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Relationship between Birth Month and Mathematics Performance in Norway

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ABSTRACT

Due to the fixed school start in Norway in August of the calendar year of students' sixth birthday, the age span in one class is up to twelve months. This can impact academic performance both in the early years and later. In this paper, we investigate the relationship between birth month and mathematics performance by paying attention to the content and cognitive domains addressed in the Trends in International Mathematics and Science Study (TIMSS) 2015. In Norway, the TIMSS 2015 included four cohorts, enabling a comparison between grades. We find significant correlations between birth month and mathematics performance overall as well as in all content and cognitive domains for grades 4, 5 and 8. Furthermore, the gap in mathematics results between the youngest and the oldest in a cohort is less in grade 9 than in grade 4. We suggest that these findings have implications for mathematics teachers' practice.

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Mathematics education; mathematics performance; relative age effect; birth month; TIMSS 2015; secondary analysis

Introduction and Background

In countries where students start school at a fixed time of year, the age difference between students in the same annual age group can be up to twelve months. Being among the oldest students in a cohort can lead to persistent benefits (Black et al., 2011); a major concern is that even though the birth month effect may change over a person's life trajectory (Larsen & Solli, 2017), the disadvantage of being among the youngest in the cohort at school entry might have long-term consequences academically, in sports and in terms of future earnings (e.g., Bedard & Dhuey, 2012; Solli, 2017; Wattie et al., 2008). If so, students' birth month can explain differences in later school years, when the conspicuous differences in a group are effaced. However, it is reasonable to expect the relative age effect (RAE)—that is, the consequences of relative age differences (Wattie et al., 2008)—to be more prominent in a cohort of younger students, because the relative age differences are percentually larger than for an older cohort. According to that argument, the RAE can be expected to decrease and almost disappear over time.

The expected decrease in the RAE is not consistently confirmed in the literature, and the impact of the RAE goes beyond academic performance on school tests during compulsory education. Studies from several countries, including Japan, Norway and the United States, have indicated that the older children at school entry tend to receive higher levels of education (Bedard & Dhuey, 2006), and men—but not women—tend to earn more, than do the younger students in their cohort (Bedard & Dhuey, 2012; Kawaguchi, 2011; Solli, 2017). However, several studies

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have found that the effect of the difference in earnings disappears when considering earnings cumulatively over a lifetime (Crawford et al., 2013a; Fredriksson & Ockert, 2009; Solli, 2017).

A logical question is whether factors other than biology and extent of life experiences might enhance or reduce the long-term disadvantage of the youngest in a cohort. Seen through our lens as researchers in mathematics education, this brings to the fore the role of the teacher in understanding students' circumstances within a context and providing appropriate support for their development in mathematics. Teachers are, after all, students' primary source of knowledge and information, and teachers' perceptions and judgments of students' performance and ability will determine the programmes and interventions to which students will gain access (Ready & Wright, 2011). The concern is that there may be an unconscious bias against the younger students in a cohort. For example, a large study of grade 3 students in Israel showed a strong correlation between chronological age and the probability of being accepted into a gifted programme, with older students having a 3.5% higher chance of acceptance (Segev & Cahan, 2014). Similarly, in the Millennium Cohort Study conducted in England among seven-year olds in schools practicing streaming, the younger students in the cohort were overrepresented in low-ability groups (Campbell, 2017).

In the context of our study, we acknowledge a body of research demonstrating that teacher perceptions affect academic development and that these effects are sometimes substantial (De Boer et al., 2010; Jussim & Harber, 2005; Smith et al., 1999). For instance, Baker et al. (2015) studied 123 pre-school teachers and their 760 pre-schoolers, and found that, after controlling for the children's actual academic skill, the older children's academic abilities were overestimated (p. 805). This coincides with Gledhill et al. (2002) findings that "on average, teachers appear to be making insufficient allowance for the chronological age of children in the class when assessing pupils' ability" (p. 46). Finally, O'Brien's (2018) study of more than 15,000 students from kindergarten to grade 3 found that, although the actual achievement advantage already begins to attenuate in grade 1 (p. 152), teachers consistently assessed older students in the cohort as having higher academic performance and better learning behaviours than younger students throughout primary school (p. 131). Hence, there are reasons to believe that teachers do perceive younger children differently than they perceive older children in the same cohort. A self-fulfilling prophecy might be one important factor contributing to the lasting RAE. We find support for this deduction from research on the RAE in sports, which suggested that the RAE can be mitigated by increased awareness in schools and among teachers (Aune et al., 2017). The question of whether there is a self-fulfilling prophecy in itself highlights the importance of investigating the nature of these correlations in more detail.

