Development of self-regulation and academic skills: The role of child factors, socioeconomic status, and cultural context

by

Ragnhild Lenes

Thesis submitted in fulfilment of
the requirements for the degree of
PHILOSOPHIAE DOCTOR
(PhD)

Faculty of Arts and Education
Norwegian Centre for Learning Environment and Behavioural Research in Education
2021

University of Stavanger
NO-4036 Stavanger
NORWAY
www.uis.no

ISBN: 978-82-8439-040-6
ISSN: 1890-1387
PhD: Thesis UiS No. 611

Foto: Steinar Figved for Agderprosjektet, UiS

“Children are only as competent as their context affords them the opportunity to be.”

Robert C. Pianta (1999, p. 64)

Acknowledgments

Denne doktorgrads avhandlingen har blitt gjennomført ved Læringsmiljøsenteret, Universitetet i Stavanger.

Doktorgradsprosjektet er finansiert av Agderprosjektet og i arbeidet har jeg brukt data fra forskningsprosjektene Skoleklar og Touch your toes! Først og fremst vil jeg takke barna som har gitt grunnlaget for alle data. Uten deres samarbeid og deres ønske om å delta, så ville ikke disse prosjektene vært mulige. I tillegg har foreldre, forskergrupper, kommuneadministrasjon, rektorer, styrere, lærere, barnehagelærere og øvrig ansatte i hvert av prosjektene bidratt til dataene som denne doktorgraden bygger på. Tusen takk!

Arbeidet med doktorgradsprosjektet har det gitt meg unike muligheter til å bli utfordret på alle plan og lære noe nytt hver dag. I tillegg har jeg blitt kjent med en rekke fantastiske mennesker. Jeg hadde mitt pliktarbeid i Agderprosjektet og der fikk jeg blant annet samarbeide med engasjerte barnehagelærer som bidro til å utvikle intervensjonen. I Agderprosjektet var jeg også så heldig at jeg ble en del av en forskergruppe bestående av Mari Rege, Ingunn Størksen, Svanaug Lunde, Dieuwer ten Braak, Ingeborg Foldøy, Åse Lea, Svanhild Breive, Martin Carlsen, Ingvald Erfjord og Per Sigurd Hundeland. Jeg takker hver og en av dere for kunnskapsdeling, inspirasjon, og gode minner.

Takk til Ingunn Størksen, Thormod Idsøe, og Megan McClelland som har vært mine veiledere. En spesiell takk til Ingunn, som har vært min hovedveileder. Jeg kunne ikke hatt noen bedre. Din kreativitet har vært til inspirasjon og jeg har satt stor pris på din faglige støtte og ikke minst på det rause og fine mennesket du er. Du har vist en uvurderlig evne til å balansere støtte og utfordring. Tusen takk!

Takk, Thormod, for at du har vært på tilbudssiden og for at du er en tålmodig og pedagogisk statistikk veileder. I tillegg er du også et veldig fint medmenneske.

Megan, takk for at du har delt din kunnskap og forskererfaring med meg. Jeg vil også takke for din generøsitet da jeg var gjest ved Hallie E. Ford Center, Oregon State University. I tillegg til å inkludere meg i forskergruppen din så åpnet du også hjemmet ditt for meg og min familie. Dette gav oss erfaringer og gode minner for livet. Under oppholdet traff jeg også Chris Gonzales, som ble en viktig medforfatter i en av artiklene. Takk for lærerike diskusjoner!

Svanaug Lunde, takk for at du er den du er. En oppmerksom og tilstedeværende gledesspreder og en unik formidler som bidrar til at barn har det trygt og godt i barnehagen.

Dieuwer, du og jeg startet våre doktorgradsprosjekt samtidig og det er jeg utrolig glad for. Sammen har vi reist på utallige turer og konferanser som har gitt oss fantastiske opplevelser, men aller mest har jeg satt pris på fellesskap vi hadde på kontoret vi delte—innerst i gangen. Gjennom deg har jeg blitt utfordret og jeg har lært mye som jeg ikke visste at jeg ikke visste. Det har jeg satt pris på! Nå ser jeg fram til å pleie vennskapet videre.

Jeg vil også takke mine medstipendiater, barnehagegruppen og øvrige kolleger ved Læringsmiljøsenteret. Det er fantastisk å få være en del av dette kollegiet!

Takk til familie og venner som har bidratt til innhold og glede i «hjemmelivet» gjennom disse årene. Jeg føler meg privilegert som har hver og en av dere i livet mitt!

Mine kjære foreldre, Kirsti og Eivind Lenes. Takk for at dere alltid er til stede og viser interesse og kjærlighet. Dere er forbilder! Det er også du, Anna, min inderlig gode venn.

Og til slutt, den lille flokken min. Vemund, du har blitt voksen i løpet av denne perioden. Takk for at du er akkurat den du er! Silje, lille jenta vår, har blitt ti år! Takk for de beste klemmene som fins. Håvard, min kjæreste, du er min klippe og min utfordrer. Hva var vel livet uten dere?

Stavanger, juni 2021

Ragnhild Lenes

Summary

Early childhood is a period of rapid learning and development, and research has made us increasingly aware of how crucial children's early experiences are both for their current well-being and for their future adjustment, well-being, and academic achievement. The present thesis investigates the role of child gender and self-regulation, family socioeconomic status (SES), and cultural context for predicting children's academic skills and self-regulation. It includes three studies, which all rely on data from a Norwegian research project. One of them—a comparative study—also relies on data from research conducted in the United States (U.S.).

The thesis had four overarching goals across the three studies. The first goal was to investigate the direct and indirect pathways from early self-regulation to fifth-grade academic achievement (Study II). The results showed that Norwegian children's early self-regulation was foundational for their later reading comprehension and mathematical achievement. The second goal was to investigate the role of child gender for predicting early-childhood academic skills (Study I) and self-regulation (Study III). Results revealed small gender differences (favoring girls) in mathematical skills and self-regulation in the spring of the last year of Early Childhood Education and Care (ECEC) among Norwegian children, but no such differences in vocabulary. There were no gender effects on the change in vocabulary and mathematical skills to the spring of first grade. The third goal was to examine the role of family SES (maternal education) for predicting children's early-childhood academic skills (Study I) and self-regulation (Study III). The results showed SES-related differences in Norwegian children's vocabulary and mathematical skills in ECEC but not in their self-regulation. Further, the change seen in academic skills from ECEC to first grade was not affected by SES. Finally, the fourth goal was to study levels of early-childhood self-regulation and the role of maternal education and child gender for

predicting self-regulation in Norway and the United States (Study III). Findings showed that children's average level of self-regulation did not differ significantly across the two samples. Norwegian girls did have higher self-regulation scores than boys while there were no such gender differences in the U.S. sample, but this difference between the samples was not significant. However, maternal education significantly predicted U.S. children's self-regulation but not that of Norwegian children, and this difference was significant across the samples.

The results are interpreted in light of the Bioecological Model of Development, previous evidence, and the social contexts from which the samples derive. Implications, especially for Norwegian ECEC, have been thoroughly discussed. The present thesis highlights the importance of conducting studies across groups and cultural contexts to understand the complexity of child development. Moreover, it emphasizes the importance of bringing self-regulation as a concept into Norwegian ECEC. In research and practice across the world, self-regulation is seen as foundational for early-childhood learning and development, but this concept is not even mentioned in the Norwegian framework plan for ECEC, which may affect pedagogical practices negatively.

The international literature on these topics is considerable, but this thesis contributes to our knowledge by investigating self-regulation in a Norwegian cultural and educational context. In addition, it has a longitudinal design that enables examination of long-term direct and indirect associations between early self-regulation and later academic achievement. This thesis also contributes by investigating the role of child gender and SES for predicting academic skills across two different educational contexts, namely the play-based ECEC and the structured first-grade classroom. Finally, this thesis includes a comparative study, which sheds light on the importance of conducting studies across cultural contexts, given that results from one context may not be valid for another.

List of Studies

Study I

Lenes, R., Størksen, I., McClelland M., & Idsøe, T. (2021). 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. Manuscript accepted July 30, 2021. The Paper is provisionally scheduled for publication in *European Early Childhood Education Research Journal*, Volume 30 Issue 3, June 2022.

Study II

Lenes, R., McClelland, M. M., ten Braak, D., Idsøe, T., & Størksen, I. (2020). Direct and indirect pathways from children's early self-regulation to academic achievement in fifth grade in Norway. *Early Childhood Research Quarterly, 53*, 612–624. doi: https://doi.org/10.1016/j.ecresq.2020.07.005

Study III

Lenes, R., Gonzales, C. R., Størksen, I., & McClelland, M. M. (2020). Children's Self-Regulation in Norway and the United States: The Role of Mother's Education and Child Gender Across Cultural Contexts. *Frontiers in Psychology, 11*(2563). doi: https://doi.org/10.3389/fpsyg.2020.566208

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1 Introduction

Research in the field of child development has made us increasingly aware of how crucially important children's early experiences are both for their well-being here and now and for their future adjustment, well-being, and academic achievement. Many countries across the world are implementing family programs and Early Childhood Education and Care (ECEC) programs in an attempt to provide all children with optimal development and opportunities during early childhood. Norway stands out in this respect by offering a wide range of social-welfare programs, including universal ECEC for all children from age one. However, there is a need to carry out research into child development in the Norwegian cultural context in order to gain more knowledge about how specific contextual and child-specific factors may be related to children's development. The number of Norwegian quantitative and longitudinal studies investigating predictors of children's development of self-regulation and academic skills is limited, and it was even more limited when the main research project upon which this thesis is based started in 2011.

This thesis includes three studies (Studies I, II, and III), and it has four overarching goals related to child factors and social factors. Table 1 summarizes its content and overarching goals.

Table 1: Summary of the content and overarching goals of the thesis

Bioecological perspectives in the present thesis				
Predictors	Child factors		Social factors	
	Self-regulation	Gender	Socioeconomic status	Norwegian and U.S. society
Overarching goals	1. Investigate direct and indirect effects of early self-regulation on first- and fifth-grade academic skills	2. Investigate the role of child gender for predicting academic skills in ECEC and first grade, and for predicting self-regulation in ECEC	3. Investigate the role of maternal education for predicting academic skills in ECEC and first grade, and for self-regulation in ECEC	4. Investigate whether children's level of self-regulation and the role of maternal education and child gender for predicting self-regulation differ between Norwegian and U.S. samples
Outcomes	Academic skills	Academic skills Self-regulation	Academic skills Self-regulation	Self-regulation
Study I		x	x	
Study II	x			
Study III		x	x	x
Discuss results from all three studies in light of pedagogical approaches, educational settings, and other societal characteristics				

ECEC = Early Childhood Education and Care, U.S. = the United States

The number of topics covered by this thesis is fairly large. This is both a good thing and a bad thing: it is positive in that it yields an overview of several important factors related to child development, but it is negative in that it makes it difficult to investigate any one topic in greater depth. Given the broad approach taken, it was deemed that the Bioecological Model of Development would be an appropriate theory to use because it highlights the complexity of child development (Bronfenbrenner, 2005c;

Bronfenbrenner & Morris, 2006). This theory and previous evidence inform the three studies included in the present thesis, it defines the research questions and analytical models used, and it helps to discuss the findings. Within the bioecological framework, development occurs in the interaction over time between a person and a social context. It is suggested that this interaction, and hence the child's development, is affected by characteristics of the child (e.g., gender, temperament, and skills), of the child's family (e.g., socioeconomic status), and of the society in which the child lives (e.g., ideology and societal organization). For this reason, there is a need to conduct studies in different societies, cultures, and social groups and then to discuss the results obtained in light of the characteristics of the social contexts within which the different studies were conducted (Bronfenbrenner & Morris, 2006).

This thesis supplements existing research in several ways. First, since Norway makes great efforts to even out social and gender differences, it is important to find out whether socioeconomic status (SES) and child gender really are prominent predictors of early academic outcomes and self-regulation. In the framework plan for the content and tasks of kindergartens (Norwegian Ministry of Education and Research, 2011, 2017)[1] and other relevant documents (Backe-Hansen, Walhovd, & Huang, 2014; Bakken, Borg, Hegna, & Backe-Hansen, 2008; NOU 2019:3, 2019), it is claimed that these factors are important, and it is stated that they should be addressed in everyday ECEC practice. In this context, the present thesis also adds value by investigating SES and gender in relation to children's self-regulation across countries, thus providing insights into child development in different cultural contexts.

