**The associations between math achievement and perceived relationships in school
among high intelligent versus average adolescents**

Abstract

Research regarding highly intelligent adolescents in Scandinavia is scarce. We know little about highly intelligent adolescents' experiences with the school-system and how they experience their social relationships and relationships with their teachers. We used survey and test data from approximately 16000 respondents from the Norwegian Armed Forces to investigate reported math grades and their potential associations with gender, teacher relations and social relations with peers. Furthermore, we explored whether intelligence moderated these associations. Intelligence and teacher relations were positively associated with math grades, social relations were negatively associated with math grades, and the association was more negative for students with higher intelligence scores. The association with gender was moderated by intelligence. Among the students with higher intelligence scores, girls reported higher math scores than boys. Intelligence did not moderate the association between teacher relations and math scores, indicating that the teacher relationship is the same across all levels of intelligence.

Keywords: highly intelligent adolescents, teacher-student relationships, peer relationships, mathematical achievement

Introduction

A recent white paper (NOU: 2016: 14) concluded that there is a lack of research addressing learning environments that fit the needs of highly intelligent adolescents (Børte, Lillejord, & Johansson, 2016). In particular, we know little about highly intelligent adolescents' experiences with the school system, how they experience their peer relationships and relationships with their teacher, and whether such issues are related to achievement. Current studies regarding highly intelligent adolescents in Scandinavia is characterized by qualitative research and the fact that large samples of this population are difficult to obtain. However, with access to a large dataset of Norwegian military recruits and their grades from junior high school, the aim of this study was to retrospectively investigate reported relationships with teachers and peers and their associations with math achievement and intelligence scores. Furthermore, we explored whether intelligence scores moderated these associations.

Although Norway is supposed to provide inclusive education in school, previous investigations have demonstrated that highly intelligent adolescents do not receive teaching that is adjusted according to their potential (Wendelborg & Caspersen, 2016). The school system does not seem to provide an optimal learning environment for this group, and these adolescents report lower satisfaction with their learning environment than the average student (Cosmovici, Idsoe, Bru, & Munthe, 2009; Herrmann & Nevo, 2011; Thuen & Bru, 2000; Knutsen, 2016). Empirical evidence suggests that students' positive relationships with their teachers can have a positive effect on work habits, academic achievement, academic self-concept and disciplinary problems (Bainbridge & Houser, 1999; Hamre & Pianta, 2005; Hughes & Ensor, 2011; Pianta, 1999). Teacher support is perceived as one of the strongest factors predicting school achievement (Chen, 2010). Norway has in general a focus on inclusion and has formalized classroom practices that are intended to provide differential classroom adaptation to all children. One of the few surveys in Norway that include questions about the learning environment for high achieving students indicates that social well-being at school is lower for this group compared with normal-achieving students (Wendelborg & Caspersen, 2016). In the present study, we use the term gifted adolescents and see this through the lens of intelligence, meaning that we view giftedness as highly related to high intelligence scores (Winner, 2000). The engine driving this perspective is a reliable, valid and comprehensive estimate of a student's overall mental capability. Preckel and Thieman (2003) suggest that the best way to identify intelligence in students is by using materials that show

high loadings of *g* (a high loading of *g* means the test measures general intelligence, also known as Spearman's *G*).