Even if the youngest students in a cohort are perceived as being different, and indeed do perform differently as they start school, this does not have to impact their mathematical development in a negative way. Norwegian school policy includes a strong commitment to including all students through adapted teaching, taking into account individual needs while at the same time rejecting the practice of systematically organising teaching according to ability groups (Ministry of Education and Research, 1998). Internationally, as well as in Norway, the type of mathematics teaching promoted by research and teacher educators is a responsive type of teaching, building on each student's understanding (e.g., National Council of Teachers of Mathematics, 2014; Solomon et al., 2017), in principle offering the same learning opportunities to the younger students as to the older students in the cohort. The endorsement is not merely of an abstract ideal; for the past decade and a half, there have been sustained research efforts in the field of noticing, a field concerned with mathematics teachers' awareness of the complexity of what takes place in the classroom, as well as their ability to interpret and act on such awareness (Jacobs et al., 2010; Mason, 2002).

Although the findings of such studies include suggestions about how teachers can be supported in making sense of and building on student thinking (e.g., Leatham et al., 2015; McDuffie et al., 2014), teacher educators and the professional community of mathematics teachers still struggle to implement these suggestions (see Eriksen & Bjerke, 2019, for more insight into the theory–practice divide). One prerequisite for change is that teachers are aware of their practices and the consequences of such practices. In this case, and in line with Chapman's (2017) call for more research to support teacher change, we aim to draw teachers' attention to how they can support the youngest students in a cohort.

In this study, we proceed to explore the nature of the RAE in mathematics, drawing on Trends in International Mathematics and Science Study (TIMSS) 2015 data from Norway. That year Norway participated with four cohorts (grades 4, 5, 8 and 9) as it transitioned from enrolling in TIMSS grades 4 and 8 to enrolling grades 5 and 9, giving a unique set of data from four cohorts instead of two. We situate our findings in the context of research about how to reduce, or even eradicate, the RAE in mathematics education.

Literature Review

The majority of the literature addressing the bias leading to the RAE is related to sports, focussing mainly on the existence, prevalence and mechanism of the RAE in different sports. The occurrence of the RAE and its potential negative consequences are clear in the literature, and there are already signs of possible solutions (Andronikos et al., 2016). Using a qualitative approach, Andronikos et al. (2016) interviewed seven experts in the field of talent identification and development, revealing several suggestions for the reduction or eradication of the RAE. It has been suggested that the RAE can be eradicated by understanding how groups are formed (e.g., by age, weight, size or skill level); recognising and prioritising long-term development over "short-term wins"; educating the relevant parties (e.g., coaches and clubs) about the RAE; and carefully considering the structure of the development environment (e.g., delayed selection, provision for late developers, focus on skills not results and a more intentional use of challenges; Andronikos et al., 2016, p. 1124).

However, in a review of the literature proposing solutions to the RAE, Webdale et al. (2019) found that most solutions—such as those proposed by Andronikos et al. (2016)—are theoretical and, due to the possible negative effects on the careers and life outcomes of the athletes involved, there has been no attempt to implement the solutions in research studies. In the context of mathematics education, Ünal (2019) suggested similar solutions to reduce the RAE, such as making enrolment dates more flexible, raising awareness about the RAE in pre-service and in-service training programmes, and reducing pressure on children for lagging in competition. To our knowledge, as in sports, there are no reports on implementations in the literature related to mathematics education.

