teachers, and these characteristics influenced the students' experiences.

It seems that the interconnectedness of social aspects with learning aspects and teacher support aspects can be informed by engagement theory because we found that cognitive engagement (e.g., motivation), affective engagement (e.g., feelings and attitudes toward peers and teachers) and behavioral engagement (e.g., collaboration and interaction) could be used to describe students' experiences with makerspace activities at talent centers.

The students reported that their cognitive engagement was improved by having their need for cognitively demanding subject content met (i.e., the makerspace activities) in addition to including proper differentiation of activities so that it was not perceived as too easy. Similarly, their affective engagement reportedly improved through appropriately challenging subject content and cognitively engaging with their peers and teachers with similar levels of content knowledge/interest. Additionally, behavioral engagement was reported to improve compared to that at regular school because of increased desires to collaborate and interact with others.

The fact that properly advanced subject content also seemed to aid in students' general engagement through increased peer and teacher interaction and collaboration may have important implications for practice. Namely, grouping students according to their content knowledge/interest with similar teachers may ease social connectedness. Furthermore, by giving them appropriately differentiated activities within the gifted student group, as one size does not fit all when developing enrichment programs for gifted students, their attitude and enthusiasm toward their peers/teachers and school may improve. These points are important because they may protect against feelings of alienation, which are strongly connected to the development of disengagement. Disengagement further increases the risk of underachievement and drop-out, and to counteract feelings of alienation before they cement themselves, disengagement is central to keeping gifted students in school by facilitating a positive social and cognitive environment for them.

Further research on how to fulfill gifted students' differentiation needs in enrichment programs should be carried out, to optimize engagement and learning outcomes from such participation.

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