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The role of mother's education and child gender for children's vocabulary and math skills in the transition from Early Childhood Education and Care to first grade in Norway

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ABSTRACT

Parental education and child gender are related to learning and development during childhood and adolescence. The present study investigated the role of mother's education level and child gender for children's vocabulary and math skills in Norway. Children's vocabulary and math skills were assessed in Early Childhood Education and Care (ECEC) centers (M_{age} = 5.8; N = 243, 49.4% girls) and first grade (M_{age} = 6.8 years). Results showed that maternal education predicted children's vocabulary and math skills in a play-based ECEC setting. There was a small gender difference (favoring girls) in math skills but not in vocabulary in ECEC. However, maternal education and gender did not significantly predict the change in vocabulary or math skills from ECEC to first grade, and gender did not moderate the relationship between maternal education and academic skills in young Norwegian children. Implications of these results are discussed.

KEYWORDS

Vocabulary; math skills; gender; mother's education level; Early Childhood Education and Care; first grade

Introduction

Educational systems across countries are concerned about achievement gaps between children from families with high and low socioeconomic status (SES) and between boys and girls (e.g. Backe-Hansen, Walhovd, and Huang 2014; Entwisle, Alexander, and Olson 2007; NOU 2019, 3; OECD 2015). Although the literature on these topics is extensive in school-age children, relatively few studies have examined SES and gender differences in vocabulary and math skills among children in a Norwegian Early Childhood Education and Care (ECEC) setting and the transition to formal schooling. The Bioecological Model of Development is one of the prevailing frameworks that help describe, explain, and predict human development (Bronfenbrenner and Morris 2006). In line with many researchers (e.g. Bornstein and Leventhal 2015; Shonkoff and Phillips

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2000), the model suggests that children's development consists of bidirectional interactions (proximal processes) between the child and the environment over time. The effect of proximal processes on development varies systematically with the characteristics of the child (e.g. gender) and the environment, such as characteristics of the parents (e.g. SES).

However, the characteristics of a society and educational setting are also related to children's development. Norway has, for example, a generous welfare system with a strong family service orientation and low poverty rates compared to other countries like the United States (U.S.). All Norwegian children have the right to attend regulated and subsidized ECEC. Attendance is high (97% of children aged three- to five years) (Statistics Norway 2013), and most children (96%) go full-time, which is up to 41 h a week. These characteristics may lower SES differences in society. Moreover, the Norwegian ECEC system emphasizes a play-based approach, valuing free play, children's autonomy, and social development. In contrast, first grade has a highly structured learning environment where children are faced with formal instructions in academic skills. The differences in these two educational settings may cause SES and gender to influence children's academic skills in ECEC and first grade differently.

An overarching policy for Norwegian ECEC centers and schools is to ensure social and gender equality and give all children equal opportunities to develop according to their potential (Norwegian Ministry of Education and Research 2011, 2017, St. meld. 16 (2006-2007)). In the present study, we investigated whether SES (as measured by maternal education) and child gender predicted children's vocabulary and math skills in the spring of the last year of ECEC and changes in these skills in the spring of first grade in Norway. Furthermore, we investigated whether the relationship between maternal education and vocabulary and math skills differed for girls and boys.

SES differences in vocabulary and math skills

Parental SES is indicated by income, education, and occupation, and in particular, maternal education has been a good indicator of SES in child development studies (Conger and Brent Donnellan 2007; Ensminger and Fothergill 2003; Magnuson et al. 2009). Mothers with high education use richer and more complex language with their children (Brushe et al. 2021; Hoff 2003), engage in more complex math interactions (Saxe, Guberman, and Gearhart 1987), show more responsiveness, and provide more learning materials (Magnuson et al. 2009) than mothers with low education. Previous research has found that these kinds of parental behavior partly mediates the relationship between parental education and child development (Bradley and Corwyn 2003; Davis-Kean 2005; Hoff 2003), indicating that maternal education influences parental behavior and the home learning environment, which is an example of the proximal processes a child experiences. Thus, maternal education is one factor that predicts the experiences and resources for learning children have during their years in ECEC and as they enter formal schooling.

Previous research has documented that children from lower SES develop vocabularies (Hart and Risley 1995; Hoff 2003) and math skills (Aunio et al. 2006; Ginsburg and Pappas 2004) more slowly than children from higher SES. Norwegian studies also find

a robust association between maternal education and two- to four-year old's language comprehension (Zambrana, Ystrom, and Pons 2012) and receptive vocabulary (Zachrisson and Ribeiro 2018).