[1] A new framework plan for Norwegian ECEC was implemented in 2017 (Framework plan for kindergartens. Contents and tasks). The 2011 framework plan (Framework plan for the content and tasks of kindergartens) applied when the studies included in the present thesis were conducted, which is why it is also cited in this thesis. Both plans belong to the social-pedagogical tradition and are based on the same values.

Second, there is a need for specifically Norwegian research into the foundational role of children's early self-regulatory skills for predicting later academic achievement, since most prior research on this topic has been conducted in the United States, where the cultural context differs from that of Norway or Scandinavia more generally. Because cultural context influences children's development (Bronfenbrenner & Morris, 2006), it is important to conduct research on children's learning and development in a Norwegian context and to carry out comparative studies including samples from different countries.

Third, there is a general trend for different pedagogical traditions to favor different research approaches. Norway has a social-pedagogical tradition, and small qualitative studies used to dominate the ECEC research field (Alvestad, Johansson, Moser, & Søbstad, 2009). By contrast, countries taking a "pre-primary" or "readiness for school" approach have been more likely to conduct effect studies as well as large national and international studies such as the Early Child Care and Youth Development (ECCYD) study in the United States (U.S.) and the Effective Provision of Pre-school Education (EPPE) study in the United Kingdom. However, large longitudinal studies have recently been conducted in Norway as well, including the Norwegian Mother, Father, and Child Cohort Study (MoBa) and the Better Provision for Norway's Children in ECEC study (GoBaN). The present thesis contributes to the field of Norwegian educational research by taking a quantitative approach and using a longitudinal design (Studies I and II) as well as by including a comparative study (Study III).

1.1 Definitions of relevant concepts

Several of the key concepts that are used in the present thesis need to be defined and discussed at the outset. The child factors focused upon are gender, self-regulation, vocabulary, phonological awareness, mathematical skills, and reading comprehension, while the social factors dealt with are SES and society-level culture, including different

educational settings and pedagogical approaches. These child factors and social factors will be defined, described, and discussed in the relevant sections of the Theory chapter, while ECEC and some related concepts are defined and discussed below.

The European Commission defines ECEC as referring to "any regulated arrangement that provides education and care for children from birth to compulsory primary school age, which may vary across [countries]. It includes [center] and [family daycare], privately and publicly funded provision, pre-school and pre-primary provision" (European Commission, 2020). In the present study, ECEC refers only to center care, which is referred to in Norway by the term *barnehage*. The direct English[2] translation of *barnehage* is *kindergarten*, and this is indeed the term used in the English version of the Norwegian framework plan (2011, 2017). However, the Norwegian *barnehage* is not comparable to kindergarten as it is known in the United States. While U.S. kindergarten tends to be a one-year program immediately before first grade, the Norwegian *barnehage* is a universal ECEC system accepting all children aged one to five, thus including children who might be enrolled in daycare or preschool in the United States. In Study II, the term *kindergarten* was used, but in the Norwegian sense. In Studies I and III, the term ECEC was used, and it is also the term used throughout the present thesis summary.

In Norwegian *barnehage*, approximately 40% (30% at the time data used in this thesis were collected) of the staff is ECEC teacher-educated (Bachelor`s degree). Other staff are assistants or have a relevant certificate of apprenticeship. For simplicity, the term teacher is used throughout this thesis, reflecting all staff.

[2] Or, technically, German; the German word *Kindergarten* literally translates as "child garden," but that term does not seem to have caught on in the English-speaking world.

1.2 Overarching projects

Three research projects form the background to the present thesis.

1.2.1 Skoleklar

Data collected in *Skoleklar* [School readiness], a longitudinal research project, were used in all three studies. The Skoleklar project was supported by the Research Council of Norway through grant No. 203326. It began in 2011 in a rural area on the southwest coast of Norway. Its overarching goal was to investigate early predictors and inhibitors of future learning in Norwegian children. For example, it aimed to investigate whether having a mother with a low educational level, being a boy, or having weak early academic skills and poor self-regulation inhibited children's learning and development. Data were first collected at the end of ECEC (spring 2012) and then in first grade (spring 2013), fifth grade (fall 2016), and eighth grade (fall 2019; eighth-grade data were not included in the present thesis). The three studies included in the present thesis rely on data collected in 2012 (T1) (Studies I, II, and III), in 2013 (T2) (Studies I and II), and in 2016 (T3) (Study II). Since the 2012 and 2013 data-collection rounds took place before I began my Ph.D. program, I contributed only to data collection in fifth and eighth grade.

1.2.2 Touch your toes!

Data collected in a U.S. research project called *Touch your toes! Developing a new measure of behavioral regulation* were used in the cross-cultural study included in the present thesis (Study III). Touch your toes! is a longitudinal study examining children's self-regulation during the transition from preschool to formal schooling (kindergarten) in a rural area in the Pacific Northwest region (Oregon) of the United States. The study started in 2010 and ended in 2015. The data used in Study III were collected in the fall of kindergarten (2012). The primary goal of the

project was to develop a reliable and ecologically valid screening measure—the Head-Toes-Knees-Shoulder (HTKS) task—of children's behavioral self-regulation. The project was supported by the United States Department of Education, Institute of Education Sciences, grant No. R305R305A100566 to Megan McClelland, Oregon State University.

1.2.3 Agderprosjektet

My Ph.D. project is part of *Agderprosjektet* (the Agder Project), supported by the Research Council of Norway through grant No. 237973, which drew upon knowledge acquired in the Skoleklar project and on international research showing that high-quality ECEC programs can have a substantial impact on children's learning trajectories. The Agder Project aimed to investigate whether Norwegian ECEC centers could improve children's developmental trajectories by implementing a more systematic cultivation of key school-readiness skills. A new playful-learning curriculum was developed in collaboration with Norwegian ECEC teachers. This curriculum included games and activities to enhance children's self-regulation, social competencies, vocabulary, and early mathematical skills (Størksen et al., 2016), and it strongly emphasized the importance of positive child–teacher relationships and a playful approach to learning. A total of 71 ECEC centers participated; they were randomly assigned to a focus and a control group (for further descriptions and results, see Rege et al., 2019).

Although the present thesis does not rely on data collected in the Agder Project, I undertook two years of mandatory work linked to that project and to *Lekbasert Læring* [Playful Learning], a research project which is a follow-up to the Agder Project. My work consisted in developing an intervention (a curriculum), implementing it, and collecting data. The Agder Project used assessment tools developed and used in the Skoleklar project, which familiarized me with the assessments later to be used in the present thesis.

Data already collected in the Skoleklar and Touch your toes! projects, and my experience from data collection and innovation in the Agder and Lekbasert Læring projects, both contributed to the research findings presented in this thesis and to my training as a researcher. Being invited to join research teams and being involved in their work has broadened my understanding of the complexity of research processes. During my time as a Ph.D. student, I spent a year at Oregon State University, where Megan McClelland, my co-supervisor, is a professor. Paper III was written during that stay, and I collaborated with Megan and her research team.

My Phd was initiated through the Agder project that focused on child development during ECEC. Additionally, the Skoleklar project had a focus on early childhood (ECEC) predictors of later development. Therefore, I choose to focus the discussions of the research results in this thesis and their practical implications mainly in relation to ECEC.

2 Theory

Research into children's development is often guided by the Relational Developmental Systems (RDS) paradigm (Bornstein & Leventhal, 2015). Theories of human development that fall within this paradigm all share certain core principles: the child's environment is complex, multidimensional, and structurally organized into interlinked contexts; children actively contribute to their development; the child and its environment are inseparably linked, with contributions both from the child and from the environment being essential for explaining or understanding development; the child's development is multidetermined; and change over time in the child, the environment, and relations between the child and the environment is normative (Bornstein & Leventhal, 2015, p. 1).

One of the theoretical frameworks to be found within the RDS paradigm is the Bioecological Model of Development (Bronfenbrenner, 1979, 2005c; Bronfenbrenner & Morris, 2006).

2.1 The Bioecological Model of Development

The Bioecological Model of Development has four principal types of elements: processes, persons, contexts, and time (the PPCT model) (Bronfenbrenner, 2005a; Bronfenbrenner & Morris, 2006). The primary engine of development in this model is proximal processes, which consist of interactions between the child (person) and the environment (context). The environment is a hierarchically organized, interlinked set of nested contexts or systems, referred to as the "microsystem," "mesosystem," "exosystem," and "macrosystem." Each system has the potential to influence other systems. Cutting across all four systems is the dimension of time, which is referred to as the "chronosystem." The form, power, content, and directions of the proximal processes producing development vary systematically as a joint function of the developing

person's characteristics (e.g., gender, age, self-regulation, experiences, and knowledge), the nature of the developmental outcomes, and characteristics, continuities and changes over time in the environment.

Within the Bioecological Model of Development, the child's characteristics function both as an indirect producer of development and as a product of development (Bronfenbrenner & Morris, 2006). On the one hand, the child's characteristics and experiences influence the proximal processes. On the other hand, the child's characteristics appear as developmental outcomes. This means, for example, that children who start formal schooling with stronger self-regulation skills may experience positive relationships with peers and teachers (proximal processes) and may have the skills needed to benefit from formal instruction, which, in turn, may positively affect their further development, such as in terms of self-regulation and academic skills.

The microsystem (see Figure 1) is the most central to the child. It consists of patterns of interactions (proximal processes) between the child and its immediate social (e.g., parents, teachers, and peers) and physical (e.g., objects) environment (Bronfenbrenner, 2005a; Bronfenbrenner & Morris, 2006). Over time, participation in proximal processes generates the ability, motivation, knowledge, and skills a child needs to engage in activities, both together with others and independently.

The microsystem is surrounded by the mesosystem, which consists of processes and links between two or more microsystems (Bronfenbrenner, 2005a; Bronfenbrenner & Morris, 2006). The collaboration between the child's parents and the staff in the child's ECEC center and the transition from ECEC to school are important mesosystems in childhood education. For example, one study found that parents with low SES were less involved in their ECEC-enrolled children and that this may lead to discontinuity and instability for the children, affecting their development negatively (Arnold, Zeljo, Doctoroff, & Ortiz, 2008).

The next layer is the exosystem. It includes aspects of the environment that the child does not encounter directly (e.g., parents' workplaces) but that still indirectly affect the child's development by influencing proximal processes (Bronfenbrenner, 2005a; Bronfenbrenner & Morris, 2006). For example, a teacher's chaotic home life or a parent's stressful job may reduce the quality of their interactions with their students or children.

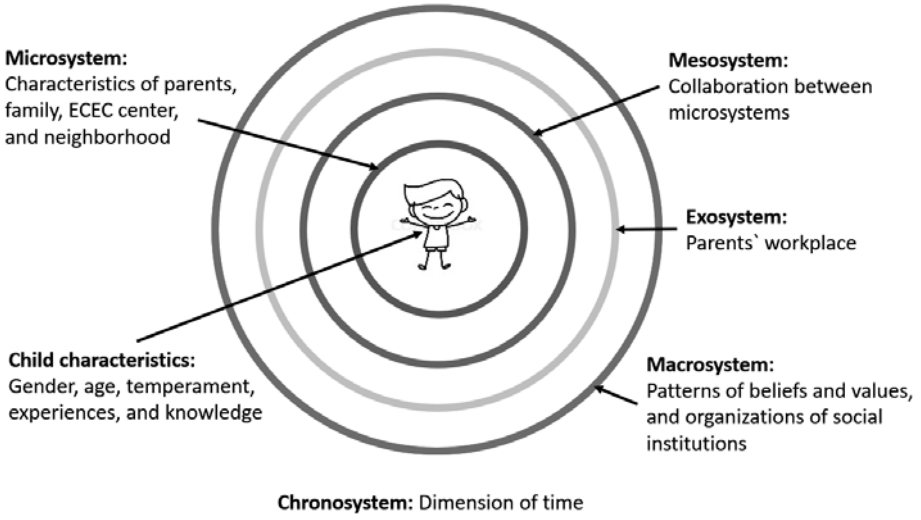

Figure 1: The Bioecological Model of Development. Based on Bronfenbrenner (2005c).

Finally, the macrosystem differs fundamentally from the other systems. It does not refer to any specific contexts affecting a particular person's life but to overarching patterns of ideology and organization of social institutions common to a particular culture or subculture (Bronfenbrenner, 1979, 2005b). It should be noted that general prototypes existing in a culture or subculture set the pattern for structures and activities at a concrete level or in proximal processes. This means that, within a given society or social group (sharing a macrosystem), the structure and substance of the micro-, meso-, and exosystems tend to be similar. Examples of macrosystem ideology and organization that indirectly affect other systems and hence proximal processes include the

existence of government-subsidized ECEC and a generous welfare system in a society or the child-rearing values and pedagogical approach prevalent in a culture.