With no tried solution in sight, the community of researchers continues to investigate and acknowledge the existence of the RAE. In mathematics, the effect of relative age on achievement has been examined in a number of countries using various methodical approaches and drawing on a variety of sources, not limited to results from large-scale international assessments. Using growth curve modelling, a Belgian longitudinal study of 3,000 Flemish children showed that the age difference in a cohort had a moderate effect on achievement in mathematics during the first 2 years of schooling, with the gap halving from school start to the end of grade 2 (Verachtert et al., 2010). The authors remark that, had this trend continued, the gap would have been closed by the end of grade 4.

However, this is not the case in general. For example, a study from South America established the presence of the RAE in mathematics by drawing on the Chilean 2011 National System of Quality Assessment in Education Survey, which includes a mathematics test with multiple-choice and closed questions (Navarro et al., 2015). Using structural equation modelling, the analysis showed that, although it is less influential than is socio-economic status, the RAE on academic performance persisted into grade 8. In England, a report on the RAE commissioned by the Nuffield Foundation and drawing on several studies found accumulating evidence of a statistically and educationally significant gap in academic achievement, including in the results of the General Certificate of Secondary Education (GCSE) exam at the end of compulsory education (Crawford et al., 2013b).

Results from large-scale international assessments such as the TIMSS and the Programme for International Student Assessment (PISA) provided data for a number of studies on the RAE in mathematics performance. Drawing on TIMSS 1995 and 1999 data from countries with unambiguous starting-age rules (including Norway), Bedard and Dhuey (2006) found a large RAE on mathematics scores in both grade 4 and grade 8, casting doubt on the idea that the effect would dissipate over time (p. 1,469). This doubt was strengthened by subsequent studies on TIMSS data from various countries, such as the TIMSS 2003 in Japan (Kawaguchi, 2011), the TIMSS 2007 in Italy (Ponzo & Scoppa, 2014) and several TIMSS and PISA studies in Norway (Olsen & Björnsson, 2018). Adding to this, and of special interest in the context of our study, is the reported existence of the RAE in the Norwegian numeracy test in data collected from the National Directorate of Education and Training, which involved more than 160,000 students from grades 5, 8 and 9 (Aune et al., 2018).

Mathematics is a school subject composed of different domains, some of which are easier for students to master than are others (e.g., see the different scores for the different domains in the TIMSS test [Mullis et al., 2016b]). Therefore, while it is of interest to be aware of the RAE in mathematics in general, it is also of interest to know whether the RAE is present in all content and cognitive domains. This would allow for a more nuanced picture that can inform and direct efforts in research on mathematics education, and perhaps even contribute to less theoretical and more practical interventions, with implications for classroom practices.

In the TIMSS 2015, mathematics scores are composed of scores in a number of content domains, specifying the subject matter to be assessed (i.e., three domains in grade 4, and four domains in grade 8; see Table 1), as well as scores in three cognitive domains, specifying the thinking processes: knowing, applying and reasoning (Grønmo et al., 2013). *Knowing* covers the facts, procedures and concepts students need to know at a given stage; *applying* focusses on the ability of students to use their knowledge and understanding to solve problems; and *reasoning* goes beyond solving routine problems to encompass unfamiliar situations, complex contexts and multi-step problems. As such, the differing natures of the three cognitive domains will potentially entail different ideas about what can be done to reduce the RAE if it is found to exist in these domains. To our knowledge, no existing studies on the RAE and mathematics performance on the TIMSS have considered each of the content and cognitive domains individually. There are arguments for and against the existence of the RAE across the domains.

On one hand, we acknowledge that instruction affects cognitive change and that this change may vary between different content domains (Hiebert & Wearne, 1988); therefore, the RAE may not exist in all content domains. The van Hiele levels of reasoning in geometry, for example, are assumed to be dependent on instruction, not age (Clements, 2003); in principle, this could be visible in the results in the *Geometric Shapes and Measures* domain in grade 4, and the *Geometry* domain in grade 8. However, in the TIMSS, geometry and measurement tasks are currently grouped together into one content domain, following the reduction in the number of content domains from the TIMSS 1995 to the TIMSS 2007 (i.e., from six to three domains in grade 4 and from six to four domains in grade 8; Mullis et al., 2016c). Likewise, there is a possibility that the development in the cognitive domain *Reasoning* is more dependent on instruction than it is on age, and the structure of observed learning outcome (SOLO) taxonomy (Biggs & Collis, 1982) supports this idea. As such, it is considered a suitable framework to assess the development of reasoning within probability (Watson et al., 1997).