The magnitude of SES differences on early skills varies substantially across studies depending on the sample and context (Vasilyeva and Waterfall 2011). There are some indications that the SES differences in children's language skills at age five are lower in Norway than in other European countries (the United Kingdom, Germany, Italy, and the Netherlands) (Passaretta and Skopek 2018), which may be related to the high attendance in ECEC and other characteristics of the welfare state. For example, prior research has found that the introduction of universal ECEC in Norway had positive long-term effects on children's educational attainment (e.g. completing high school, attending college, and years of education) and labor market participation (e.g. how much they earned and whether they were on welfare) (Havnes and Mogstad 2011). Notably, most of the effects on children's education stemmed from children with low educated mothers, while most of the effects on labor market participation and earning were related to girls. Moreover, it is documented that attending ECEC in Norway positively affected children's language skills when mothers had low education levels compared to children with mothers having low education who were cared for at home (Schjølberg et al. 2008). However, other research has found that SES differences in Norwegian children's language comprehension increased from 18 to 36 months (Zambrana, Ystrom, and Pons 2012), an age most children have started in ECEC.

Prior research is not clear whether SES differences in children's academic skills increase, decrease, or persist over time when starting elementary school. Because ECEC and first grade represent such different learning environments, the SES gap may change during the transition from ECEC to first grade. Some U.S. studies have found SES differences in vocabulary (Farkas and Beron 2004), reading and math scores (Crosnoe et al. 2010) in preschool-age, but not in changes in these skills to the end of elementary school. In line with these results, the European study using samples from Norway, the United Kingdom, Germany, Italy, and the Netherlands (Passaretta and Skopek 2018) found that SES differences in language skills increased over early childhood and remained relatively stable and only slightly increased after school entry and throughout primary education. Specific to the Norwegian data in this study, higher maternal education was related to fewer language problems for children at age three, and the SES difference remained fairly stable through second grade (Zachrisson and Ribeiro 2018).

In summary, most research finds SES differences in children's early vocabulary and math skills, although the magnitude varies across cultural contexts. However, prior research is less clear about the SES differences in children's change in these skills one year after school entrance, although some evidence suggests these differences persist.

Gender differences in vocabulary and math skills

Gender theories acknowledge that a combination of biological and social factors influence gender development (Leaper and Friedman 2007; Reilly, Neumann, and Andrews 2018), which aligns with the Bioecological Model of Development (Bronfenbrenner and Morris 2006). Some studies have found that boys and girls meet different expectations related to their gender in ECEC (Meland and Kaltvedt 2019) and that

three-year-old girls are more interested in activities known to promote language in ECEC than boys (Stangeland, Lundetræ, and Reikerås 2018). ECEC (play-based) and first grade (formal instructions) are two educational settings with different characteristics, and they may affect boys' and girls' vocabulary and math skills differently. The learning environment in ECEC is highly unstructured, which may give boys and girls different learning opportunities due to their self-selected environments, at least to the extent that their choices are gender-specific (Fabes, Martin, and Hanish 2003), in contrast, all children meet instructions in reading and math in the first grade classroom.

Prior findings, however, are mixed regarding gender differences in language and math skills for young children. Norwegian studies have found that boys (18- 36 months) were behind girls in receptive vocabulary and production and language comprehensions (Simonsen et al. 2014; Stangeland, Lundetræ, and Reikerås 2018; Zambrana, Ystrom, and Pons 2012), although the gender differences in language comprehension decreased during this period (Zambrana, Ystrom, and Pons 2012). However, other studies have not found gender differences in expressive vocabulary among U.S. preschoolers (Matthews, Ponitz, and Morrison 2009) or Norwegian children at school entry (McTigue et al. 2021).

For math skills, prior studies have not found gender differences among four-to-seven-year-old U.S. children (Ginsburg and Pappas 2004) and Finnish children (Aunio et al. 2006). In contrast, others have found four-to-five-year-old Finnish girls (Aunio et al. 2006) and 67 months old Norwegian girls (Brandlistuen et al. 2021) to have higher average scores in numeracy than boys. In the latter study, boys increased more than girls the last year in ECEC (61–71 months), although they did not catch up.

Some evidence suggests the developmental trajectories in language skills are different for boys and girls in the way that girls mature at an earlier age than boys and that boys increase more than girls around the age they enter formal schooling (Bornstein, Hahn, and Maurice Haynes 2004; Toivainen et al. 2017). Likewise, during the first two years of primary school, boys have shown a faster growth rate than girls in math skills, particularly among high-achieving children (Aunola et al. 2004). A recent Norwegian study also found that girls scored significantly higher than boys in overall literacy skills (including vocabulary and decoding skills) at the start of school (McTigue et al. 2021). However, the growth trajectories narrowed over time (from school start to the end of second grade), although the boys did not fully catch up.

In summary, previous research indicates that girls have an advantage in vocabulary and math at an early age but that boys catch up around school entry. However, the mixed findings in these prior studies emphasize the importance of investigating whether gender is related to vocabulary and math skills at the end of ECEC and change in these skills to the end of first grade.

Interactions between gender and SES

There is a larger variation within gender groups than between them. Therefore, gender differences must not be considered binary but nuanced (Hyde 2005), and more attention should be given to interaction effects between gender and other factors, such as social class (Backe-Hansen, Walhovd, and Huang 2014).