In general, intelligence predicts academic achievement (Gottfredson, 2002; Gustafsson & Undheim, 1996; Hyde, 2005; Kuncel, Hezlett, & Ones, 2004; Soares, Lemos, Primi, & Almeida, 2015). Karbach and colleagues (2013) found that general cognitive ability has the strongest predictive value for native language performance and general academic performance. Duckworth & Seligman (2005) suggested that over time, self-discipline surpasses intelligence in predicting academic outcome. To develop self-discipline and task commitment, children need a curriculum that is adapted to their learning capabilities. A recent study of highly intelligent adolescents suggests that up to 30% of this population underachieves (Kim, 2008). All types of students might underachieve, but in the population of highly intelligent children, the estimated gap between performance and potential might be higher than average (Winner, 2000). Underachievement is often explained by lack of motivation, low academic self-concept, negative relationships with peers, few challenging topics and social stigmatization for being highly intelligent. Additionally, a general curriculum aimed at students with general achievement levels rather than those with high learning potential and high intelligence can explain some underachievement because in such an instructional setting, highly intelligent students receive few challenges and can lose motivation (Gross, 1989; Reis, Burns, & Renzulli, 1998; Whitmore, 1980; Yun Dai, Moon, & Feldhusen, 1998). Highly intelligent adolescents who do not receive emotional support and understanding from teachers are at risk for developing negative school references (McCoach & Siegle, 2003; Reis & McCoach, 2000). Studies suggest that the separation of underachievers from high achievers relies on individual factors, such as motivation and self-concept, and on factors related to the teacher and peers and whether the school identifies highly intelligent adolescents (McCoach & Siegle, 2003)

A learning environment that promotes success in individual students is characterized by positive relationships (Deci & Ryan, 2000; Eccles, Early, Fraser, Belansky, & McCarthy, 1997). Environmental support and challenging tasks, activities, goals and positive expectations from the teacher, are important for student engagement, motivation and learning (Shernoff, Ruzek, & Shina, 2017; Summer, Davis, & Hoy, 2017). Positive expectations from teachers, peers and oneself have an effect on learning in school (Klem & Connell, 2004). Students' relationships with teachers, peers and parents are essential for their academic growth and social and emotional well-being (Hamre & Pianta, 2005; Mashburn, Hamre,

Downer, & Pianta, 2006). Deci and Ryan (2000) argue that students' basic psychological needs must be met in school to promote their motivation and academic performance. Such needs are emotional stability, peer relationships and a learning environment that provides individual differentiation (Clarke-Stewart, Vandell, Burchinal, O'Brien, & McCartney 2002; Early et al., 2006; Hur, Buettner, & Jeon, 2015; Romano, Lyzon, Pagani, & Dafina, 2010). Teachers' academic support (instrumental support), emotional support, ability to regulate the classroom, and support for student autonomy are important dimensions of a positive learning environment (Bru, Boysen Munthe, & Roland, 1998; Bru, Stephens, & Torsheim, 2002). Positive peer relationships can influence academic achievement and decrease negative behavior (Rambaran et al., 2016). Students tend to choose friends with similar levels of academic performance, which can reinforce peer differences in school (Wong et al., 2017). Students with high levels of goal orientation, self-acceptance and a sense of autonomy tend to develop positive peer-relationships and higher academic achievement (Liem, 2015; Shim & Finch, 2014; Vêronneau et al., 2010). However, empirical evidence that a positive relationship between adults and students in general predicts academic performance is insufficient (Gregory & Weinstein, 2004).

Studies have shown that girls score higher on language performance tests and lower on a general intelligence index compared with boys (Feingold, 1994; Feingold, 1992). Research suggests that girls have better grades than boys in subjects such as foreign and native languages. Males typically score higher in math and higher than girls overall on all intelligence measures (*general, verbal and numerical*) (Spinath, Freudenthaler, & Neubaners, 2010). Motivational factors can explain some of the difference in academic outcome between genders. Girls tend to be more motivated towards language-oriented subjects, while boys are more motivated towards math and science (Lachance & Mazzocco, 2006; Meece, Bower, & Burg, 2006). In the highly intelligent population, a gender difference in math and science that favors boys emerges at an early age (Benbow & Lubinski, 1993; Hyde et al., 1990; Leahey & Guo, 2001).

Based on a meta-analysis of highly intelligent adolescents, Neihart (1999) suggests that this population can be categorized into subgroups based on their social and psychological well-being. Overall, these highly intelligent children and adolescents show more resilience and pro-social development than average students (Neihart, 1999). Other studies suggest that there is a correlation between intellectual ability level and negative well-being (Neihart, 1999). Differences between verbally gifted adolescents and those who are mathematically

gifted have been suggested. Mathematically gifted students show less negative social adjustment than verbally gifted students (Dauber & Benbow, 1990; Swiatek, 1995). Students participating in special programs for the gifted and talented also show more resilience than students who are underachieving or participating in regular classrooms.