On the other hand, results from research into TIMSS 2011 data across countries showed that, except for the *Data and Change* domain, all content and cognitive domains in the TIMSS 2011

Table 1. Content domains in TIMSS 2015 Mathematics.

Content domains (grade 4)	Content domains (grade 8)
Number	Number
Geometric Shapes and Measures	Algebra
Data Display	Geometry
	Data and Chance

have a significant bearing on mathematics performance (Pogoy et al., 2015). This might suggest that the RAE that has been found to exist in mathematics (Bedard & Dhuey, 2006; Kawaguchi, 2011; Olsen & Björnsson, 2018; Ponzo & Scoppa, 2014) should also exist for the content and cognitive domains separately. In this paper, we pursue this line of inquiry, examining the relationship between age at school entry and performance in mathematics and in the underlying content and cognitive domains, based on TIMSS 2015 data from Norway.

In Norway, students start school in August of the calendar year of their sixth birthday. In 2015, Norway moved from enrolling grades 4 and 8 in TIMSS to enrolling grades 5 and 9, with the transitionary year resulting in an exceptional data set from four cohorts (Bergem et al., 2016) instead of two. We put forward the following research questions (RQs):

RQ1: To what extent is RAE present in the content and cognitive domains in mathematics?

RQ2: What is the relationship between grade and RAE?

Methodology

The secondary analyses in this paper are based on the mathematics achievement tests that were part of the TIMSS 2015, as well as on the month of birth of the participants. The achievement tests consisted of 169 mathematics tasks for students in grade 4 (and in grade 5 in Norway) and 212 mathematics tasks for students in grade 8 (and in grade 9 in Norway). Each participant answered a subset of these tasks, and the scores were calculated in terms of the students' overall mathematics performance (for which probable value methodology was used) and in terms of each of the content and cognitive domains individually. As the mathematics tasks are not publicly available, we could not conduct independent analyses of the tasks (Mullis et al., 2016a).

The analyses in this paper are based on Norwegian participants in the TIMSS 2015 from grade 4 (N = 4,141), grade 5 (N = 4,292), grade 8 (N = 4,738) and grade 9 (N = 4,630), born in 2005, 2004, 2001 and 2000, respectively. In Norway, while some students start earlier or later, most start school in the year they turn six, and repeating grades is unusual. As a result, the expected birth years for the four groups are those listed above; however, a small percentage of participants (0.6, 0.9, 1.2 and 1.4% for those in grades 4, 5, 8 and 9, respectively) reported another year of birth. In grades 8 and 9, birth year is self-reported in the TIMSS, and this might explain why the reported birth years spanned from 1997 to 2005. The extremes are not reliable, and we chose to consider only students born in 2001 and 2000 for those in grades 8 and 9, respectively. Similarly, in line with Kyriakides (2002), we assumed that delayed and early admission were not random with respect to intellectual development; therefore, for the analyses of the data of students in grades 4 and 5, we exclusively included students born in 2005 and 2004, respectively. As the publicly released data sets do not include the students' month of birth, which is our main predictor, we obtained access to restricted-use files from the International Association for the Evaluation of Educational Achievement (IEA). The TIMSS has a complex design, involving both a multi-stage sample design and an assessment design where individual results are computed based on student answer on a subset of complete text (Martin et al., 2016). In this study, we used the IEA International Database (IDB) Analyzer software in addition to SPSS Statistics to tackle the complex design of the TIMSS and make use of the probable value methodology it employs.