Boys may be more vulnerable as a group than girls are (Entwisle, Alexander, and Olson 2007). For example, disadvantaged environments, such as low family SES and school quality, are factors that affect boys` development more negatively than girls` (Autor et al. 2016, 2019; Fan, Fang, and Markussen 2015). Previous studies have found that having a highly educated mother contributed more to Finnish boys` number sense than girls` (mean age 74.3 months) (Aunio et al. 2006) and to Norwegian boys` increase in language comprehension than girls` (18–36 months) (Zambrana, Ystrom, and Pons 2012). The results from these studies emphasize the importance of investigating whether the role of maternal education for vocabulary and math skills and changes in these skills differs between boys and girls.

The present study

Theoretical perspectives suggest that socioeconomic disparities occur partly because of different parental behavior and home learning environments (Bradley and Bornstein 2003; Bronfenbrenner and Morris 2006; Conger and Brent Donnellan 2007). Thus, children may get different experiences at home, resulting in different academic trajectories and pathways for learning. Norway is a rich country with a social-democratic welfare system and a strong focus on social and gender equality, which may reduce such differences. Moreover, the different educational settings in the Norwegian ECEC and first grade may influence children's learning and development differently depending on family SES and the child's gender. With this in mind, the following research questions were examined:

(1) Do maternal education and child gender predict vocabulary and math skills in the spring of last year of ECEC and change in these skills between ECEC and spring of first grade?
(2) Does gender moderate the relationship between maternal education and vocabulary and math skills in the spring of last year of ECEC and change in these skills between ECEC and spring of first grade?

Based on prior research (e.g. Hart and Risley 1995; Schjølberg et al. 2008; Zambrana, Ystrom, and Pons 2012), we expected children with mothers with higher education to have higher scores in vocabulary and math skills in spring in the last year of ECEC compared to their peers with less-educated mothers. We expected the SES differences to be relatively stable from ECEC to the spring of first grade (e.g. Farkas and Beron 2004; Zachrisson and Ribeiro 2018).

Based on prior findings, we expected girls to have higher vocabulary and math scores in ECEC than boys (Aunio et al. 2006; Bornstein, Hahn, and Maurice Haynes 2004; Brandlistuen et al. 2021; Zambrana, Ystrom, and Pons 2012). We expected girls` advantage in these skills to decrease from ECEC to first grade (Aunola et al. 2004; Bornstein, Hahn, and Maurice Haynes 2004; Toivainen et al. 2017). Finally, we expected that boys might be more affected by maternal education than girls (Autor et al. 2016, 2019; Fan, Fang, and Markussen 2015; Zambrana, Ystrom, and Pons 2012). However, research is sparse on these interaction effects,

especially among children in the transition from the play-based ECEC setting to the structured learning environment in formal schooling.

Method

Participants

Data in this study derive from the Skoleklar [School readiness] research project. The project was approved by the Norwegian Center for Research Data. All children (N = 287) who were in their last year of ECEC in a municipality on the Norwegian southwest coast were invited to participate. A total of 243 children (84.7%) attending 19 ECEC centers had parental consent to participate. Among these were 119 girls (49%), and 124 were boys (51%). For more details of this sample, see previous research (Størksen et al. 2015). The children's mean age at data collection in the spring last year of ECEC was 5.8 years, ranging from 5.3–6.3 years (SD = 0.29). After the first data collection point, three children moved, leaving a sample of 240 children at data collection in the spring of first grade (eight different schools).

At the first data collection point maternal education level was reported as follow: 1 = junior high school (2.9%), 2 = senior high school (40.0%), 3 = one-to-two years of college/university (8.8%), 4 = three years of college/university education (22.9%), and 5 = more than three years of college/university education (25.4%). Thus, nearly half (48.3%) of the mothers reported having three years of college/university education or more. About half of the women aged 25–39 in Norway have some higher education, suggesting that our sample was relatively representative of the Norwegian population in terms of SES (Statistics Norway 2015).

Parents were born in 21 different countries in addition to Norway. Thirteen children (5.3%, four girls and nine boys) had both parents born in another country than Norway and were coded as immigrants. They included five children (2.0%) whose parents were born in the EU/EEA, USA, Canada, Australia, or New Zealand and eight children (3.3%) whose parents were born in either Asia, Africa, Latin America, Oceania (except Australia and New Zealand), or from another country in Europe outside the EU/EEA.

Missing data

Close collaboration with the municipality, ECEC centers, and schools ensured that the rate of missing data was low (0.0–4.1%) for all variables (Kline 2016). The Little's MCAR test obtained for this study's data indicated no evidence of systematic missing, and we thus assumed that missing was completely at random in the further analyses. Therefore, full information maximum likelihood (FIML) estimation was used in the present study (Enders 2010).

Procedure and measures

The test battery was individually administered using computer tablets in ECEC centers and schools. The testing was carried out by testers (trained in a two-day course) who

had an education related to child development. Parents reported demographic information (highest obtained education level, country of birth, child age, and gender) through a questionnaire.