The aim of this study was to test the relationships with teachers, relationships with peers, and gender are associated with grades in mathematics and whether these associations were moderated by intelligence. The associations in the model can be expressed through four research questions: 1) Are student-teacher relationships associated with grades in mathematics subjects? 2) Are peer relationships associated with grades in mathematics subjects? 3) Is gender associated with grades in mathematics subjects? 4) Are these possible associations moderated by intelligence? 5) What are the associations between IQ and grades in mathematics subjects?

Method

Design

This study uses a cross-sectional design and reports on observed intelligence test scores from a large dataset of recruits in the Norwegian military service and their respective grades from junior high school. The study is based on the participants' retrospective reports of their relationship with their teacher and social relationships through an online questionnaire. In Norway, military service has been mandatory for every able male since 1953. In 2009, induction also became mandatory for females. Furthermore, the military categorizes recruits into nine different groupings according to their scores on an intelligence test. Levels one throughout nine indicate the recruits' performance/score on the test, with level nine representing the top 4% of the population, with scores 1,75 standard deviations or more above their normative age peers. School grades are self-reported by the recruits, and lying on these reports is forbidden by law. We used self-reported data and intelligence scores to explore whether associations between teacher relationships, peer relationships, gender and mathematical achievement were moderated across intelligence levels.

Current research is characterized by the difficulty of obtaining good data describing intelligence and school grades in Norway. In Norway, these factors can be studied using data from the military. Norway requires conscription for both sexes, with a two-step process for selection and enlistment. The first step includes an initial screening, selection part 1, followed by more comprehensive testing in selection part 2. Selection part 1 is an online questionnaire that all Norwegian men and women are obliged to answer. It consists of self-reported health, education, physical performance, motivation for service and a social life scale. Part 2 is a one-day muster with a full medical examination, physical capacity test, cognitive ability tests, and an interview with a selection officer. The scores on the cognitive tests of selection part 2 were combined with the responses to the questions regarding the teacher and student relationship and peer relationships from selection part 1 to explore the research questions.

Sample

The sample consisted of N=16 220 respondents with an age range of 17-20 years from the 2012 cohort of recruits. Many recruits are 17 years old when they participate in the testing. This was the first year that no pre-selection based on school grade was conducted, meaning that the full range of grades used in Norway (1-6) was represented. The military categorizes recruits according to their scores on the intelligence test. Therefore, we used the raw scores to answer our research questions. In the total sample, 63.7% were boys, and 36.3% were girls. Recruits come from a widespread geographic area, but we had no data connecting our participants to a particular region. Recruits are brought before separate draft boards depending on their geographic origin. All the tests are now digital; this change could strengthen the validity of the results by reducing stress factors that might influence them.

Measures

General mental ability (GMA) is measured with a computer-based test battery during selection part 2. The test battery consists of three different sub-tests measuring Numerical Ability (30 items in 25 minutes), Word Similarities (54 items in 8 minutes), and General Reasoning Ability (36 items in 20 minutes) (Skoglund, Martinussen, & Lang-Ree, 2014; Torjussen & Hansen, 1999). In this study we only had access to the overall GMA-score. For all the tests, the number of correct answers was recorded and transformed into a stanine score (See Sundet et al., 2004). In total, the tests present a coherent picture of the recruits' general mental capabilities (Schimdt, 2016; Skoglund, Martinussen, & Lang-Ree, 2014). A study conducted by Sundet, Tambs, Magnus, and Berg (1988) reported a correlation between the total test result and the Wechsler's adult intelligence scale (WAIS FS-IQ) of $r = .72$. The WAIS is a test battery standardized to Norwegian norms that the Norwegian psychology service often uses.