One advantage of the Bioecological Model of Development is that it highlights the interactive processes involving the child and the social contexts. The model is complex—but so is development. Although the present thesis cannot fully test the model, it is deemed to constitute a suitable theoretical framework. Among other things, it is able to accommodate predictors of child development at many different levels, for example that being a girl, having a high level of self-regulation, having a highly educated mother, and having access to high-quality ECEC are all associated with better developmental outcomes because these factors and characteristics have been found to affect proximal processes positively. Figure 2 draws upon Table 1 to show an overview of the bioecological perspectives and relevant factors explored in the present thesis. The connections between the model and the topics and goals of the present thesis as well as the relationships between the factors will be thoroughly described below.

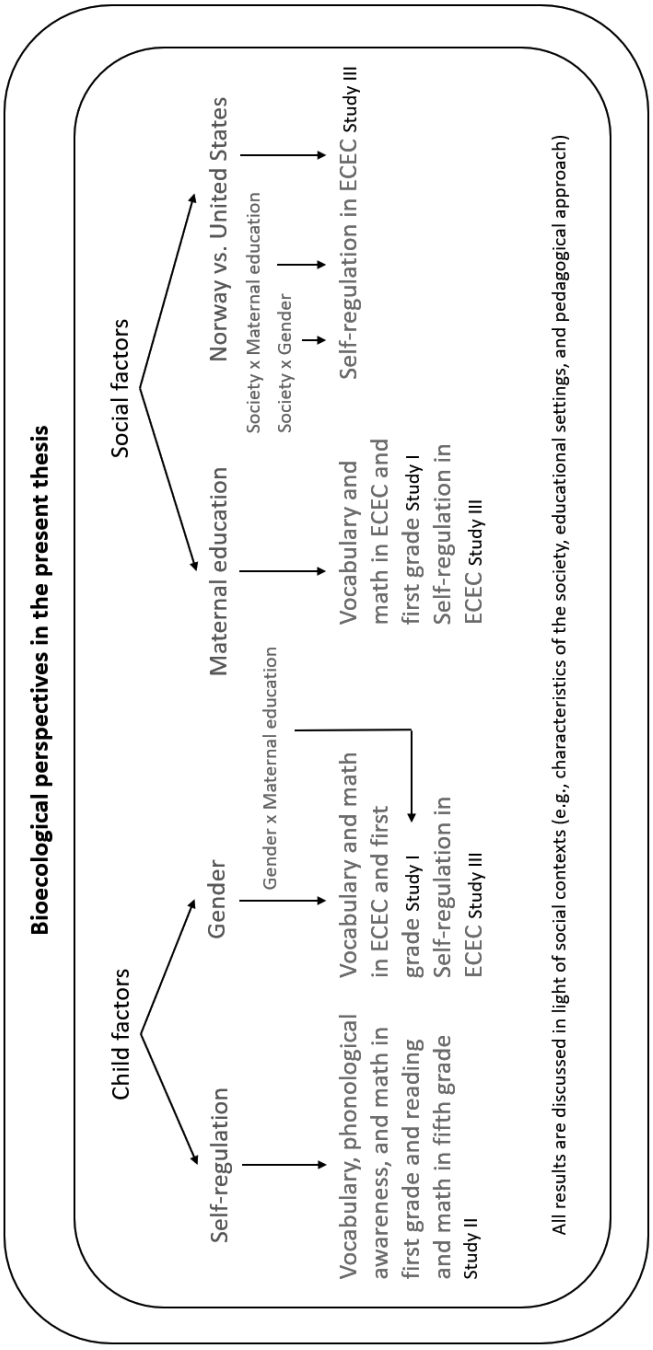

Figure 2: Bioecological perspectives in the present thesis. Blue = predictors, green = interactions, and red = outcomes

2.2 Child factors

As mentioned above, child characteristics or factors may function both as indirect producers of development and as products of development (Bronfenbrenner & Morris, 2006). For example, early self-regulation, which is central to the present thesis, is the product of SES and child gender in Study III but an indirect producer of later academic achievement in Study II. Numerous studies have identified children's early self-regulation, literacy, and mathematical skills as critical school-readiness skills as well as foundational for future learning and development (e.g., G. J. Duncan et al., 2007). In addition, gender differences in academic learning and learning-related skills, such as self-regulation, have received a great deal of attention lately, both in Norway (NOU 2019:3, 2019) and internationally (OECD, 2015).

Below are definitions and descriptions of the child factors relevant to this thesis as well as the associations between them.

2.2.1 Language skills and reading comprehension

The present thesis applied measures of phonological awareness, expressive vocabulary, and reading comprehension. Phonological awareness is the ability to detect and manipulate the sound structure of words independently of their meaning (Phillips, Clancy-Menchetti, & Lonigan, 2008). Expressive vocabulary consists of the words that the child understands and produces. Previous studies have consistently demonstrated that phonological awareness (in addition to letter knowledge and rapid automatized naming) is fundamental to the development of decoding skills (Hjetland, Brinchmann, Scherer, & Melby-Lervåg, 2017; Lervåg, Bråten, & Hulme, 2009; Melby-Lervåg, Lyster, & Hulme, 2012). Further, the size, breadth, and depth of children's vocabulary underlie their language comprehension (Powell & Diamond, 2012).

Reading comprehension has at its core the ability to extract meaning from a written text (Hjetland et al., 2017). According to the *Simple View of Reading*, reading comprehension is the product of decoding and language comprehension (Gough & Tunmer, 1986). Previous research has confirmed the Simple View of Reading by finding that, in preschool and primary school alike, decoding and language comprehension subskills both play a crucial role in learning to read (e.g., Melby-Lervåg et al., 2012; Storch & Whitehurst, 2002) and for reading comprehension (e.g., G. J. Duncan et al., 2007; Kendeou, van den Broek, White, & Lynch, 2009; Storch & Whitehurst, 2002). A recent review (including 64 studies) found that the foundation for reading comprehension (as assessed at a mean age of 8.4 years) was laid in the preschool years through the development of decoding and language comprehension subskills (Hjetland et al., 2017). Also, it has been found that decoding skills are the most important for reading comprehension in beginning readers but that language comprehension gradually takes over as children grow older and read more complex books and texts (Hjetland et al., 2017; Storch & Whitehurst, 2002).

In our text-based society, reading comprehension is of great importance, both for academic performance and for participation in society and the labor market (National Early Literacy Panel, 2008). Since children's vocabulary and phonological awareness are important contributors to their later reading comprehension (according to the Simple View of Reading), it is essential to include these skills in models investigating reading comprehension (Study II). Further, it is of crucial importance to identify factors that may be related to these skills at an early age, in particular to ensure that efforts to attain social and gender equality are successful. Study I investigated gender and maternal education (as an indicator of SES) in relation to children's vocabulary in the spring of the last year of ECEC and in relation to the change in vocabulary seen between ECEC and the spring of first grade.

2.2.2 Mathematical skills

The present thesis used a measure reflecting children's numeracy, geometry skills, and problem-solving abilities in ECEC and first grade (ten Braak & Størksen, 2021). In fifth grade, these aspects—alongside the statistical aspect of mathematics—were measured in the context of a mandatory national assessment (Norwegian Directorate for Education and Training, 2016b). These aspects of mathematics are foundational for the content of the subject (Clements & Sarama, 2014).

Numerous studies have demonstrated that aspects of children's early mathematical skills predict their later mathematical achievement (Aunio & Niemivirta, 2010; Aunola, Leskinen, Lerkkanen, & Nurmi, 2004; Byrnes & Wasik, 2009; G. J. Duncan et al., 2007; Jordan, Glutting, & Ramineni, 2010). Mathematical learning is cumulative in nature. For example, a child needs knowledge of whole numbers to learn fractions, and knowledge of fractions is foundational for algebra, which is a gateway to later achievement (National Mathematics Advisory Panel, 2008). When it comes to participation in society and the labor market, a solid grasp of basic mathematics is indispensable in many contexts, and a strong mathematical competence is critical for anyone working in the STEM (science, technology, engineering, and mathematics) field (Jordan et al., 2010).

Children who bring foundational early mathematical skills to formal schooling are more likely to benefit from mathematical experiences and instruction throughout the elementary grades than those who lack or have weak early mathematical skills (Aubrey, Godfrey, & Dahl, 2006; Jordan et al., 2010). Given the high stability and cumulative nature of mathematical development, it is important to investigate early predictors of mathematical skills and to include early mathematical skills in models investigating later mathematical achievement.

In this thesis, Study I investigated gender and maternal education in relation to children's mathematical skills in the spring of the last year of

ECEC and in relation to the change in mathematical skills seen between ECEC and the spring of first grade. In Study II, the measures of children's mathematical skills in the last year of ECEC and in first grade were included in the model investigating pathways from early self-regulation to mathematical achievement in fifth grade.

2.2.3 Self-regulation

Despite terminological variation, there is a consensus that self-regulation is a multidimensional construct that includes controlling, directing, and planning cognition, emotions, and behavior (Baumeister & Vohs, 2004; McClelland, Ponitz, Messersmith, & Tominey, 2010).

The present thesis focuses on those aspects of self-regulation that are the most relevant in classroom contexts. These aspects are related to executive function (EF) and hence to behavioral or cognitive self-regulation (McClelland et al., 2019). The terms "self-regulation" and "EF" are used interchangeably in this thesis, but although they are related concepts, they are not entirely synonymous. Self-regulation is understood to be composed of interrelated top-down and bottom-up components (Blair & Raver, 2012), whereas EF is a top-down cognitive process that enables the self-regulation of a more automatic, bottom-up set of processes (Blair & Ursache, 2011). In simple terms, EF refers to aspects of cognition that are called upon in situations when brain and behavior require voluntary actions (Blair & Ursache, 2011); it is essential for organizing information, for planning and problem-solving, and for orchestrating thoughts and actions in goal-directed behavior.

Three of the cognitive processes underlying EF are inhibitory control, attentional or cognitive flexibility, and working memory (Blair & Ursache, 2011; Cameron Ponitz, McClelland, Matthews, & Morrison, 2009). In outward behavior, these processes can play different roles. Inhibitory control helps children stop one response and choose a more adaptive behavior instead (Center on the Developing Child at Harvard

University, 2011; Dowsett & Livesey, 2000). For example, children use inhibitory control to wait for their turn instead of taking a toy from a peer or to raise their hand instead of immediately answering their teacher.

Attentional or cognitive flexibility allows children to deploy their attention voluntarily and adjust to changing demands and expectations so that they may follow different rules in different settings (Center on the Developing Child at Harvard University, 2011; Rothbart & Posner, 2005). For example, children in Norwegian ECEC are taught not to shout indoors but are allowed to use a loud voice outdoors.

Finally, working memory relates to the ability to keep information in mind while processing it (Gathercole & Pickering, 2000). Working memory allows children to remember and follow directions and rules, and it helps them plan solutions. In academic learning, working memory may help children decode an unfamiliar word while keeping the meaning of the previously decoded text in mind or help them remember the various steps involved in solving a mathematical problem.

It should be noted that EF requires each of these three cognitive processes to draw upon elements of the others. For example, it takes working memory to hold two rules in mind, it takes inhibitory control to ignore one of those rules, and it takes attentional or cognitive flexibility to switch between the rules as the setting changes (Center on the Developing Child at Harvard University, 2011).

In addition to the aspects of self-regulation related to the cognitive processes underlying EF, the present thesis focuses on the behavioral and social manifestations of those processes in the learning environment, including cooperation, taking turns, following directions, and independence. Throughout the thesis, "self-regulation" refers both to children's cognitive processes underlying EF and their behaviors as manifested in specific settings, such as structured one-to-one settings (measured through direct assessment) and to the broader self-regulation

construct as manifested in children`s behaviors in the social and complex classroom setting (measured through teacher report).

2.2.3.1 Measuring self-regulation

Self-regulation can be measured by means of direct assessments (performance-based), observations, or questionnaire ratings by teachers or caregivers (Campbell et al., 2016). The present thesis used direct assessment (Head-Toes-Knees-Shoulders task; HTKS; McClelland et al., 2014) and a teacher report (Survey of Early School Adjustment Difficulty; ESAD; Rimm-Kaufman, 2005) to capture children's self-regulation in ECEC and first grade.

All types of assessments have advantages and disadvantages. For example, direct assessments of self-regulation may provide information about children's skills in highly structured one-to-one settings and are more likely to capture the cognitive processes (EF) involved in self-regulation (Allan, Hume, Allan, Farrington, & Lonigan, 2014). However, they may not adequately reflect children's ability to regulate their behavior in "real-life" settings (Campbell et al., 2016; Toplak, West, & Stanovich, 2013). In contrast, teacher ratings often focus on self-regulation more broadly and tend to capture children's ability to self-regulate in everyday tasks, across classroom contexts, and over time (Campbell et al., 2016; Wanless et al., 2013), but they may be hampered by rater subjectivity or other shortcomings (Allan et al., 2014).