Despite the implications that can be drawn from both the van Hiele levels of reasoning (Clements, 2003) and the SOLO taxonomy (Biggs & Collis, 1982), based on the RAE literature reviewed and the findings from Pogoy et al. (2015) and in line with our RQs we put forward the following two hypotheses:

Hypothesis 1: There is a correlation between birth month and mathematics performance (for students in each of grades 4, 5, 8 and 9). This is true for all content and cognitive domains.

Hypothesis 2: The differences in mathematics performance between students born early and students born late are larger in grade 4 than they are in grade 9.

To test Hypothesis 1—that there is a correlation between birth month and mathematics performance—we used linear bivariate models, with student performance, Y_i, as a function of $BirthMonth_i$ for student i: $Y_i = b_0 + b_1 \cdot BirthMonth_i$. Note that b_1 will be negative if a later birth month (i.e., a younger student) is correlated with lower scores. We ran separate regressions for each content and cognitive domain of mathematics and for each grade level. If b_1 is significantly different from 0, it indicates a correlation.

To test Hypothesis 2— that the differences in mathematics performance between students born early and students born late are larger in grade 4 than they are in grade 9—we use Fisher's z-test for differences between correlation coefficients in independent samples (Asuero et al., 2006).

Besides the limitation that follows from conducting secondary analysis, there are some additional important limitations to our study. We do not go beyond the content domains to analyse the topic areas within each domain. Such an approach could have potentially enabled us to dig deeper in the domain of geometry and measurement, which entails two topic areas. Although such analyses are arguably feasible (Provasnik et al., 2020), we were hesitant to do this because of the small number of tasks relevant to each topic area. As we have not had access to the items, we have not been able to analyse these ourselves and we draw here on the categorisation done by the TIMSS researchers.

Results

Our RQs and hypotheses were formulated on the basis of what the literature revealed. Taken together, if the first hypothesis holds for a cohort, this means that there are differences in mathematics performance throughout the cohort, in all content and cognitive domains, that correlate with birth month. Moreover, if the second hypothesis holds, the differences caused by birth month in the overall mathematics scores are less prominent in grade 9 than in grade 4, indicating a reduction in the RAE across these grades.

Hypothesis 1 took the previously observed correlation between birth month and mathematics performance (Bedard & Dhuey, 2006; Kawaguchi, 2011; Olsen & Björnsson, 2018; Ponzo & Scoppa,

Table 2. Regression coefficients, correlation coefficients and t-values for Hypothesis 1.

	4th grade	5th grade	8th grade	9th grade
Math	$b_1 = -2.64$, r=0,12 (t = −5.53**)	$b_1 = -1.61$, r=0,07 (t = −4.12**)	$b_1 = -1.14$, r=0,06 (t = −3.52**)	$b_1 = -0.56$, r=0,03 (t = −1.04)
Data display	$b_1 = -2.93$, r=0,10 (t = −4.65**)	$b_1 = -1.70$, r=0,07 (t = −3.71**)		
Data and chance			$b_1 = -1.24$, r=0,05 (t = −2.69**)	$b_1 = -0.83$, r=0,03 (t = −1.50)
Algebra			$b_1 = -1.12$, r=0,05 (t= −2.27*)	$b_1 = -0.52$, r=0,02 (t = −1.04)
Geometric shapes and measures	$b_1 = -2.35$, r=0,10 (t = −4.67**)	$b_1 = -1.69$, r=0,07 (t = −3.54**)		
Geometry			$b_1 = -0.90$, r=0,04 (t = −2.06*)	$b_1 = -0.64$, r=0,03 (t = −1.44)
Number	$b_1 = -2.30$, r=0,11 (t = −4.61**)	$b_1 = -1.49$, r=0,07 (t = −4.08**)	$b_1 = -1.26$, r=0,06 (t = −3.15**)	$b_1 = -0.43$, r=0,02 (t = −1.03)
Knowing	$b_1 = -2.34$, r=0,10 (t = −4.71**)	$b_1 = -1.51$, r=0,07 (t = −3.74**)	$b_1 = -0.89$, r=0,05 (t = −2.84**)	$b_1 = -0.50$, r=0,03 (t = −1.25)
Applying	$b_1 = -2.43$, r=0,11 (t = −4.61**)	$b_1 = -1.46$, r=0,07 (t = −3.76**)	$b_1 = -1.00$, r=0,05 (t = −2.86**)	$b_1 = -0.72$, r=0,03 (t = −1.79)
Reasoning	$b_1 = -2.32$, r=0,10 (t = −3.43**)	$b_1 = -1.76$, r=0,08 (t = −4.18**)	$b_1 = -1.06$, r=0,05 (t = −2.58**)	$b_1 = -0,50$, r=0,02 (t = −1.13)