Vocabulary

Expressive vocabulary was assessed by the Norwegian Vocabulary Test (NVT; Størksen et al. 2013), α = .84 in ECEC and α = .82 in first grade. Pictures (45) appeared on a tablet computer screen, and the child was subsequently asked to name the object depicted. NVT has demonstrated predictive validity by vocabulary scores in ECEC being related to children's reading comprehension in fifth grade (r = .48, p < .01) (Lenes et al. 2020).

Math skills

Math skills were assessed by the Ani Banani Math Test (ABMT; Størksen and Mosvold 2013), α = .73 in ECEC and α = .68 in first grade. ABMT is administered on a tablet and has 18 items assessing three overlapping math areas: problem-solving, geometry, and numeracy. It includes a little monkey called Ani Banani and his imagined everyday activities, such as counting toys, eating a certain amount of bananas, and doing a puzzle or copying a pattern with beads. The ABMT has shown good concurrent, discriminant, and predictive validity (ten Braak and Størksen 2021).

Demographics

Demographic variables included mother's education, gender, child age, and immigrant status. Mother's education and child gender were predictors, and age and immigrant status were covariates in all analyses.

Analytic strategy

Descriptive data are reported in Tables 1 and 2. As shown in Table 1, the shape of the distribution of the data was not severely non-normal (Kline 2016). However, because some of the variables were slightly skewed, the estimator = mlr (robust maximum likelihood) in M*plus* Version 7.3 was specified in the analyses (Muthén and Muthén 1998-2012).

We applied the simplest latent growth curve model (LGM) involving one variable measured the same way at two time points (Duncan, Duncan, and Strycker 2006). Two temporally separated observations allow for estimating the direction and amount of change (the difference score). In growth models, the intercept may be defined as children's initial status (score in ECEC), and the slope represents the difference score between ECEC and first grade (change in score) (see Figure 1). To account for error variance, we incorporated time-specific measurement error into the model by using the estimate of the composite measure's Cronbach alpha as the reliability of the measure (Wang and Wang 2012).

Maternal education and gender were modeled as predictors of intercept factors (vocabulary and math skills in ECEC) and slope factors (change in vocabulary and math skills from ECEC to first grade) within the LGM framework (Duncan, Duncan, and Strycker 2006). The moderation effect (gender by maternal education) was tested by computing

Table 1. Descriptive statistics with effect sizes (ES) for gender differences.

	N	*All M (SD)*	*Girls (= 1) M (SD) N = 119*	*Boys (= 2) M (SD) N = 124*	*ES*	*Girls (Boys) Skewness/Kurtosis*	*Girls (Boys) Min/Max*
Vocabulary [a] T1	241	26.35 (5.70)	27.01 (5.69)	25.73 (5.70)	.22	-.53 (-.35)/-.02 (-.18)	10 (12)/39 (38)
Vocabulary [a] T2	239	30.72 (4.97)	31.26 (4.87)	30.21 (5.06)	.21	-.79 (-.50)/.90 (.25)	15 (14)/41 (42)
Math [b] T1	241	10.62 (3.13)	11.15 (2.96)	10.13 (3.21)	.33*	-.40 (-.21)/.39 (-.48)	2 (2)/18 (17)
Math [b] T2	239	14.52 (2.57)	14.91 (2.64)	14.18 (2.44)	.29*	−1.37 (-.77)/2.34 (.70)	5 (6)/18 (18)
Percent maternal education [c]	240						1 (1)/5 (5)
1		2.9	2.5	3.3			
2		40.0	38.7	41.3			
3		8.8	5.9	11.6			
4		22.9	25.2	20.7			
5		25.4	27.7	23.1			
Percent immigrant status [d]		5.3	3.4	7.6			

Note. T1 = ECEC, T2 = first grade, [a] Norwegian Vocabulary Test, [b] Ani Banani Math Test, [c] 1 = middle school, 2 = high school, 3 = 1-2 years of college/university, 4 = 3 years of college/university, and 5 = more than 3 years of college/university [d] 1 = children with both parents born in another country than Norway, and 0 = all other children. *p <. 05. ES = Cohen`s d

a Chi-square difference test, using the Satorra Bentler correction due to the mlr estimator (Bryant and Satorra 2013; Satorra and Bentler 2010). We controlled for children's age and immigrant status in all analyses, and additionally, we controlled for the initial level of academic skills (ECEC scores) when investigating change (slope factor).

Results

Table 1 shows mean scores and standard deviations in ECEC and first grade, with effect sizes (ES) for gender differences. A one-way ANOVA showed that girls had significantly higher math scores than boys in ECEC ($F(1, 237) = 6.489$, $p = .011$, $d = .34$) and first grade ($F(1, 235) = 5.007$, $p = .026$, $d = .30$). There were, however, no significant gender differences on the vocabulary test in ECEC ($F(1, 237) = 3.030$, $p = .083$, $d = .23$) or first grade ($F(1, 235) = 2.593$, $p = .109$, $d = .21$).

Table 2 contains correlations for all the variables considered in the analysis for boys and girls separately. Maternal education was significantly related to all outcome variables and was most strongly related to boys` math skills in school ($r = .35$, $p < .001$) and most

Table 2. Correlations for All Study Variables. Girls above the diagonal in the top panel and boys below. N = 243.