Study II provides more detailed information about the advantages and disadvantages of direct assessments and teacher reports when studying children's early self-regulation. It also addresses the importance of including different types of self-regulation assessments.

2.2.3.2 Association between self-regulation and academic skills

In a U.S. study, 30–50% of teachers reported that at least 50% of children entering kindergarten did not have the basic skills needed to do well in

school, such as following directions, working independently, and working as a part of a group (Rimm-Kaufman, Pianta, & Cox, 2000). These skills all fall under the broader category of self-regulation, and they are among the behavioral and social manifestations of the cognitive processes in EF that a child needs when adjusting to a complex classroom context. Purposeful and flexible adaptation to the learning environment is an important prerequisite in order for children to have a successful transition to formal schooling where they meet the new demands and are able to take advantage of the instructional learning environment. Hence self-regulation is related to general knowledge acquisition. Reading and mathematical tasks additionally require attention and problem-solving skills, which are also part of the self-regulation construct.

Research has found co-development between domain-general cognitive skills (e.g., EF) and traditional academic skills (Schmitt, Geldhof, Purpura, Duncan, & McClelland, 2017). Co-development means that one skill develops alongside another and that skill gains in one area tend to track skill gains in another (McClelland & Cameron, 2019). Study II intended to investigate the foundational role of early self-regulation for predicting academic skills as well as the pathways to later academic achievement. For this reason, its focus was on the direct and indirect pathways from self-regulation to later academic outcomes, not the reciprocity as such—but another study using the Skoleklar data has investigated that issue (ten Braak, Størksen, Idsoe, & McClelland, 2019).

Language skills and reading comprehension. As noted above, the Simple View of Reading is an influential framework for explaining reading comprehension. However, it may be too simple. Reading comprehension is actually one of the most complex skills that children must master in early elementary school in that it draws upon many different cognitive skills and processes (Braze, Tabor, Shankweiler, & Mencl, 2007). This is the background to the *Augmented* Simple View of Reading, which advocates a broader perspective, suggesting that domain-general cognitive skills, such as self-regulation, are also

involved in reading comprehension (Hjetland et al., 2017). Prior research has supported the Augmented Simple View of Reading by demonstrating that self-regulation aspects are indeed associated with reading comprehension after decoding and language comprehension are controlled for (e.g., Conners, 2009; Sesma, Mahone, Levine, Eason, & Cutting, 2009). A few longitudinal studies also found that self-regulation in preschool and kindergarten predicted reading achievement later on in elementary school (Birgisdottir, Gestsdottir, & Geldhof, 2020; G. J. Duncan et al., 2007; McClelland, Acock, & Morrison, 2006). However, others did not find any support for the Augmented Simple View of Reading (see Hjetland et al., 2017).

There are also studies demonstrating that early self-regulation predicted vocabulary (Bohlmann & Downer, 2016; Gestsdottir et al., 2014; Weiland, Barata, & Yoshikawa, 2014), early literacy skills (Blair & Razza, 2007; Matthews, Cameron Ponitz, & Morrison, 2009; Schmitt, Pratt, & McClelland, 2014; Welsh, Nix, Blair, Bierman, & Nelson, 2010), and early reading achievement (Birgisdóttir, Gestsdóttir, & Thorsdóttir, 2015; Hernández et al., 2018; Welsh et al., 2010). However, prior findings are inconsistent: other researchers did not find self-regulation to be a significant predictor of vocabulary or early literacy skills (Blair & Razza, 2007; Cameron Ponitz et al., 2009; Fuhs & Day, 2011; Hubert, Guimard, Florin, & Tracy, 2015; Schmitt et al., 2017; von Suchodoletz et al., 2013). These inconsistent findings may be due to study-specific factors such as the choice of measurements; to differences in the aspects of early literacy investigated or in the number and choice of control variables; or to demographic and cultural characteristics of the samples studied (e.g., age, SES, and culture).

Blair, Protzko, and Ursache (2011) stress the importance of considering children's developmental level and the type of reading-related skill being assessed when discussing the importance of self-regulation. They argue that a shift in brain activity takes place as children become more accomplished readers: from the effortful, deliberate processing

associated with learning a skill to the more automatic processing associated with assimilating information. This shift in brain activity can also be connected to aspects of intelligence; Blair et al. (2011) make a distinction between *fluid intelligence* and *crystallized intelligence* when discussing the relevance of self-regulation (EF) to academic outcomes.

Crystallized intelligence refers to acquired and acculturated aspects of intelligence, such as factual information and general knowledge. In contrast, fluid intelligence refers to reasoning ability and the processing of novel information; it is closely associated with EF. Blair et al. (2011) argue that much of the focus in the teaching of early language skills is on building crystallized intelligence by making beginning readers acquire knowledge associated with reading ability, such as letter and phonological knowledge and vocabulary knowledge. EF plays an important role when such knowledge is acquired (which typically takes place in early childhood). However, once this crystallized knowledge has been acquired, it might well be that it is more important than EF for continued reading success at a general level. By contrast, aspects of reading that require the comprehension and integration of information will still largely reflect the ongoing contributions of EF (Blair et al., 2011; Blair & Razza, 2007; Sesma et al., 2009).

In path analysis, theory and prior empirical results form the basis for model specification (Kline, 2016). In Study II, the Augmented Simple View of Reading, previous evidence, and the Bioecological Model of Development determined the model specification in the path analysis. That study first investigated whether early self-regulation significantly predicted vocabulary and phonological awareness in first grade and reading comprehension in fifth grade. Then it investigated the indirect effects of self-regulation in ECEC on reading comprehension in fifth grade through vocabulary, phonological awareness, and self-regulation in first grade.

Mathematical skills. The association between EF and early mathematical skills is somewhat stronger than that between EF and reading-related skills and reading achievement (e.g., Allan et al., 2014). The reason for this may be that EF is more strongly related to fluid intelligence than to crystallized intelligence (Blair et al., 2011). For example, unlike in reading, where vocabulary growth builds on the same alphabet, advancing in mathematics involves learning new symbolic forms representing more advanced concepts and more complex procedures (McClelland & Cameron, 2019). Demonstrating sufficiency in mathematics thus requires meeting consistent and ongoing demands on aspects of self-regulation, such as the components of EF (working memory, inhibitory control, and cognitive flexibility). When performing complex mathematical tasks, it is necessary to store partial results in working memory, retrieving or replacing them as and when necessary (Bull & Lee, 2014; Van der Ven, Kroesbergen, Boom, & Leseman, 2012). Working memory thus enables a person to hold multiple pieces of information in mind while manipulating this information to solve problems. Further, inhibitory control is often needed to suppress inappropriate strategies, such as using addition when subtraction is required, and cognitive flexibility is required to shift between operations, solution strategies, quantity ranges, and notations (Bull & Lee, 2014).

Previous research has demonstrated that various aspects of self-regulation are consistently associated with children's early mathematical skills (Blair & Razza, 2007; Blair, Ursache, Greenberg, & Vernon-Feagans, 2015; Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Cameron Ponitz et al., 2009; Fuhs, Nesbitt, Farran, & Dong, 2014; Gestsdottir et al., 2014; Hernández et al., 2018; Matthews et al., 2009; McClelland et al., 2014; ten Braak, Kleemans, Størksen, Verhoeven, & Segers, 2018; Welsh et al., 2010). Moreover, aspects of self-regulation in preschools and kindergarten have been found to predict mathematical achievement later on in elementary school (Birgisdottir et al., 2020; G.

J. Duncan et al., 2007; McClelland et al., 2006; McClelland, Morrison, & Holmes, 2000).

Theory and prior evidence also determined the specifications of the path-analysis model for the mathematical domain in Study II. That study first investigated whether early self-regulation significantly predicted mathematical skills in first grade and mathematical achievement in fifth grade. Then it investigated whether self-regulation in ECEC exerted an indirect effect on mathematical achievement in fifth grade through first-grade mathematical skills and self-regulation.

2.2.4 Child gender[3]

Many theories acknowledge that a combination of biological and social factors influence gender development (Leaper & Friedman, 2007; Reilly, Neumann, & Andrews, 2018). These theories are well in line with the Bioecological Model of Development (Bronfenbrenner & Morris, 2006). In terms of biological factors, neuroscience has, for example, established that there are differences in brain structure between boys and girls and that girls mature earlier than boys do (Walhovd, 2014). However, it is not well known how these differences are related to girls' and boys' development (Walhovd, 2014). Children may also contribute to their gender socialization through their selection of activities and playmates (Stangeland, Lundetræ, & Reikerås, 2018). Moreover, gender researchers have emphasized the importance of context in creating, erasing, or reversing gender differences. For example, boys and girls typically encounter different expectations (Meland & Kaltvedt, 2017), which may differ across cultural contexts (Gestsdottir et al., 2014).

[3] Both "sex" and "gender" are used as terms in research regarding this topic. In the present thesis, the social term "gender" rather than the biological term "sex" is used in the studies and in the thesis summary. However, although recent research into societal development has challenged the traditional binary division of humans into only two genders, for practical reasons the present studies only use the categories of boys and girls, as indeed most research still does.

Hence gender differences can never be understood in isolation but must always be examined in context (Bronfenbrenner & Morris, 2006; Hyde, 2005, 2014). One implication of the requirement to examine gender differences in context is that scientists should not make general statements about gender differences referring to an entire country, let alone to all of humankind (Hyde, 2005, 2014).

As educational settings, ECEC and first grade differ and may socialize gender differently. For example, children's autonomy and free play are emphasized in Norwegian ECEC centers. The learning environment there is highly unstructured, which may give boys and girls different learning opportunities as a result of their self-selected environments, at least to the extent that their choices are gender-specific (Fabes, Martin, & Hanish, 2003). By contrast, when children enter first grade, they encounter formal instruction and predefined learning goals. The learning environment is highly structured and probably makes similar demands of boys and girls in terms of skills and effort. These two learning environments may thus provide different gender-socialization opportunities for boys and girls. To this should be added that gender differences may also be due to other social factors, such as parental SES or the characteristics of a society (Studies I and III) because differences in norms and values (e.g., with regard to gender equality) influence how parents and teachers interact with and respond to boys and girls.

2.2.4.1 Gender differences in academic skills and self-regulation

Today boys are overrepresented in several negative statistics, including dropout numbers, behavioral problems, special needs, and poor academic outcomes (Backe-Hansen et al., 2014; Entwisle, Alexander, & Olson, 2007; NOU 2019:3, 2019; OECD, 2015; Reilly et al., 2018). Regarding academic outcomes, a report from the Organization for Economic Cooperation and Development (OECD, 2015) relating to results from the Program for International Student Assessment (PISA) concluded that, on average, girls outperform boys across countries.

Norway and the other Scandinavian countries actually have the largest gender differences in school achievement at age 15 among the OECD countries (OECD, 2015).

In recent years, gender differences in school settings have been given a great deal of attention in Norway, including two knowledge reviews (Backe-Hansen et al., 2014; Bakken et al., 2008) and two official government reports (NOU 2019:3, 2019; NOU 2019:19, 2019). However, less interest has been devoted to gender differences in young children. Since academic skills and self-regulation have been found to be relatively stable over time, and since poor school performance predicts school dropout, which is related to worse social outcomes later in life (Markussen, Frøseth, & Sandberg, 2011; OECD, 2015), it is important to gain more knowledge about the onset of gender differences in children's academic skills and self-regulation.

Previous research is inconsistent when it comes to gender differences in vocabulary and mathematical skills in early childhood: some studies reported gender differences (Aunio, Hautamäki, Heiskari, & Van Luit, 2006; Brandlistuen, Flatø, Stoltenberg, Helland, & Wang, 2020; Simonsen, Kristoffersen, Bleses, Wehberg, & Jørgensen, 2014; Zambrana, Ystrom, & Pons, 2012) while others did not (Aunio, Niemivirta, et al., 2006; Ginsburg & Pappas, 2004; Matthews et al., 2009; McTigue, Schwippert, Uppstad, Lundetræ, & Solheim, 2020). Again, gender differences must be studied in context, particularly given that they do not seem to occur universally across all social groups and cultures. Previous evidence has also indicated that gender differences in language skills vary by children`s age (Bouchard, Trudeau, Sutton, Boudreault, & Deneault, 2009; Toivainen, Papageorgiou, Tosto, & Kovas, 2017; Zambrana et al., 2012).