Mathematical knowledge/mathematical achievement was measured using the grades at the end of the school semester. We had access to information about the participants' math grades for their final semester before high school. In Norway, math grades are arranged from 1 (fail) to 6 (best possible grade). It is the same as the internationally used A-F scale but uses numbers instead of letters. The school grades are self-reported in an online schema before the recruits are brought before the draft board, and it is illegal for the recruits to report the wrong

grades. Reporting false grades can have consequences for serving in the Norwegian armed forces.

Relationship with peers and relationships with teachers were measured using items from “The Level of Social and Life Skills” questionnaire used by the military. The questionnaire is used to gain a sense of the recruit’s adaptability to service. The items measuring relationships with peers were: Initiates contact with peers easily, enjoys the company of peers, and Social frequency (Cronbach’s alpha, .69). Teacher relationship was measured through two items from the same questionnaire: “Cooperates well with the teacher” and “withstands criticism” (Cronbach’s alpha, .5). Empirical evidence suggests that students which perceive teacher feedback as negative tend to develop a less positive relationship with their teacher and (Baron, 1988) Nicole & Dick, 2006). Such low Cronbach’s alpha values reflect rather low internal consistency for the questionnaire used in this study. Pre-selection exclusion of the participants who only participated in part 1 of the test (the questionnaire) was performed to ensure that the adolescents for whom we had intelligence results and those who answered the questionnaire were the same.

Data analysis

Conventional analyses were conducted using SPSS version 23. We used structural equation modeling (SEM) to test our conceptual model. Measurement models (CFA) were estimated and evaluated separately from structural models using Mplus 7.3 (Muthén & Muthén, 1998 – 2014). Choosing a latent variable approach allowed us to test the relationships among variables that are free of measurement error, reducing the bias of coefficients (Jöreskog & Sörbom, 1988). However, this was not possible for the IQ-variable since we only had access to the overall score. The observed variables were ordinal, so we applied the WLSMV estimator. Structural models containing interactions with latent variables were estimated using a maximum likelihood estimator with robust standard errors and a numerical integration algorithm. We investigated each independent variable separately to determine whether it interacted with IQ in its effect on math achievement. Finally, we estimated a model that included only the interactions that had significant effects in these initial steps. We conducted this stepwise procedure to avoid unnecessary complexity as numerical integration becomes increasingly more computationally demanding as the number

of factors and the sample size increase (Muthèn & Muthèn, 1998 – 2014). Goodness-of-fit was evaluated with frequently used criteria. The TLI and CFI are measures on which values above .90 and .95 indicate acceptable and excellent fit, respectively. The RMSEA is also reported with a 90% confidence interval. Values below .05 indicate a close fit, while values below .08 indicate an acceptable fit (Browne & Cudeck, 1993). Correlations and descriptive statistics of the study variables are presented in *table 1*.

Results

[Table 1 in about here]

Measurement models (confirmatory factor analyses)

Before we could investigate our research questions using SEM modeling, we had to evaluate the factor solution of the independent variables. Because there were only two indicators for teacher-student relationships, we had to evaluate the factor structure of this model together with the measure of peer relationships. We thereby specified a two-factor solution. The solution had a close fit with the data according to the fit indices, RMSEA = .049, 90% CI (.042, .056); CFI = .99; TLI = .98, which supports the two-factor solution. The factor loadings in the standardized metric were all above .65. The measurement model is portrayed in Figure 1.

[Figure 1 in about here]

Structural models

First, we estimated a model with only main effects, and this had a close fit to the data; RMSEA = .051, 90% CI (.048, .055); CFI = .95; TLI = .93. All the independent variables had significant effects except peer relations. The effect of gender on mathematics was low but significant ($\beta = .15$, $p < .01$), and the same was true for the effect of teacher relationships on mathematics scores ($\beta = .09$, $p < .01$). The effect of peer relations was the lowest one but not significant ($\beta = -.02$, ns). However, as expected, intelligence had a very high effect ($\beta = .64$, p

< .01). Altogether, the variables in the model explained 41% of the variance in mathematics achievement.