(*: significant on .05 level, **: significant on .01 level)
Source: TIMSS 2015 © IEA 2018.

2014) as its point of departure. Even though we had reason to expect that some content and cognitive domains might deviate from this assumption (Clements, 2003; Watson et al., 1997), we drew on Pogoy et al. (2015) and hypothesised that the correlations hold for all domains. Table 2 shows that there were significant correlations between birth month and mathematics performance in all content and cognitive domains for all grades, except for grade 9, for which there were no significant correlations in any content or cognitive domains (or even mathematics in general). However, looking at the correlation coefficients in Table 2, we find a consistent gradual reduction in the effect size from grade to grade for all cognitive and content domains included in the study.

Hypothesis 2 suggested that the RAE is smaller in grade 9 than in grade 4. Fisher's z-test for differences between correlation coefficients in independent samples gave z=4.479 (significant at .01 level), revealing a significant difference in the RAE in the overall mathematics score. Thus, we discard the null hypothesis of no differences in the population.

Discussion and Perspective

The existence of the RAE in the mathematics portion of the TIMSS has been identified in earlier implementations in a number of countries (Bedard & Dhuey, 2006; Kawaguchi, 2011; Ponzo & Scoppa, 2014). In Hypothesis 1, despite some signs in the literature that suggest the opposite (Clements, 2003; Watson et al., 1997), we asserted that there is a correlation between students' birth month and mathematics performance within the included grades for all content and cognitive domains in the TIMSS. While biological factors and having had fewer experiences disadvantage the youngest students in a cohort during the early years of school, learning opportunities based on individual needs can be created by teachers through eliciting and responding to student thinking in mathematics. In view of the existing theories about how to develop understanding in mathematics (Biggs & Collis, 1982; Clements, 2003), such teaching practices could potentially wipe out the RAE on mathematics achievement over time.

We found a significant RAE within all content domains for students in grades 4, 5 and 8. In addition, the findings for the *Number* domain were consistent with Aune et al.'s (2018) findings from the Norwegian numeracy test. At the same time, the findings seem to contradict the theoretical assumption that geometric reasoning is determined by instruction and not age (Clements, 2003). However, this is not necessarily a contradiction, because the two content domains that include geometry (i.e., the *Geometric Shapes and Measures* domain and *Geometry* domain) also include measurement items, such as measuring lengths, calculating perimeters and areas, and estimating volume (Mullis & Martin, 2013); this makes it impossible to distinguish between the contributions from geometry and those from measurement. As mentioned in the Methods section, this is clearly a limitation in our study. To investigate further whether parts of mathematics are affected less by the RAE, measures that are more detailed and specific than the TIMSS domains may be needed. In addition, a more informed discussion of the findings related to geometry would have been possible if we had access to the actual tasks given to the students.

Although instruction is certainly an important factor in the development of knowing, reasoning and applying, the age effect is still significant, based on our analyses, we can conclude that the RAE is present in all cognitive domains for grades 4, 5, and 8, but we cannot conclude whether it is present in grade 9. However, the R-values given in Table 2 (comparing across cells in each row), show that the effect of the birth month gradually decreases with age. The corresponding R^2-values, which can be interpreted as the portion of the variance in students' scores that can be explained by RAE, are small. The results from our test of Hypothesis 2 show that the RAE is larger in grade 4 than in grade 9. This suggests that the RAE may be substantial in the early grades of primary school. If so, our data indicate that teaching practices have succeeded reasonably well in reducing the RAE in mathematics achievement over time. However, our findings reveal that RAE exists in mathematics. To eradicate the RAE, we assert that teachers need, in light of Norway's longstanding commitment to including all students (Ministry of Education and Research, 1998), to be aware of its existence and consider students' relative age alongside other dimensions of diversity in the class.