Similarly, previous findings on gender differences in early-childhood self-regulation are also inconsistent (e.g., Matthews et al., 2009; McClelland et al., 2007; Størksen, Ellingsen, Wanless, & McClelland,

2015). In addition, differences have been found to exist across cultures (e.g., Wanless et al., 2013). However, a recent review found that girls outperformed boys in both Western and East Asian samples (Schirmbeck, Rao, & Maehler, 2020). More detailed overviews of prior findings with regard to gender differences in academic skills and self-regulation are provided in Studies I and III.

The view that men and women and boys and girls are psychologically different is often expressed both in mass media and by the general public. As an antidote to this view, Hyde (2005, 2014) advocated the Gender Similarities Hypothesis: given that most gender differences on psychological variables are close to zero or small, it is more reasonable to start from the assumption that males and females are more alike than they are different. She argued that the exaggeration of gender differences in the fields of parenting, education, and career might deflect attention from more important matters.

Except for two very recent studies (Brandlistuen et al., 2020; McTigue et al., 2020), few prior Norwegian studies have investigated gender differences in academic skills during the period when children make the transition from ECEC to first grade. The present thesis adds to the existing knowledge by investigating gender differences in academic skills in two different educational settings (the last year of ECEC and first grade) and by investigating whether gender and SES interact in predicting academic skills (Study I). In addition, Study III compared the self-regulation of boys and girls across the Norwegian and U.S. cultural contexts.

2.3 Social factors

In the present thesis, children are studied as they are growing up and developing in different social contexts. Some factors (SES, society, and educational settings) characterizing those contexts and how they might

be related to children's development and learning are addressed in the following.

2.3.1 Socioeconomic status

The term "socioeconomic status" (SES) traditionally refers to the relative position of an individual, a family, or a group in a stratified social system where certain societal goods (e.g., education, occupation, and economic resources) are not uniformly distributed (Bradley & Bornstein, 2003). Following the Bioecological Model of Development, the family is the most important microsystem. Children belonging to different socioeconomic strata will experience different proximal processes because the characteristics of their family, both social and physical, differ across these strata.

2.3.1.1 Measuring socioeconomic status

It has been argued that education indexes human capital, income indexes financial capital, and occupation indexes social capital (Conger & Dogan, 2007). Educational, financial, and occupational factors all work to create SES-related differences in parents' circumstances and characteristics that will affect various developmental outcomes (Conger & Dogan, 2007; G. J. Duncan & Magnuson, 2003).

Maternal education is used as an indicator of SES in the present thesis, and it is in fact the most commonly used single indicator of SES in child-development research (Ensminger & Fothergill, 2003). This is due in part to ease of data collection and to reliability of data (Hoff, Laursen, & Bridges, 2012), but also to the instability of other SES components: parental occupation and income may fluctuate throughout an individual's childhood, but his or her parents' level of education tends to be relatively stable (G. J. Duncan & Magnuson, 2003).

Parenting behavior is more strongly influenced by education than by income or occupation, and empirical findings have shown that maternal

education is the best single indicator of SES in predicting child outcomes (Bornstein, Hahn, Suwalsky, & Haynes, 2003; Hoff et al., 2012). Maternal education is interpreted as reflecting a process in which parenting behavior (e.g., style and practice) mediates the effect of SES on development (e.g., Hoff et al., 2012).

Moreover, previous research has found the correlation between income and education to be weaker in Norway than in other Western countries (Barth, 2005). One reason for this may be that Norway is a rich oil-producing country where, in recent years, being highly educated has not been a prerequisite for a well-paid job (Størksen et al., 2015). Considering these research findings, maternal education is particularly well suited as a sole indicator of SES in studies investigating child development and in studies conducted in countries such as Norway, with a well-functioning welfare system and relative economic parity as compared with countries such as the United States.

2.3.1.2 Socioeconomic status and children's academic skills and self-regulation

There is a large body of evidence linking parental SES to many aspects of child development. Studies have found associations between SES and brain structure (Noble et al., 2015), cognitive development and intellectual functioning (Eilertsen et al., 2016; Hoff, 2003), academic achievement (Bakken & Elstad, 2012; Sirin, 2005), self-regulation (Montroy, Bowles, Skibbe, McClelland, & Morrison, 2016; Størksen et al., 2015), and mental health (Bøe, Øverland, Lundervold, & Hysing, 2012). The present thesis investigated associations between SES and children's vocabulary and mathematical skills in Study I and between SES and self-regulation in Study III. Moreover, Study II controlled for SES to account for variation in the home environment. More detailed overviews of prior findings with regard to SES differences in academic skills and self-regulation are provided in Studies I and III. In the

following, perspectives and theory related to mechanisms underlying SES differences in child development are addressed.

SES and child development are both multifaceted variables, and many factors that have been found to influence child development covary with SES. Hence it may be a challenging task to uncover the causal relations underlying the effects of SES on child development (Hoff, 2003). Two main mechanisms have been suggested when it comes to explaining the association between SES, social processes, and individual development: *social causation* and *social selection* (Conger & Donnellan, 2007). According to the social-causation perspective, social and economic conditions influence individual functioning and development. Two approaches consistent with this perspective are the Family Stress Model (FSM) and the Investment Model (IM). The FSM links socioeconomic disadvantage (i.e., poverty) to a family-stress process that increases parents' emotional distress and jeopardizes the healthy development of their children (Yeung, Linver, & Brooks–Gunn, 2002). An environment that has fewer resources and is less predictable may cause attention systems, emotional systems, and biological stress systems to become more reactive, which is less conducive to the development of EF abilities and self-regulation (Blair & Ursache, 2011). In contrast, environments that are high resources and where appropriate support is provided may cause attention systems, emotional systems, and biological stress systems to develop in ways that promote EF and self-regulation.

The IM is rooted in economic principles of investment but has been extended to include social and human capital. It builds on the notion that higher-SES parents have better access than lower-SES parents to financial (e.g., income), social (e.g., occupational status), and human (e.g., education) capital. Families' investments of such capital are associated with positive child development. It has been found that family-stress processes better predict behavioral problems, whereas parental investments—which are more relevant than family-stress

processes when maternal education is the indicator of SES—better predict cognitive development (Kalil & Ryan, 2020; Yeung et al., 2002).

According to the social-selection perspective, the associations observed between parental SES and child development are spurious because they are caused by a third variable (Conger & Donnellan, 2007). This third variable may be parental intelligence and personality, in which case it is thus hypothesized that both parental SES and children's development emanate from such parental characteristics.

Conger and Donnellan (2007) conclude that there is empirical support both for the social-causation perspective and for the social-selection one, arguing that the tension between these two views on the relationship between SES and human development is redolent of the nature–nurture debate and that neither view is likely to reflect the complexity of human development. Instead, they suggest a comprehensive model—the "interactionist perspective"—that incorporates both perspectives alongside child characteristics. This comprehensive model aligns well with the Bioecological Model of Development (Bronfenbrenner & Morris, 2006), which encompasses both the biological realities of the individual and the characteristics of the family (microsystem). In addition to this, however, the Bioecological Model of Development also includes other social contexts such as ECEC (microsystem), and it takes account of how the ideology and organization of the relevant society (macrosystem) influence the proximal processes in the microsystems (e.g., the effect of SES on child outcomes).

Several studies have investigated the associations between parental SES and child development. Bradley and Corwyn (2003) found parental education to be positively related to children's vocabulary, reading, and mathematical skills as well as negatively related to behavioral problems, even when several other variables were controlled for. In addition, they found that parental stimulation of learning partly mediated the relationship between parental education and child competence.

Compared with lower-SES parents (including in terms of maternal education), higher-SES parents are more likely to use a rich vocabulary and to engage in cognitively stimulating activities with their children (Hart & Risley, 1995; Hoff, 2003). Likewise, higher-SES parents tend to engage in complex mathematical interactions with their children more often than parents with a lower SES (Saxe, Guberman, & Gearhart, 1987). The above-mentioned studies show that SES-related differences in children's outcomes can be associated with SES-related differences in their experiences and proximal processes.

In summary, research suggests that parents with higher SES are likely to invest their resources and behave in ways that facilitate their children's development in terms of vocabulary, mathematical skills, and self-regulation.

2.3.2 Norwegian versus U.S. society

Different societies are characterized by different values, beliefs, and socioeconomic organization (macrosystem) (Bronfenbrenner & Morris, 2006). Such differences may influence children's development, including in terms of self-regulation, because differences in factors such as family-support organizations, child-rearing practices, and pedagogical approaches will affect the proximal processes. As children spend time in different social environments, they gather information about where and when their culture dictates that it is acceptable or beneficial to behave in a particular way.

Study III investigated children's level of self-regulation and the role of maternal education and child gender across Norway and the United States. Norwegian and U.S. children's early-childhood experiences are rooted in the goals and expectations emphasized in the respective cultural

context[4] (McClelland, Geldhof, Cameron, & Wanless, 2015; Trommsdorff, 2009).

Most prior research in this field compared self-regulation as between collectivistic (e.g., East Asia and Portugal) and individualistic (Western) cultures (Schirmbeck et al., 2020). In collectivistic (also known as "interdependent" or "relational") cultures, simply put, the goal of socialization is to turn children into well-adjusted members of society (Salminen, Guedes, Lerkkanen, Pakarinen, & Cadima, 2021; Trommsdorff, 2009). By contrast, in individualistic (also known as "independent" or "autonomous") cultures, the goal is to turn them into autonomous individuals. Norway and the United States are both individualistic cultures where children's independence is stimulated and where autonomy is likely to be a goal for caregivers. This may make caregivers' expectations and practices similar compared with those of caregivers in, say, East Asia.

Some researchers have found children's levels of self-regulation to vary between Western and Asian cultures (Oh & Lewis, 2008) and between cultures that differ in sociocultural orientation and parenting style (Keller et al., 2004; Oh & Lewis, 2008), but others have found children's self-regulation to be similar in U.S. and Turkish low-income families (Veziroglu-Celik et al., 2018). A recent review documented that East Asians outperformed their Western peers on directly assessed self-regulation from the preschool age through adolescence (Schirmbeck et al., 2020). However, few studies (if any) have compared samples from two individualistic cultures such as Norway and the United States, as was done in Study III.

It should be kept in mind that although Norway and the United States both have individualistic cultures, they have different patterns of ideology and organization of the social institutions (macrosystem). For

[4] The term "cultural context" is used in the present thesis as a proxy—not a synonym—for the characteristics of a society.

example, Norway's well-functioning welfare system, its relative economic parity, its universal ECEC provision, and the pedagogical approach used in ECEC are all characteristics of the macrosystem. Because of these and other characteristics, the proximal processes, children's development of self-regulation, and the roles of maternal education and child gender may differ between Norway and the Unites States (Bronfenbrenner & Morris, 2006).

Socioeconomic heterogeneity in a society has been found to be positively correlated with the percentage of the variance in academic performance that is explained by SES (OECD, 2016). Norway tends to perform above average in terms of PISA scores, and the relationship between student performance and parental SES is significantly weaker than the OECD average. The United States also performs above average in PISA, but its relationship between student performance and SES is significantly stronger than the OECD average. The same patterns could be expected to exist for children's self-regulation, in which case maternal education would be more important for self-regulation in U.S. children than in Norwegian children.

See Study III for a thorough description of the two societies. The following text mainly focuses on educational settings and pedagogical approaches.

2.3.2.1 Educational settings

The present thesis used data collected in Norway (Klepp) (Studies I, II, and III) and the United States (Oregon) (Study III). The children in the Norwegian sample first attended ECEC centers characterized by a play-based pedagogical approach. Upon starting first grade, they had to adapt to a structured learning environment and were faced with instruction in academic skills.

The children in the U.S. sample attended kindergartens at the time of data collection. In the United States, both preschool and the transition (kindergarten year) to primary school have a school-readiness approach.

OECD (2006) refers to these two pedagogical approaches as the *social-pedagogical approach* and the *pre-primary* or *readiness-for-school* approach to early education. Other terms commonly used are "child-centered" versus "teacher-centered." The social-pedagogical approach is found in the Nordic and Central European countries; curricula based on this approach have been characterized as "whole-child" and "holistic." The pre-primary approach is found for example in France, the Netherlands, and many English-speaking countries; the related curricula have been characterized as "skill-specific."

The present thesis uses the terms *play-based* and *school-readiness* for these two approaches. It is important to note that, although a clear distinction is often drawn between them, it may be more accurate to see them as different curricular emphases along a continuum (OECD, 2006).