To investigate whether intelligence moderated the effects of the other independent variables, we conducted latent variable interaction analyses for the interaction terms between IQ and teacher relationships and peer relationships. The interaction term between IQ and gender was conducted by simply multiplying the two using the define command in Mplus. As a first step, we ran the three interaction analyses separately to ease the computational burden of the final model by allowing the possibility of omitting possible interactions that were not significant in the initial analyses.

While gender and social relations both demonstrated significant interactions with IQ in their effects on mathematics achievement, this was not the case for teacher relationships. Therefore, for the final model, we included only the interaction terms for gender and social relationships with friends. So, even though peer relations did not have a significant main effect, we found an interaction effect that was interesting to investigate.

The final model is portrayed in Figure 2 in an unstandardized metric, as standardized metric is not provided by Mplus for analyses involving latent interactions. We can see that the main effect of gender was still significant after the interaction term with IQ was introduced. This significant interaction effect ($b = .044$, $p < .01$) means that gender was differentially associated with mathematics achievement for different IQ levels. The positive direction of the effect means that the tendency for girls to score higher than boys in math was stronger at the highest IQ levels. The nature of this interaction is portrayed in Figure 3 where the association between gender and mathematics achievement is displayed for three different levels of IQ. As expected, IQ had an effect on mathematics achievement ($b = .389$, $p < .05$). Furthermore, social relationships had no significant direct association with math achievement ($b = -.060$, ns). However, the significant effect of the interaction between social relationships and IQ ($b = -.037$, $p < .01$) indicated that higher scores in math was associated with lower ratings of peer relations for the adolescents with the highest IQ levels. The nature of this interaction effect is portrayed in Figure 4. Finally, we can see that teacher relationships were associated with mathematics achievement ($b = .319$, $p < .01$) and that this effect was the same for all IQ levels as we found no significant interaction effect with IQ.

[Figure 2, 3 and 4 in about here]

Discussion

In the present study, we found that mathematical achievement was positively associated with IQ and teacher relationships, while there was no association related to peer relationships. We also found a main association with mathematical achievement for gender. Using IQ as a moderator this association was still present and revealed that girls had higher grades than boys at higher levels of IQ. Furthermore, IQ moderated the negative association between peer relationships and mathematical achievement: the association was more negative for higher IQ levels. According to previous research (Deary, Strand, Smith, & Fernandes, 2007), intelligence scores and mathematical achievement correlate; our study supports this association. The results related to the first research question suggest that teacher relationships are associated with mathematical achievement across all levels of intelligence (see Figure 2). The effect of the teacher on mathematical achievement across different levels of intelligence is important because earlier research indicates that we tend to think that highly intelligent students do well on their own in school if they achieves at a high level. A recent trend in the Norwegian teacher education is emphasizing teacher knowledge within topics such as math; the findings indicate that students across levels of mathematical achievement can benefit from such knowledge. Although the relationship with the teacher has a given effect, we have little information regarding what specific aspects of their relationship with their teacher the students rated highly. Both interpersonal relationships and subject-matter knowledge can be important for students. It may be that the students rated their interpersonal relationship with the teacher more important than the teachers' actual subject-matter knowledge (Clark, 2013; Starko, 2008). In terms of the teachers' status, the quality of and recruitment to teacher education programs in many countries have changed over the past 30 years (Skaalvik & Skaalvik, 2011). The present study suggests that teachers in Norway may be good at differentiating instruction for different students, including those achieving at a high level in mathematics. In terms of the standard teaching mechanism in a classroom, one might expect that the general classroom instructions from the teacher are often aimed at the normal