	1.	2.	3.	4.	5.	6.
1. Maternal education T1	–	-.09	.21*	.31**	.31**	.30**
2. Immigrant status T1	-.19*	–	-.18*	.00	-.35***	-.10
3. Vocabulary [a] T1	.33***	-.52***	–	.46***	.81***	.44***
4. Math [b] T1	.27**	-.08	.43**	–	.42***	.67***
5. Vocabulary [a] T2	.31**	-.47***	.80**	.39**	–	.41**
6. Math [b] T2	.35***	-.04	.31**	.65**	.35**	–

Note. T1 = ECEC, T2 = first grade, [a] Norwegian Vocabulary Test, [b] Ani Banani Math Test.
*p <. 05, **p <. 01, ***p <. 001.

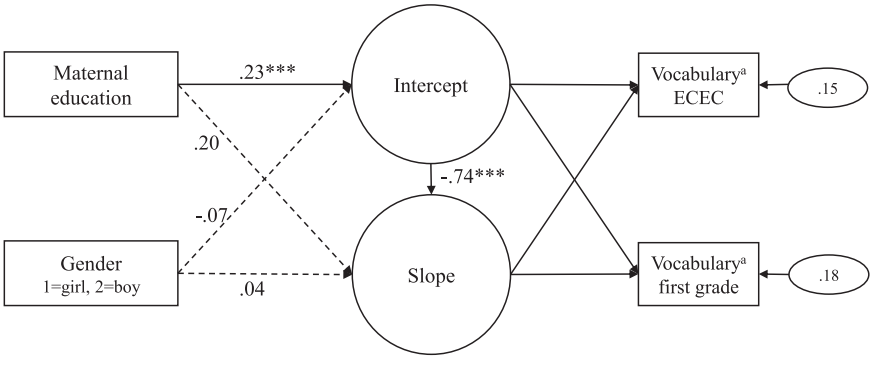

Figure 1. Maternal education and gender predicting initial vocabulary and change from ECEC to first grade. The oval labeled intercept represents the initial status (ECEC), and the oval labeled slope represents the difference score between ECEC and first grade (corrected for measurement error). Predictors are allowed to correlate. [a]Norwegian Vocabulary Test. Dashed lines are nonsignificant. Covariates are age and immigrant status. ***$p < .001$.

weakly related to girls` vocabulary in ECEC ($r = .21$, $p < .05$). The relationship between maternal.

education and boys` ($r = .33$, $p < .001$) and girls` ($r = .21$, $p < .05$) vocabulary in ECEC showed the largest gender difference in terms of correlation size. However, this difference was not significant ($p = .16$). Immigrant status was strongly related to vocabulary, and particularly to boys` vocabulary in ECEC (r = -.52, $p < .001$). High stability over time was found for vocabulary (boys, $r = .80$, $p < .001$ and girls, $r = .81$, $p < .001$) and math skills (boys, $r = .65$, $p < .001$ and girls, $r = .67$, $p < .001$).

The role of maternal education and gender for children's vocabulary and math skills

Results (see Figures 1 and 2, intercept factors) indicated that maternal education significantly predicted children's vocabulary ($\beta = .23$, $p < .001$) and math skills ($\beta = .33$,

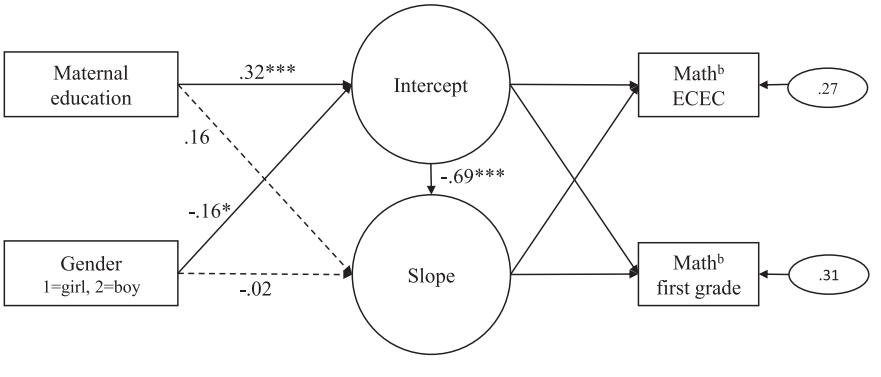

Figure 2. Maternal education and gender predicting initial math skills and change from ECEC to first grade. [b]Ani Banani Math Test. Dashed lines are nonsignificant. Covariates are age and immigrant status. *$p < .05$, ***$p < .001$.

$p < .001$) in spring of the last year of ECEC. Being a boy had a small significant negative effect on math skills in ECEC ($\beta = -.16$, $p < .05$), but there were no significant gender differences in vocabulary ($\beta = -.07$, $p = .264$).