2.3.2.1.1 Play-based approach

A broad concept of pedagogy is common in countries where the social-pedagogical tradition is prevalent, meaning that care, upbringing, and learning are combined without any hierarchy (OECD, 2006). The ECEC system is seen as a broad preparation for life and practices a holistic approach to learning. National curricula guide the work of the ECEC centers, but they are not considered instruments of normalization. Instead, each center enjoys a high degree of autonomy and is expected to formulate a learning plan which should be guided by the national curriculum or framework. See, for example, Broström, Einarsdottir, and Samuelsson (2018) for an overview of the Nordic ECEC tradition.

In Norway, the ECEC centers are governed by the framework plan for their content and tasks (2011, 2017). The framework plan emphasizes the intrinsic value of childhood and children's current well-being. Free

play and children's autonomy are highly valued, and there is less emphasis on academic and cognitive learning. A recent Norwegian study showed that children in ECEC centers devoted 60% of their time to free play (Karlsen & Lekhal, 2019). Another characteristic feature of the Norwegian ECEC is outdoor play: children devote as much as 70% of their time to outdoor play in the summer and 31% in the winter (Moser & Martinsen, 2010).

2.3.2.1.2 School-readiness approach

Holistic, child-centered curricula recognizing that children learn through play are predominant in the United States as well (Schleicher, 2019), although many U.S. ECEC programs have a school-readiness approach. Countries where the school-readiness approach is prevalent, tend to introduce the content and methods of primary schooling in early education or let children start school at age five (OECD, 2006). The U.S. standards-based education model reinforces school-type learning approaches and content across pre-kindergarten, kindergarten, and elementary school. Moreover, there is a consensus among teachers and policymakers that preschool-program standards should include child outcomes in areas such as literacy, mathematics, and scientific thinking (OECD, 2006). This approach is also conceptualized as a social-investment model because it focuses strongly on identifying the children who are at risk and on preparing those children for school in order to achieve equal opportunities (Tuastad, Bjørnestad, & Alvestad, 2019).

Proximal processes will be affected by the pedagogical approach applied in different educational settings (ECEC vs. first grade) and cultural contexts (Norway vs. the United States). For example, children attending an ECEC center with a play-based approach emphasizing children's autonomy and free play will experience other proximal processes than children attending an ECEC institution based on a school-readiness approach emphasizing formal teaching and instruction as well as testing and screening.

3 Overarching goals and study aims

The present thesis investigates the role of child factors (self-regulation and gender) and social factors (SES and cultural context) for predicting children's developmental outcomes. The theoretical framework used is the Bioecological Model of Development, which emphasizes that development consists of complex and bidirectional interactions over time between the child and the social context. Hence it is important to consider both the children themselves and the context that they find themselves in. The child factors included in the thesis functioned as predictors and outcomes in the three different studies while the social factors were predictors as well as characteristics of the societies and educational settings within which the studies were conducted.

3.1 Overarching goals

As already mentioned in the Introduction (Table 1, page 2), the present thesis has four overarching goals related to child factors and social factors. The first goal is to investigate the direct and indirect effects of early self-regulation on first- and fifth-grade academic achievement (Study II). The second goal is to investigate the role of child gender for predicting early-childhood academic skills (Study I) and self-regulation (Study III). The third goal is to examine the role of socioeconomic status (SES) for predicting children's early-childhood academic skills (Study I) and self-regulation (Study III). Finally, the fourth goal is to investigate whether children's level of self-regulation and the roles of maternal education and child gender for self-regulation differ between Norwegian and U.S. samples (Study III). All results obtained will be discussed in light of the pedagogical approach, educational settings, and other characteristics of the respective society.

3.2 Study aims

In addition to the four overarching goals of the thesis, each study had the following specific aims:

Study I investigated whether maternal education and child gender were related to Norwegian children's vocabulary and mathematical skills in the spring of the last year of ECEC and to the change in those skills until the spring of first grade. It also examined whether gender moderated the role of maternal education for vocabulary and mathematical skills in ECEC and for changes in those skills from ECEC to first grade.

Study II investigated whether directly assessed and teacher-reported self-regulation in the last year of ECEC uniquely predicted vocabulary, phonological awareness, and mathematical skills in first grade and whether these measures of self-regulation in ECEC and first grade predicted reading comprehension and mathematical achievement in fifth grade. It also examined the indirect effects of directly assessed and teacher-reported self-regulation in ECEC on fifth-grade achievement through self-regulation and academic skills in first grade.

Study III examined whether children's mean level of self-regulation was similar in samples from Norway and the United States, respectively, and whether the role of maternal education and child gender for children's self-regulation differed between those two samples.

4 Method

The present thesis uses a quantitative research approach. Quantitative research involves testing objective theories by examining relationships among variables (Creswell & Creswell, 2018). It has its roots in the positivist paradigm, although current approaches in quantitative research have a postpositivist paradigm (Creswell & Creswell, 2018) which retains the idea of objective truth or the existence of one reality but accepts that the researcher's theoretical frames, background, knowledge, and values influence what is observed or measured (Harrison & Wang, 2018).

Further, the present thesis has a nonexperimental and correlational design. Data were collected through parental and teacher questionnaires and direct assessment of children's skills. Studies I and II are longitudinal while the cross-cultural Study III is cross-sectional.

All three studies relied on data collected in the Norwegian Skoleklar project. Study III also relied on data collected in the U.S. Touch your toes! project. Both research projects applied a convenience-sample approach. In Skoleklar, all ECEC centers in a municipality were invited to participate. In Touch your toes!, preschools in a certain area that were willing to participate were included. The main characteristics of the respective datasets are presented below.

4.1 Participants and procedures

4.1.1 Norwegian data

In the Skoleklar project, all children (287) who were in their last year of ECEC (at 19 different centers) in a municipality on the Norwegian west coast were invited to participate. The children were all born in 2006. A total of 244 children received parental consent to participate in ECEC

and in first grade, but one child's consent was withdrawn during the first round of data collection, meaning that 243 children (84.7% of 287) remained. Among these, seven children were selectively invited from a neighboring municipality to maintain a higher number of children with minority status in the project (see more details; Størksen et al., 2015).

The children were assessed in the spring of their last year in ECEC and in the spring of first grade. Ahead of the third round of data collection, which was to take place in the fall of 2016, when the children were in fifth grade, their current school affiliation was contacted to enable the collection of new parental-consent forms. Children that had moved from the municipality could not be reached. In addition, lack of project funding did not allow the research team to detect the seven minority children from the neighboring municipality who were invited during ECEC to fill up the share of minority children. In fact, the funding for Skoleklar had ended by the time fifth-grade data were collected. Unfortunately, this resulted in a higher attrition rate among minority and immigrant children, and only 14 out of 27 minority children and three out of 13 immigrant children remained in the fifth-grade sample (Lenes, McClelland, ten Braak, Idsøe, & Størksen, 2020). This process of asking for new consent from their parents resulted in some attrition from the study, leaving a sample size of 160 (see Figure 3 for a flow chart and Table 2 for descriptive data).

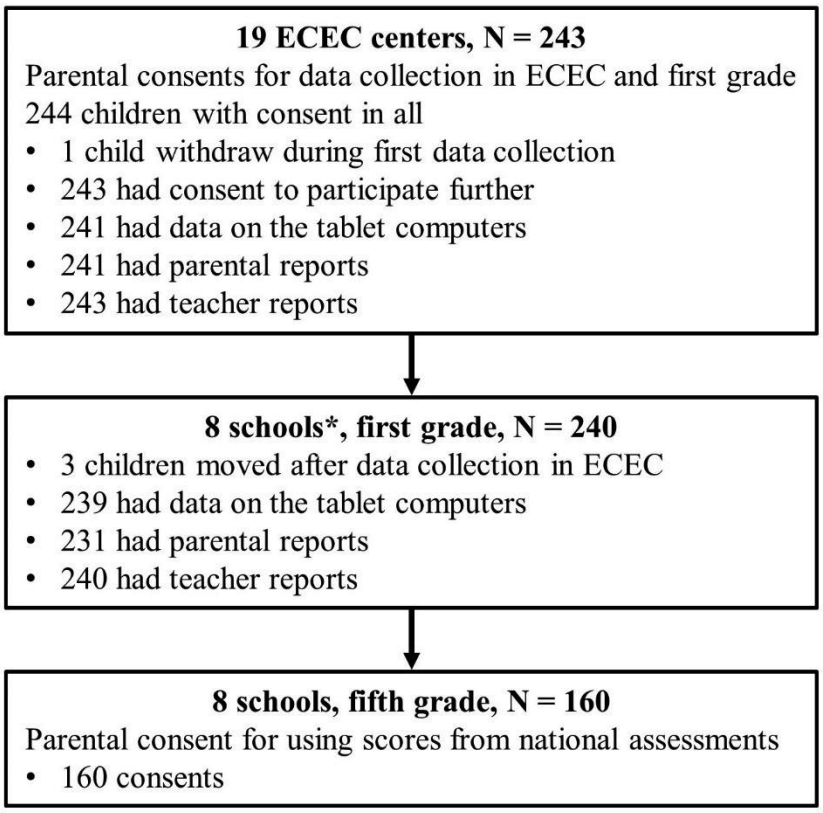

Figure 3: Flow chart. *Additionally, one category was named "other" and included schools in neighboring municipalities.

A test battery of school-readiness assessments was administered individually using tablet computers on the first two data-collection occasions (ECEC and first grade). Testing was carried out by research assistants who had received training on a two-day course. The children were tested in the Norwegian language during a one-to-one session in a room adjacent to their classroom so as to reduce any excess distraction during testing. They completed the test battery in a single test session that took 30–40 minutes, and the timeframe for testing all children was a maximum of three to four weeks. The parents reported demographic information in questionnaires administered by the ECEC centers and schools in collaboration with the project administrators. The ECEC

teachers and first-grade teachers filled in a questionnaire about the individual children's self-regulation.

The scores for reading comprehension and mathematics obtained at the third data-collection point derived from mandatory national assessments. The schools carried out the national assessments in collaboration with the Norwegian Directorate for Education and Training, a government agency.

Table 2: Demographic variables in Studies I and II

Demographic variable	Participants, N = 243
Child age (years) in ECEC	Mean (SD) = 5.79 (0.29)
Child gender (boys)	51.0%
Maternal education	Mean (SD) = 3.28 (1.30)
1 = Middle school	2.9%
2 = High school	40.0%
3 = 1–2 years of college/university	8.8%
4 = 3 years of college/university	22.9%
5 = More than 3 years of college/ university.	25.4%
Minority status*	11.1%
Immigrant status**	5.3%

* One or both parents born outside Norway. ** Both parents born outside Norway.

Of all mothers, 48.3% reported having three years of college/university education or more (see Table 2)[5]. Parents reported being born in 22 different countries, including Norway. In the case of 27 children (11.1% of 243), one or both parents were born abroad; those children were

[5] Maternal education was reported as valid percent in the three Studies. By mistake, minority status and immigrant status were calculated as percent of the total sample (missing was included in the total sample), and these values are also reported in the thesis summary. Valid percent in the Norwegian sample: 11.4% reported minority status and 5.5% immigrant status. Valid percent in the U.S. sample: 26.1% reported minority status.

assigned minority status in Study III. In the case of 13 children (5.3%), both parents were born in a country other than Norway; those children were assigned immigrant status in Studies I and II. This group included five children (2.0%) both of whose parents were born in the European Union (EU)/European Economic Area (EEA), the United States, Canada, Australia, or New Zealand and eight children (3.3%) both of whose parents were born in either Asia, Africa, Latin America, Oceania (except Australia and New Zealand), or in a European country outside the EU/EEA.

4.1.2 U.S. data and re-coded Norwegian data used in Study III

The U.S. data derive from children recruited from 17 local preschools in a rural area of the Pacific Northwest as part of the Touch your toes! research project. The principal investigator contacted preschool directors via telephone, email, and individual meetings to invite them to join the study. Study III relied on data collected in the fall of kindergarten (2012) and included 310 children attending 38 institutions. See Table 3 for demographic variables.

Trained research assistants assessed children on a battery of school-readiness assessments in a one-to-one session. All sessions were conducted in a quiet corner of the classroom or in a room or hallway adjacent to it. The children completed the assessments over two to three 15-minute sessions within two weeks. Parents were sent demographic questionnaires in the mail and were asked to return them by the completion of the study.

A total of 46 children (15% of 310) were identified as English-language learners (ELL) and were assessed in Spanish. Preliminary analyses showed that these children obtained significantly lower scores on the HTKS task than the children tested in English (M = 28.80, SD = 28.14 vs. M = 53.24, SD = 21.58).