achievement level and that therefore, the teacher has little effect on the knowledge of students who are already performing at a high level. This tendency was described in earlier research that suggested that teachers target their classroom instructions to the level of the average pupil (Cosmovici et al., 2009). Hill, Rowan, and Ball (2005) reported that teachers' mathematical knowledge and their ability to create a positive learning environment predict student's gains in mathematical achievement. The results of this study suggest that many teachers possess the knowledge and ability to make a learning environment sufficient for different types of students. Furthermore, in Norway, there is little tradition of grouping highly intelligent adolescents according to their intelligence scores or achievement level. Nevertheless, it seems students in general develop positive relationships with their teacher regardless of intelligence or performance. For the group performing at the highest level in math, some studies suggest that ability grouping can have a positive effect on both achievement and how the most intelligent students relate to their teachers (Betts & Shkolnik, 2000; Kulik & Kulik, 1982). Furthermore, it seems the students develop good relationships with their teacher without ability grouping, and therefore, it may be that some students receive sufficient challenge within the normal classroom. The results may also be interpreted as indicating that students' ratings of their teachers are related to how teachers are able to motivate them at a given achievement level or in a way that is important for the achievement of students in general. It is plausible that students achieving at an average level might be easier to motivate because the curriculum makes more room for differentiation. However, based on our findings, relationships with teachers are important across intelligence levels. Furthermore, average-achieving students have a greater developmental potential within the same curriculum because the curriculum in Norway is often limited by goal orientation towards a specific age group and school level. It may be that these teachers use good enrichment strategies and that fewer students in general feel they are sufficiently challenged in school. Thus, it might be that teachers would benefit from more knowledge regarding how to teach in ways that help the highest-achieving students meet higher goals. Indeed, studies suggest that Norwegian teachers tend to direct their teaching towards the middle level of achievement (Dalland & Klette, 2014; Cosmovici et al., 2009). Furthermore, evidence suggests that teachers tend to not differentiate between high-achieving students and highly motivated students (Gagné & St Pêre, 2001). This means that teachers see students who achieve at a high level as being highly motivated. The teacher's conception of a motivated or non-motivated student can influence whether he or she feels the need to individualize the approach to this particular student. Earlier studies in the Norwegian context suggest that high-achieving students rate their learning environment

factors more poorly than average-achieving students do (Cosmovici et al., 2009). It is natural to assume that a student who needs help with a given task at school will ask for help more often within the class and therefore will receive more help. Nevertheless, if a teacher assigns challenging tasks across levels of achievement, all students will need help and feel motivated toward the subject. This may be the case in general.

Concerning our second research question, we found that there were no significant association between social relationships and mathematical achievement. This finding is in line with some previous research (Dauber & Benbow, 1990; Swiatek, 1995). Where the students in the higher end of the intelligence scale in general seem to report good social relationships in school. However, some studies also seem to indicate that negative social relationships are associated with the group of gifted adolescents that underachieves and not with the group that achieves at a high level (Reis & McCoach, 2000). In our study, we probably have information about those students that both have high scores on intelligence tests and perform at a high level. To develop positive social relations, children and adolescents need to be in a social and academic environment that stimulates their intellectual ability and allows them to meet other adolescents who share the same ideas, conceptual understanding and intellectual ability. Neihart's (1999) meta-study suggests that highly intelligent adolescents participating in regular classrooms tend to develop a more negative self-concept and lower levels of resilience and have a higher risk of developing depression and negative peer relationships compared with highly intelligent adolescents participating in ability groups or in special programs. As emphasized previously, Norway has no tradition of giving highly intelligent and high-performing adolescents special opportunities in school. Furthermore, the Norwegian Pupil Survey (2013; 2014) concluded that high-achieving students report lower rates of social well-being in school compared with normal-achieving students. High-achieving students score similar to low- and moderately low-achieving students in social well-being (Wendelborg & Caspersen, 2016). In this study, there are no indication that the high intelligent students suffer socially by placement in the regular classroom. As the tendency to rate social relationships well is the same across levels of intelligence, it may be that all type of students are comfortable in a regular classroom setting and that highly intelligent adolescents tend to feel socially stimulated in the same classroom, at least in this study.