The variance of the vocabulary`s slope factor was nonsignificant when correcting for measurement error and before entering predictors in the model ($var = 1.56$, $p = .211$), although it was significant for math skills ($var = .90$, $p = .048$). Even if the slope factor variance is not statistically significant, the inclusion of predictors often shows that they have a significant influence on the slope so that the slope does vary (as a function of the predictors) (Statmodel 2002). These seemingly conflicting results may be due to a higher power to detect variability when predictors are included (Statmodel 2002). Therefore, the role of maternal education and gender on the slope factors was investigated further. However, results (see Figures 1 and 2, slope factors) showed that maternal education did not significantly predict change in vocabulary ($\beta = .20$, $p = .221$) or math skills ($\beta = .16$, $p = .289$). Similarly, there was no evidence of gender predicting change in vocabulary ($\beta = .04$, $p = .769$) and math skills ($\beta = -.02$, $p = .895$).

The moderating role of gender for the relationship between maternal education and vocabulary and math skills

Figures 3 and 4 (see intercept factor) show separate analyses of the relationship between maternal education and girls` and boys` vocabulary and math skills in ECEC. The chi-square difference test showed no significant differences in maternal education`s role for vocabulary ($\Delta\chi^2$ (1) = .06, $p = .805$) across genders. Thus, the effect of maternal education on children's vocabulary did not differ significantly between boys and girls. The effect of maternal education also did not differ significantly for girls` and boys` math scores in ECEC ($\Delta\chi^2$ (1) = .11, $p = .746$). Because maternal education did not significantly predict change in boys` and girls` vocabulary and math skills and the variance of the slope factors was nonsignificant, we did not investigate whether gender moderated the relationship between maternal education and change in vocabulary and math skills.

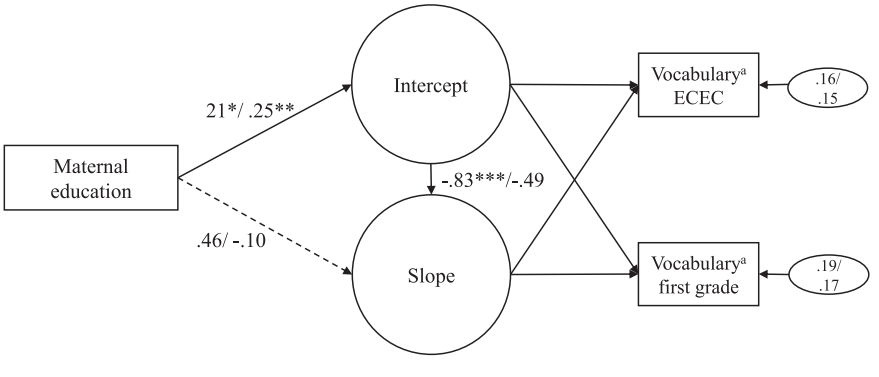

Figure 3. Maternal education predicting the intercept and slope factors for girls' / boys' vocabulary. [a]Norwegian Vocabulary Test. Dashed lines are nonsignificant. Covariates are age and immigrant status. *p <. 05, **p <. 01, ***p <. 001.

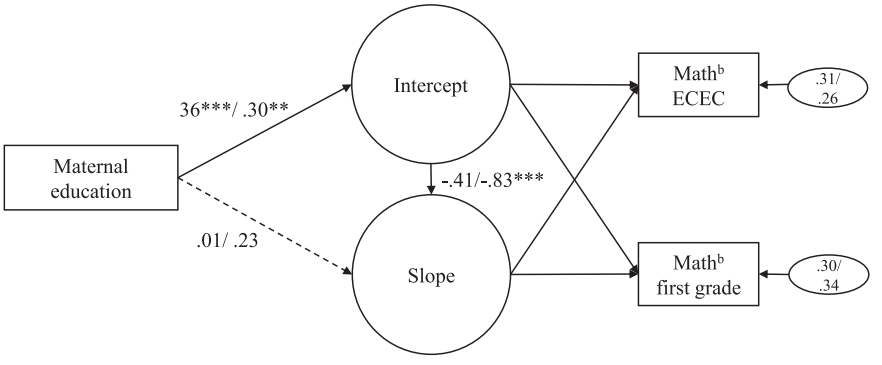

Figure 4. Maternal education predicting the intercept and slope factor for girls` / boys`math skills. [b]Ani Banani Math Test. Dashed lines are nonsignificant. Covariates are age and immigrant status. $^{**}p < .01$, $^{***}p < .001$.

Discussion

The role of maternal education on vocabulary and math skills

The present study supports previous research (e.g. Aunio et al. 2006; Schjølberg et al. 2008; Zambrana, Ystrom, and Pons 2012) in showing that children with higher educated mothers were more likely to have higher vocabulary and math scores at the end of ECEC compared to children with less-educated mothers. SES-related differences in children's language have been found at a very early age and in some studies as early as before the age of two (Farkas and Beron 2004; Hart and Risley 1995; Hoff 2003; Zambrana, Ystrom, and Pons 2012). Thus, the onset of the SES differences in children's vocabulary we identified in this study might have appeared before entering ECEC or during the first years.