To ensure a more valid comparison of the Norwegian and U.S. samples in Study III, and also because both were convenience samples, the two samples were matched on key variables of interest (Minkov, 2013). Specifically, to ensure that any self-regulation differences found would not be due to characteristics of the subgroup of children assessed in Spanish in the U.S. sample (Banks, Marmot, Oldfield, & Smith, 2006), those 46 children were excluded, leaving a total U.S. sample size of 264 children. Of those, 111 (42%) were enrolled in Head Start, a program aiming to increase the school preparedness of young children in low-income families. The median time spent in daycare (ages 0–3) by the 264 children was five months; 90 of them had no daycare experience. The median time spent in preschool/Head Start was 12 months.

To ensure comparability between the Norwegian and U.S. datasets with regard to maternal education, the Norwegian maternal-education data were re-coded. Concretely, the two Norwegian categories of "middle school" and "high school" were merged and scored as zero, so that the two datasets had the same scoring system for this variable. In the U.S. sample, 55.3% of mothers reported having three years of college/university education or more, as against 48.3% in the Norwegian sample. Table 3 shows an overview of the re-coded demographic variables used in Study III.

In the U.S. sample, parents reported their child as White (69.7%), African American (0.4%), Latino/Hispanic (4.9%), Asian/Pacific Islander (3.4%), Middle Eastern (0.8%), more than one ethnicity (14.4%), or other (0.8 %). All categories except White were assigned minority status (24.6%). Norwegian children with one or both parents born in a country other than Norway (11.1%) were assigned minority status.

Table 3: Demographic variables in Study III

Demographic variable	Norwegian participants, N = 243	U.S. participants, N = 264
Child's age (years) in ECEC	Mean (SD) = 5.79 (0.29)	Mean (SD) = 5.65 (0.30)
Child's gender (boys)	50.6%	49.2%
Maternal education *	Mean (SD) = 1.31 (1.26)	Mean (SD) = 1.53 (1.20)
0 = High school or less	42.9%	31.3%
1 = Some college or an associate's degree	8.8%	13.5%
2 = Bachelor's college degree	22.9%	26.9%
3 = Advanced degree	25.4%	28.4%
Missing data for maternal education	1.2%	21.2%
Minority status	11.1%	24.6%
Missing data for minority status	2.5%	5.7%
Not minority: maternal education	Mean (SD) = 1.32 (1.26)	Mean (SD) = 1.59 (1.19)
Minority: maternal education	Mean (SD) = 1.15 (1.29)	Mean (SD) = 1.30 (1.23)

* Norwegian maternal-education data have been re-coded.

4.2 Ethical considerations

Children who take part in research are particularly entitled to protection (National Committee for Research Ethics in the Social Sciences and the Humanities, 2016). They are often more willing to obey authority than adults, and they often feel that they cannot object. It is important that researchers have knowledge about children and that they can adapt their methods to the age of participants.

The data used in this thesis were collected in a Norwegian and a U.S. research project. The Norwegian research project was reported to and approved by the Norwegian Center for Research Data (NSD) while the U.S. research project was reported to and approved by the Internal Review Board (IRB) at Oregon State University.

The Norwegian and U.S. children in the present thesis were four to six years old when they were recruited. In both projects, to ensure that the children's right to protection was respected, their parents (legal guardian/next of kin) were sent a letter with information about the project and were asked to give informed consent to their children's participation. In both projects, research assistants were trained in how to administer the tests used and in how to test children. The children were given age-appropriate information about the projects, and the research assistants were instructed to respect the children's choice if they were unwilling to participate.

Data collection and data storage were carried out in accordance with the NSD and IRB guidelines. All data were de-identified and stored in a secure place. Finally, the publications included in this thesis comply with the ethical guidelines for scientific publications set out by the American Psychological Association (APA) (2010).

4.3 Measuring children's skills in early childhood

Most constructs of interest in the educational and psychological sciences are not directly visible or measurable (Kleven, 2008). To be available for empirical research, they must therefore be operationalized by means of observable indicators.

The present thesis used several performance-based measures of children`s skills. Further, Study II used two different types of self-regulation measures (performance assessment and teacher report). Study III used the same performance-based measure of self-regulation (the HTKS task) in a comparative study of samples from Norway and the United States, highlighting the importance of ensuring that the measure was valid for both samples. These issues are thoroughly discussed in Studies II and III, and the self-regulation measures (especially the HTKS task) are dealt with at an overall level in the Methodological considerations chapter on pages 91-96. However, some general theoretical points about the validity of psychometric measurements are addressed in the following.

4.3.1 Measurement validity

Construct validity relates to whether an assessment actually measures the construct that it is designed to measure (Messick, 1995). Messick (1995) suggests a unified framework of construct validity integrating considerations of content, criteria, and consequences for the empirical testing of rational hypotheses about score meaning and theoretically relevant relationships. This framework distinguishes various aspects of construct validity that may function as general validity criteria or standards for all educational or psychological assessments, including the content, structural, generalizability, external, and consequential aspects.

The *content* aspect pertains to the boundaries of the construct domain to be assessed (Messick, 1995). The aim is to ensure that the items or tasks in question actually represent the construct domain. This is assessed on

the basis of professional judgment, for example by means of logical analyses and evaluations of the test content, including items, task formats, wording, and demands placed on respondents completing the task (Brown, 2010).

The *structural* aspect concerns the relationship between the internal structure of the assessment used and the internal structure of the construct domain it represents (Messick, 1995). For example, the HTKS task should include the components of inhibitory control, attentional or cognitive flexibility, and working memory. The structural aspect of construct validity also encompasses reliability (internal consistency and interrater and test-retest reliability), and it provides evidence about the internal structure of the assessment (Brown, 2010). See the Measures section below for an overview of the reliability of the assessments used in this thesis.

The *generalizability* aspect concerns whether the assessment can represent the construct domain it is designed to represent across time or place. For example, Study III investigated the generalizability of the HTKS task across a Norwegian and a U.S. sample.

The *external* aspect is to do with the extent to which assessment scores are related (high/low) to scores on other assessments, as expected by the relevant theory. Both convergent and discriminant correlation patterns are important. A convergent pattern indicates a correspondence between measures of the same construct. For example, McClelland et al. (2014) investigated the convergent validity of the HTKS task by relating it to traditional assessments of components of executive function (EF).

Finally, the *consequential* aspect includes evidence and grounds for evaluating the consequences of score interpretation and use in both the short and long term. Important concerns related to the consequential aspect include construct underrepresentation (too narrow) and construct-irrelevant variance (too broad).

In summary, construct validity cannot be measured directly, meaning that the validation process must combine scientific inquiry with rational arguments (Messick, 1995). What needs to be valid are the meaning or interpretation of the score and any implications for action that this meaning or interpretation entails.

4.4 Measures

The present thesis is based in part on data that were directly assessed in structured one-to-one situations and in part on data consisting of teachers' and parents' questionnaire answers.

Below is a description of the measures used. Table 4 shows an overview of them, with information about the studies in which they were applied.

Table 4: Overview of measures used

Measure	Target concept	Method	Predictor	Mediator	Outcome	Covariate
NVT	Expressive vocabulary	DA		Study II	Studies I, II	Study II
ABMT	Problem-solving, geometry, and numeracy	DA		Study II	Studies I, II	Study II
Blending test	Phonological awareness	DA		Study II	Study II	Study II
HTKS	Self-regulation	DA	Study II	Study II	Study III	
ESAD	Self-regulation	TR	Study II	Study II		
Reading comprehension*	(1) finding information in texts (2) interpreting and comparing (3) reflecting and evaluating	DA			Study II	
Mathematical achievement*	(1) numeracy and the four arithmetic operations (2) measuring and geometry (3) statistical aspect	DA			Study II	
Maternal education	Socioeconomic background	PR	Studies I, III			Study II
Gender		PR	Studies I, III	Study I**		Study II
Age in ECEC		PR				Studies I, II, III
Immigrant status	Both parents born abroad	PR				Studies I, II***
Minority status	One or both parents born abroad	PR				Study III

NVT = Norwegian Vocabulary Test, ABMT = Ani Banani Math Test, HTKS = Head-Toes-Knees-Shoulders task, ESAD = Survey of Early Schools Adjustment Difficulty, DA = Direct Assessment, TR = Teacher Report, PR = Parent Report, * National Assessment, ** Moderator, *** Auxiliary

4.4.1 Academic skills in ECEC and first grade

4.4.1.1 Vocabulary knowledge

The Norwegian Vocabulary Test (NVT; Størksen et al., 2013) was used to assess the children's expressive vocabulary in ECEC and first grade. NVT is a naming test where an illustration appears on a tablet-computer screen and the child is asked to name the object. The test has 45 items (0–45). Its reliability (Cronbach's alpha) was α = .84 in ECEC and .82 in first grade. The full 45-item NVT has shown good psychometric properties in the Skoleklar data (Størksen, Ellingsen, Tvedt, & Idsøe, 2013), and so has an abridged version using only 20 items in other Norwegian samples (e.g., McTigue et al., 2020).

4.4.1.2 Phonological-awareness skills

Phonological-awareness skills were assessed in ECEC and first grade using a blending test (Norwegian Directorate for Education and Training, 2012). The test has 12 items (0–12) of increasing difficulty and is automatically discontinued after three subsequent errors. The children were required to blend separately pronounced phonemes into the corresponding word. For example, the tester might say, "Here you see pictures of /hus/, /mur/, /mus/, and /pus/ [house, wall, mouse, cat in English]. … Listen carefully and touch the picture that goes with /p/-/u/-/s/." Reliability could not be tested because only the composite score was available in the dataset. However, another Norwegian study found the reliability (Cronbach's alpha) of this test to be acceptable: α = .75 (Solheim, Brønnvik, & Walgermo, 2013).

4.4.1.3 Early mathematical skills

The Ani Banani Math Test (ABMT; Størksen & Mosvold, 2013; ten Braak & Størksen, 2021) was used to measure the children's mathematical skills in ECEC and first grade. This test is a digital

assessment carried out on a tablet computer. It has 18 items and addresses three areas of mathematics: problem-solving, geometry, and numeracy. The items are embedded in a playful context featuring a little monkey called Ani Banani. The children are asked to help Ani Banani with everyday activities such as counting toys, solving jigsaw puzzles, creating sets with the same amount of items, and recognizing shapes. The reliability (Cronbach's alpha) of ABMT was $\alpha = .73$ in ECEC and $\alpha = .68$ in first grade. The test has recently been validated in a more thorough manner (using the Skoleklar data) and has been found to be a reliable and valid research tool for assessing early mathematical skills (ten Braak & Størksen, 2021).

4.4.2 Academic skills in fifth grade

4.4.2.1 Reading comprehension

Reading comprehension in fifth grade was assessed in the fall of 2016 through a mandatory national assessment (Norwegian Directorate for Education and Training, 2016a). The test used is intended to assess how children use reading in different academic and everyday contexts. The questions are designed to capture their ability to (1) find information in texts, (2) interpret and compare information, and (3) reflect on and evaluate the form and content of the texts. The test includes five texts, each of which is followed by multiple-choice questions. There are 5–7 items per text and a total of 30 items. The test was performed on computers and students were given ample time (90 minutes) to complete it. The national average score in 2016 was 50, with scores ranging from 22 to 76. The average score of all children in the municipality where the Skoleklar project was carried out was 48. For the Skoleklar sample, the average score was 49.89 and the range was 26 to 74, meaning that the sample scored above the average for the municipality. The reason might be that there is a relatively small number of children with immigrant and minority status in the sample, as this is one factor that has been found to

be negatively related to reading comprehension (Miyamoto, Pfost, & Artelt, 2018).

4.4.2.2 Mathematical achievement

Mathematical achievement in fifth grade was also assessed in the fall of 2016 through a mandatory national assessment (Norwegian Directorate for Education and Training, 2016b). This test focuses on how children use mathematical skills in academic and everyday contexts, assessing three different aspects of mathematics: (1) the number aspect, which measures children's numeracy and how they manage to use the four arithmetic operations, (2) the measuring and geometry aspect, which is about length, area, volume, angle, mass, time, and purchase and sale, and (3) the statistical aspect, which measures children's ability to organize, analyze, present, and evaluate data, tables, and charts. The test has 45 items. The children either selected an option in multiple-choice questions or wrote their answers directly on the computer. The national average score in 2016 was 50, with scores ranging from 20 to 80. The average score of all children in the municipality where the Skoleklar project was carried out was 51. For the Skoleklar sample, the average score was 50.88, with scores ranging from 28 to 78. Having immigrant and minority status is less strongly related to mathematical achievement than to reading comprehension, which may explain why the average score of those included in the project and the average score of the entire municipality were more similar for mathematics than for reading.