The third aim of the present study was to investigate whether gender is associated with differences in mathematical grades and whether intelligence can moderate gender differences. Earlier studies suggest that boys in general score better than girls within the mathematical

domain. However, studies conducted by Feingold, (1992; 1994) indicate that boys distribute differently on intelligence scales than girls (more boys than girls receive the highest and lowest scores on intelligence tests). Often, these tests have a logic and mathematical reasoning section, which may explain why boys in general have higher intelligence scores. In our sample, the girls seemed to do better in mathematics within the group of highly intelligent individuals, and the difference between boys and girls in regard to math achievement seemed to increase with intelligence level. Furthermore, from this indication one might discuss whether girls are better able than boys to use their intelligence when it reaches a certain point. It is natural to assume that one needs more than just high intelligence scores to perform at high levels in school. Previous studies suggest inconclusive results concerning gender differences and academic achievement (Skaalvik, 1997). Even fewer studies have assessed differences while controlling for intelligence scores and gender differences. When gender differences and mathematical self-concept have been measured in Norwegian adolescents, the results tended to favor boys. Furthermore, the difference is often explained by motivational features. Girls tend to be more motivated toward verbal subjects, and boys tend to be more motivated toward mathematics (Skaalvik & Skaalvik, 2004). Nevertheless, these studies often analyze mathematical self-concept in terms of gender and sometimes intelligence (Benbow et al., 2000; Gallagher & Kafumann, 2005). Studies suggest that girls have a lower mathematical self-concept but still can achieve at the same level as boys (Preckel, Goetz, Pekrun, & Kleine, 2008). However, many of the studies comparing highly intelligent students' motivation and academic self-concept recruit their participants from special science programs or within ability groups. Students who have already been identified as academically gifted might achieve at a higher level than their "*non-identified*" counterparts.

Regarding whether any associations are moderated by intelligence, it seems that teacher relationships was the only category not moderated by intelligence levels, as discussed earlier in the paper. However, the study underlines some trends described in earlier research. Especially in terms of social relationships, high-achieving students seem to rate their social well-being higher than highly intelligent students do.

Limitations and future research

Several limitations of the present study should be addressed. First, we examined whether intelligence levels moderate associations between teacher and peer relations on the

one hand and math achievement on the other. Studies of highly intelligent adolescents often identify the students based on high scores on a given test (top 3-5%), something we did not do. The operational definition of IQ in this study rests upon one observed score. Due to restricted access from the Army sub-test scores for IQ was not available for this study. This would have given a better measurement model. Also, since part of the IQ-score variable includes numerical ability it is plausible that the correlation with Math Achievement is overestimated. Furthermore, this study used a cross-sectional design and therefore provides no support for effect, causality, or prediction. The results only allow for tentative suggestions, and these must also be interpreted as meaningful in accordance with a priori considerations. When applying SEM models, it is also important to remember that even though one model fits the data reasonably well, other equally good or better models may exist (MacCallum et al. 1993). The data are limited to those of adolescents brought before the draft board in the military. Although this group may represent a general population, adolescents with physical issues, for example, are eliminated; hence, the group is not necessarily representative of the whole population. Grades were self-reported, and self-reported school grades and other personal information can always present a bias; however, the use of a large sample can eliminate some of the bias, as can informing participants that giving misleading information is forbidden by law. The measures of the teacher relationship and social relationships variables should have involved more questions to more accurately measure these categories. For example, the Cronbach's alpha for the measurement of teacher relationships was on the borderline of what can be accepted as valid for a measurement. We chose to keep it due to the limitations of the variables addressed by the military questionnaire. Low Cronbach's alpha values can be due to a low number of questions, poor inter-relatedness between items or heterogeneous constructs (Dennick & Tavakol, 2011). Although the items used raise serious validity questions, a two-item scale should be applied instead of single-item scales whenever possible to decrease standard measurement errors (Gliem & Gliem, 2003). However, we cannot rule out the possibility that construct under-representation may have affected the associations in our model. The results should be interpreted with caution.

More research is needed in the area of highly intelligent adolescents in Norway to enhance the knowledge of this under-researched group (NOU: 2016: 14). The findings from this study can only permit speculations regarding the motivational features and other personal characteristics of highly intelligent adolescents and why they rate their social well-being

lower. Furthermore, distinctions or similarities between verbally and mathematically orientated students were not addressed, which would have broadened our picture of the group.

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