Even if the portion of the variance in the students' mathematics scores that can be explained by RAE, are small, on a TIMSS test, where the average score is around 500, a grade 4 student born in December can be expected to score about 25 points less than a January-born student. Hence, the importance of drawing teachers' attention to how they can support the youngest students in a cohort is still present, especially in the earliest grades. In the following discussion, we lean on the body of research conducted in sports, a field with a strong standing in relation to research on the RAE, as well as research in mathematics education. Within both fields, most of the suggestions for reducing the disadvantage of the younger students in a cohort have not been researched. The suggested solutions that have thus far been presented address different levels of the issue. As the RAE seems to stem from the disadvantage of being the youngest in a group, one possible strategy to reduce it may be to vary the groups, including having mixed age groups. Clearly, this has far-reaching consequences for the organisation of schools. Within a group, one alternative is to have particular concern for the youngest students, such as by providing them with special help. Another alternative is to change the teaching style for the whole group, by focussing more on skills and less on results, aiming for the achievement of long-term goals instead of short-term success, and striving to give each individual student the challenges that student needs. Based on our results, all content and cognitive domains need consideration. No matter which strategies are chosen, we can gain from raising awareness about the RAE among teachers, to combat their tendency to judge all students in the classroom by the same criteria, regardless of their age.

Our starting point for examining the nature of the RAE in primary mathematics education in more depth was the idea of a self-fulfilling prophecy being a possible important factor contributing to the lasting RAE. Teachers' perceptions matter; because of perceptions, teachers may provide a more supportive climate for high-expectancy students, praise them more, give them more time and assign them more challenging tasks (Jussim et al., 2009). With respect to relative age, teachers' perceptions tend to be inaccurate: the older students in a cohort are perceived by teachers as having stronger academic abilities (Baker et al., 2015; Segev & Cahan, 2014), while the younger are more likely to be placed in low-ability groups (Campbell, 2017) or to be considered as having learning difficulties (Gledhill et al., 2002). These are solid empirical reasons for raising teachers' awareness about the RAE.

Following the Salamanca Statement (United Nations Educational, Scientific and Cultural Organization, 1994), in Norway, the inclusion of all learners in the form of adapted education has become a long-standing aim (Ministry of Education and Research, 1998). Norway has taken on a pioneering role in addressing the challenges of inclusive mainstream schooling, in line with a definition of *inclusion* as a process of addressing and responding to the diversity of the needs of all children. In spite of their prominent profile in statutory curricular documents and in mathematics education research, teaching mathematics for understanding (e.g., National Council of Teachers of Mathematics, 2014; Solomon et al., 2017) and building on student thinking (e.g., Leatham et al., 2015; McDuffie et al., 2014) are ideals that are not yet being achieved in schools. This suggests a continuing need for research to support teacher change (Chapman, 2017, p. 303). In particular, this means understanding teachers' existing practices and, in the context of our paper, reflecting also on the consequences of their teaching for the youngest students in each cohort. Research in the field of noticing seems to be one promising avenue to take (Jacobs et al., 2010; Mason, 2002).

The reviewed literature and the results of our analysis underline that there are gains from acknowledging the consequences of being amongst the youngest in a cohort. While our results show that the portion of the variance in the students' test scores that can be explained by RAE is small, it is important to see these results in a bigger context, remembering that mathematics is only one of many school subjects. If RAE exists in a range of – or perhaps in all – school subjects, the consequences of being among the youngest in a cohort can stretch well beyond the academic inequity, with lifelong consequences, as reported by e.g., Bedard and Dhuey (2012), Solli (2017), and Wattie et al. (2008). Therefore, teachers' awareness is crucial for the individual student. Hence, research is needed on RAE across subjects, including on how teaching practices can combat the RAE.

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