Although Norway has a well-functioning welfare system, a strong family service orientation, and offers a full-time universal ECEC, we found SES differences in early childhood vocabulary and math skills. However, the findings might be smaller than what had been the case if children did not attend ECEC, as some prior Norwegian research has indicated (Havnes and Mogstad 2011; Schjølberg et al. 2008). Still, there is some evidence that SES differences in children's language comprehension increase during children's first years in the Norwegian ECEC (Zambrana, Ystrom, and Pons 2012). Moreover, as the present study found, there were moderate SES differences in children's vocabulary and math skills when Norwegian children start first grade, indicating that Norway can do more to lessen SES gaps in ECEC.

We found no significant effect of maternal education on children's change in vocabulary and math skills from the spring of ECEC to the spring of first grade. Thus, the SES differences we found in ECEC persisted, aligning with previous research showing that SES differences are stable or slightly increase after school entry (e.g. Farkas and Beron 2004; Passaretta and Skopek 2018). One reason for this result may be that all children were exposed to math instruction in first grade, which enhanced all children's math skills, independent of social background. Another reason may be that we found high stability in vocabulary and math skills from ECEC to first grade. The estimated variance

of the slope factor was not significant for vocabulary and very small for math, indicating that children did not vary around the mean slopes. Hence there was practically no variance left to be explained by other factors. Previous research has also found that the rank order between children is highly stable in vocabulary from four to eight years (Melby-Lervåg et al. 2012).

In summary, SES differences in vocabulary and math skills at the end of ECEC were still present at the end of first grade. These findings align with other research showing that SES differences in school achievement are rooted substantially in the early years (Passaretta and Skopek 2018). Thus, the years before entering school are formative for patterns of inequality observed in school-age.

The role of gender on vocabulary and math skills

Results partly supported our hypotheses and showed that girls had a small advantage in math skills at the end of ECEC, but we found no gender differences in vocabulary. Prior findings are mixed regarding gender differences in vocabulary and math skills (e.g. Aunio et al. 2006; Brandlistuen et al. 2021; Ginsburg and Pappas 2004; Matthews, Ponitz, and Morrison 2009; McTigue et al. 2021; Zambrana, Ystrom, and Pons 2012). These mixed findings may be due to variations in study parameters, such as child age when examining gender differences, assessment tools, and cultural differences in societies and educational settings. However, they may also be related to the fact that gender differences in cognitive skills are small (Hyde 2005, 2014).

Findings show that although boys typically learn to comprehend and produce language more slowly than girls, gender differences decrease at age three (Zambrana, Ystrom, and Pons 2012), and it is also reported that boys catch up to girls by 30 months of age (Bouchard et al. 2009). The present study supports the notion of boys catching up since no gender differences in vocabulary were found among children at the end of ECEC, which is in line with findings in a recent Norwegian study (McTigue et al. 2021).

We found girls to have slightly higher math scores than boys at the end of ECEC. Compared to vocabulary, which develops in everyday communication, developing math skills may require a more intentional focus. Thus, our result may reflect that girls participate in more adult-initiated activities, as has been found by several researchers (Fabes, Martin, and Hanish 2003; Stangeland, Lundetræ, and Reikerås 2018). The Norwegian ECEC, which is characterized by a high degree of autonomy for children, may cause girls to choose activities that enhance their math skills to a larger degree than what is seen among boys. There is a lack of emphasis on math activities in the Norwegian ECEC compared to language activities (Østrem et al. 2009), which may potentially harm boys more than girls. However, the result may also be related to the measurement used. ABMT has shown robust item functioning across age and SES, but gender-related item biases for three out of a total of 18 items (ten Braak and Størksen 2021). However, the gender differences in maths skills were small in magnitude, and these results should therefore be interpreted with some caution.

Results showed no significant differences between girls` and boys` changes in vocabulary and math skills from ECEC to first grade. Thus, our hypothesis, which was based on previous research indicating girls` advantage in these skills would decrease from ECEC to

first grade (Aunola et al. 2004; Bornstein, Hahn, and Maurice Haynes 2004; Toivainen et al. 2017; McTigue et al. 2021), was not supported. As already mentioned, children's vocabulary and math skills were highly stable from ECEC to first grade, and there was practically no variance left to be explained by other factors, such as gender. It is also possible that in the more structured first-grade classroom with formal teaching, children are more likely to receive adult-guided math activities than in ECEC, which may enhance math among both girls and boys. In summary, the results showed nonsignificant or small gender differences in vocabulary and math skills which align with previous findings.

The moderating role of gender on the relationship between maternal education and vocabulary and math skills

The influence of maternal education on vocabulary and math skills in ECEC did not differ for boys and girls. This finding did not support previous research indicating that boys could be more dependent on family SES than girls (e.g. Autor et al. 2019; Entwisle, Alexander, and Olson 2007). A previous Norwegian study (Zambrana, Ystrom, and Pons 2012) found that having a mother with low education was more detrimental for boys' change in language comprehension than girls' (between 18–36 months). However, there may be larger gender differences in vocabulary at an early age, which may explain why these researchers found that maternal education was more important for boys' than girls' change in vocabulary while there were no indications of this for the five- to six-year-old children in the present study.

Practical implications

SES inequalities in children's vocabulary and math skills are well established before children enter formal schooling and persist throughout their educational careers. This points to the importance of interventions in the early years of life that facilitate an equal start in formal schooling, which may reduce SES differences later in school. Many social contexts influence children's development. Moreover, the values, ideology, and organization of the social institutions (e.g. welfare- and educational system) will affect SES differences in societies. In Norway, most children stay full-time in ECEC from age one. Thus, ECEC may be one important social context that may contribute to lessening SES differences in early childhood, which is supported by previous research findings showing that high-quality ECEC can reduce SES differences (Sylva et al. 2020). Norway enjoys a reputation for providing high-quality ECEC, characterized by free play and child autonomy. However, during free play, research has also documented that staff is absent much of the time (Karlsen and Lekhal 2019). Moreover, recent studies have documented that Norwegian ECEC centers score at the lower level on educational support (Bjørnestad et al. 2020; Bjørnestad and Os 2018) and thus may not sufficiently support children's learning to counteract the effects of parental SES. Some research has found that families with high SES to a larger degree enroll their children into ECEC centers with higher quality than low SES families (Alexandersen et al. 2021), while others have not (Rege et al. 2018). In order to reach the important goal of evening social differences in the Norwegian ECEC (Norwegian Ministry of Education and Research 2017), all children should get

access to high-quality ECEC with rich opportunities for stimulating activities and play. Together with other well-fare initiatives, this seems to be an important intervention to narrow SES gaps in child development.

In order to increase the quality in all ECEC centers, professional development for teachers is needed. An OECD report recommends that Norway raise qualifications for all ECEC staff (Engel et al. 2015). Resources such as coaching, videos, webinars, and systematic observations, reflections, and evaluations can be used to enhance the staff's knowledge and actions. There is also a need for research-based teacher education to bridge the gap between research and the practical field. Furthermore, theory (e.g. Bronfenbrenner and Morris 2006) indicates that supporting children's home learning environments may also reduce SES differences, e.g. through various initiatives to strengthen parenting skills.

It is important to note that the gender differences found in this study were small and were secondary to other sources, such as SES. Still, although there are few differences in girls` and boys` academic skills, there are larger gender differences in their academic achievement, course selection, and career choices as they get older (Bussey 2011). Thus, teachers and parents must be aware that unintentional teaching approaches and behaviors may transmit traditional gender roles by signaling different expectations and possibilities to boys and girls. However, large variations in Norwegian children's vocabulary and math skills exist at the end of ECEC and first grade, independent of gender, and the overinflation on gender differences can deflect attention from more important directions, such as SES. Therefore, all children and students should get opportunities to develop according to their potential, independent of gender and background.

Limitations and future directions

Overall, the present study extends existing research by investigating SES and gender differences in a Norwegian cultural context and the transition from a play-based ECEC to formal schooling. There were, however, some limitations. The study relied on a convenience sample, and results may not generalize to a broader population of children and families. Still, the sample was fairly representative of the Norwegian population in terms of maternal educational level. It was, however, relatively homogenous in terms of ethnicity compared to urban parts in Norway and other western countries, which could limit the generalizability of results to more diverse populations.

This study relies on SES (maternal education) and not the characteristics of the home learning environment. In order to investigate the mechanisms behind SES and gender differences, observations are needed to examine the contribution of parent–child interaction processes. Moreover, this study describes the characteristics of the pedagogical settings in ECEC and first grade, but it does not directly measure them, and more observational studies are needed. Future research should also include other SES indicators, such as income and parental occupation, since each indicator may have an important independent influence on how children are raised and develop (Conger and Brent Donnellan 2007), especially as we see development toward increasingly diverse populations. Still, maternal education remains one of the strongest predictors of children's vocabulary and math skills (e.g. Magnuson et al. 2009; Sektnan et al. 2010).

Finally, it is not possible to study the shape of the developmental trajectory with only two time points, only the directions and amount of change. This study examined change (or growth) from the end of ECEC to the end of first grade, and therefore this model was suitable.

Conclusion

Results showed that maternal education predicted Norwegian children's vocabulary and math skills at the end of ECEC, but not their change in these skills to the end of first grade. Girls had a small advantage compared to boys in math skills at the end of ECEC. There were, however, no gender differences in the change in vocabulary and math skills to the end of first grade. The role of maternal education did not differ for boys and girls. Overall, the findings suggest that it is crucial to continue efforts to increase quality in ECEC to give all children rich opportunities to develop according to their potential.

Ethical considerations

The studies involving human participants were reviewed and approved by Norwegian Centre for Research Data (NSD). Written informed consent to participate in this study was provided by the participant's legal guardian/next of kin. Research assistants were trained in the tests and how to test children. Children were given age-appropriate information about the research project, and research assistants were instructed to respect children's choices if they were unwilling to participate.

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