4.4.3 Self-regulation in ECEC and first grade

4.4.3.1 Directly assessed self-regulation

Self-regulation was directly assessed using the Head-Toes-Knees-Shoulders task (HTKS; McClelland et al., 2014). This assessment is a short game appropriate for children aged four to eight years. The HTKS version used in this thesis has three parts, and each of the three parts

consists of one practice section (4 items) and one subsequent test section (10 items). There are thus a total of 12 practice items and 30 test items. Scoring is performed as follows: 2 points for a correct response, 1 point for a self-correct response (i.e., involving rapid self-correction), and 0 for an incorrect response. To move on to the next part, a child has to score at least 4 (out of 20) on the test section.

In the first part of the game, the child is asked to touch the opposite body part to that mentioned. For example, when the instructor says, "touch your toes," the child must touch his or her head, and vice versa. The children go on doing the opposite of what they are told throughout the game. In the second part, knees and shoulders are added (as a second pair of opposites), and in the third part the rules are switched so that head and knees go together and shoulders and toes go together. This test requires children to integrate cognitive aspects of executive function (EF) skills into their behavior, namely (1) paying attention to the instructions, (2) using working memory to remember and execute new rules, (3) using inhibitory control to inhibit a natural response to the instructor's commands, and (4) using cognitive flexibility and working memory when the rules are changed in the second and third parts (McClelland et al., 2014).

The HTKS has shown good psychometric properties in previous studies conducted in the United States, Asia, and Europe (Cameron Ponitz et al., 2009; von Suchodoletz et al., 2013). It has been found to have high interrater reliability and high internal reliability, and support has been found for convergent and predictive validity (McClelland et al., 2014; McClelland et al., 2007). In the Skoleklar dataset, the only data available were sum scores for the practice and test sections, meaning that it was not possible to calculate Cronbach's alpha. However, in a recent Norwegian study (Rege et al., 2019) involving a similar age group, the HTKS task showed a Cronbach's alpha of $\alpha = .87$. In the U.S. data used in Study III, the reliability was $\alpha = .96$.

Study II used the sum score of the test sections (30 items, score range: 0–60). In Study III, the three practice sections (12 items) and the three test sections (30 items) were amalgamated (score range: 0–84). Prior studies have also included the practice items in the overall score (Fuhs et al., 2014; McClelland et al., 2014). This increases variability at the low end of the measure (Fuhs et al., 2014). In addition, it yielded six indicators rather than three to be used when testing for measurement invariance in Study III.

4.4.3.2 Teacher-reported self-regulation

Study II also used a teacher-reported measure of self-regulation. This was based on the Survey of Early Schools Adjustment Difficulty (ESAD; Rimm-Kaufman, 2005), which consists of 11 items. Its developers were originally interested in learning about children's adjustment during the first three weeks of school, but the measure can be adapted for younger or older children. The questionnaire focuses more broadly on self-regulation as part of a wider learning-related skills concept, meaning that it does not explicitly focus on the predictive utility of working memory, attention, and inhibitory control. Even so, it represents the realization of children's self-regulation in the classroom context across time, containing items such as (2) "this child has shown difficulty following directions," (3) "this child has shown difficulty working as part of a group," (5) "this child has shown difficulty working independently," (8) "this child has shown difficulty sitting appropriately during circle time or other times when they are expected to sit," (9) "this child has shown difficulty adjusting to the schedule or rhythm of the day," and (11) "this child has shown difficulty taking turns or waiting until his/her turn to speak," which represent behaviors typical of children who are struggling to regulate themselves and adjust to the classroom context. Teachers responded to the statements for each child using a 5-point scale ranging from 1 (no, not at all true) over 3 (sometimes true) to 5 (yes, very true).

The questionnaire also includes a few items pertaining to children's academic skills. For this reason, a composite score for the six items (2, 3, 5, 8, 9, and 11) most representative of EF skills was calculated. Then it was examined to what extent this composite score correlated with the score for all 11 items. It was found that the two scores were highly correlated both in ECEC (r = .98) and in first grade (r = 1.0). Hence the full score was used in further analyses. Previous findings have found support for convergent validity for the ESAD questionnaire (Cameron Ponitz, Rimm-Kaufman, Brock, & Nathanson, 2009).

Reliability (Cronbach's alpha) was .91 in ECEC and .93 in first grade. To ensure that higher scores would reflect better self-regulation in the classroom, all items were reversed after the data had been entered.

The ESAD questionnaire and the HTKS task correlated significantly both in ECEC (r = .32, p < .001) and in first grade (r = .34, p < .001).

4.4.4 Demographic variables

4.4.4.1 Demographic variables in the Norwegian data

Demographic data were collected through questionnaires completed by parents. The variables used in this thesis were the child's age and gender, the mother's level of education, and the parents' country of birth (see Table 2).

Maternal education was used as a continuous variable in all three studies. As already mentioned, it was re-coded into new categories for Study III to ensure comparability with the U.S. data (see Table 3).

4.4.4.2 Demographic variables in the U.S. data

In the U.S. research project, parents completed questionnaires yielding data pertaining to the child's age, gender, and ethnicity and the mother's level of education (see Table 3).

4.5 Statistical methods

4.5.1 Missing data

4.5.1.1 Norwegian data

In the Skoleklar project, the rate of missing data was low: it was in the range of 1.2–4% for all variables collected in ECEC and first grade. By contrast, the rate of missing data at the participant level was relatively high from first grade to fifth grade: 34.6% were missing for the national assessment of reading comprehension and 34.2% for that of mathematics (Study II). The main reasons for this attrition are probably that the parents had to renew their consent before data were collected in fifth grade (see Figure 3), that the fifth-grade teachers (who were to collect and pass on the consent forms) were less involved in the project than the ECEC teachers and first-grade teachers had been, and that it was not possible to reach those children who had left the relevant municipality.

The children for whom fifth-grade values are missing had significantly lower mean scores for mathematics and vocabulary in ECEC and for phonological awareness, vocabulary, and teacher-reported self-regulation in first grade. Further, children were less likely to remain in the study if their parents had reported them as having immigrant or minority status. Concretely, the data collected in ECEC covered thirteen children with immigrant status, but only three of them were left in the fifth-grade sample (see Study II for a further discussion of this issue). Further, only 14 out of 27 children with minority status remained in fifth grade.

4.5.1.2 U.S. data

The U.S. dataset had a low rate of missing data for the HTKS task (in the range of 1.5–1.9%). However, the maternal-education variable was missing for 56 children (21.2%). T-tests showed there to be a significant

overrepresentation of children with minority status among these 56 cases. Moreover, the children with missing data for maternal education obtained significantly lower mean sum scores on the HTKS task than those for whom this variable was reported (see Study III for further discussion).

4.5.1.3 Strategies

Missing values lower than 5% may be of little concern (Kline, 2016). The formal definition of "missing completely at random" (MCAR) requires the probability of missing data on a variable to be unrelated to other measured variables and to the variable itself (Enders, 2010). Little's MCAR test, which is one method of assessing MCAR, indicated no evidence of systematic missing data for the first two data-collection rounds in the Skoleklar dataset. Hence the Skoleklar data were assumed to be MCAR in Study I and Study III.

"Missing at random" (MAR) refers to missingness that is due to a predictable reason and therefore becomes a random effect that is easily estimated (Enders, 2010; Little, Jorgensen, Lang, & Moore, 2014). The practical problem with the MAR mechanism is that there is no way to confirm it. This represents an important practical problem for missing-data analysis because maximum-likelihood estimation and multiple imputation assume a MAR mechanism. The MCAR and MAR mechanisms are referred to as ignorable-missing-data mechanisms because bias is nonexistent (MCAR) or recoverable (MAR) and power is restored when a modern treatment is used. By contrast, missing data cannot be ignored when they are missing not at random (MNAR), that is, when the missingness on a given variable is caused by the subjects' levels on that variable. Like for the MAR mechanism, there is no way to verify that scores are MNAR without knowing the values of the missing variables.

The missing data with regard to the fifth-grade national assessments in the Skoleklar project and with regard to maternal education in the U.S. project were deemed not to be missing at random (see discussion in Studies II and III). Owing to the challenge of satisfying a MAR assumption in those studies, an auxiliary variable (immigrant status) was incorporated into the analysis, and controls were made for variables (e.g., minority status and academic skills) that correlated with missingness (Enders, 2010). Further, to appropriately deal with missingness, full-information maximum-likelihood (FIML) estimators were used. FIML outperforms traditional techniques for missing-data handling (listwise and pairwise deletion) because it uses all available data to estimate the parameters and the standard errors (Enders, 2010). Hence all available data on the variables included in the models contributed to the model parameters in the analyses conducted in Studies I, II, and III.

Maximum-likelihood (ML) (or full-information maximum-likelihood, FIML) estimation is a normal-theory method that assumes multivariate normality for the joint population distribution of the endogenous variables, given the exogenous variables (Kline, 2016). Some of the variables used in this thesis showed non-normal distribution (skewness and kurtosis). Therefore, a robust maximum-likelihood (MLR) estimator for continuous endogenous variables was used in all three studies. The consequences of analyzing non-normally distributed variables using the ML estimation are that standard errors tend to be too low (resulting in inflated rates of Type I error) and model-test statistics tend to be too high (resulting in inflated rates of true-model rejection) (Kline, 2016).

In Study II, the standard ML estimator was used in the mediation analyses because the MLR estimator is not compatible with the bias-corrected bootstrap option applied in those analyses (Hayes, 2012).

4.5.2 Analyses

Descriptive analyses were conducted in SPSS for all three studies. Mplus version 7.3 (Muthén & Muthén, 1998-2012) was used for several analyses in this thesis. The growth-curve modeling framework was used in Study I. Study II relied on path analyses and Study III on confirmatory factor analyses (CFA) and structural equation modeling (SEM).

4.5.2.1 Growth-curve modeling framework

The simplest latent growth-curve model involves one variable measured in the same way (using the same unit) at two timepoints (T. E. Duncan, Duncan, & Strycker, 2006). If the scores have the same units (metric), the assessment can be said to measure the same construct at each timepoint (Kline, 2016). Two temporally separated observations make it possible to estimate the amount and direction of change (change score), but not to study the shape of the development trajectory or the rate of individual change (T. E. Duncan & Duncan, 2009).

Study I involved variables measured in the same way at two timepoints. The intercept factor in the growth-curve model used in Study I represented the initial factor at the first data-collection timepoint (ECEC) (T. E. Duncan et al., 2006). The slope factor represented the difference score (first-grade mean score minus ECEC mean score). A model with two observations is saturated, meaning that error variances could not be estimated. For this reason, time-specific measurement error was incorporated into the models in Study I using the estimated Cronbach's alpha for the composite measure as the reliability of the measures used (Wang & Wang, 2012).

4.5.2.2 Path models

In Study II, path analyses were conducted to examine direct and indirect pathways from children's early self-regulation to academic achievement in fifth grade. Path models were suitable for the research questions in

Study II because longitudinal and concurrent relations can be specified simultaneously. Compared with multiple regression, path analyses can be used to analyze more complex models (Streiner, 2005), such as ones involving full or partial mediation, or—as done in Study II—to investigate both direct and indirect effects. Path analyses relate to effects among the variables observed. Importantly, path analysis is a technique for testing models, not building them. Hence models must rely on theory (e.g., Kline, 2016).

Indirect effects and mediation analysis. Study II examined whether self-regulation in ECEC had an indirect effect on fifth-grade achievement through self-regulation and academic skills in first grade, using the MODEL INDIRECT command in Mplus and the bootstrapping-process procedure. Bootstrap confidence intervals have been suggested to represent a useful approach to statistical inference for a proposed indirect effect (testing the null hypothesis) (Hayes, 2012).

Both directly assessed and teacher-reported self-regulation in ECEC correlated positively and significantly with the fifth-grade outcomes (Table 2 in Study II). However, when all variables were included in the path models, the self-regulation measures in ECEC did not directly affect fifth-grade achievements. Even so, indirect effects from self-regulation in ECEC to fifth grade through first-grade skills were tested, because mediation analysis no longer requires evidence of simple associations between the predictor and the outcome variable as a precondition (Hayes, 2013).

The path analysis in Study II included several mediators. A simple mediation analysis may reveal evidence of an indirect effect from a predictor on an outcome variable through a sole mediator in the model, but show no such indirect effect when other mediators are included in the model (Hayes, 2013). This is more likely when the mediators are correlated, which is precisely when multiple-mediator models are most useful. Nevertheless, when the intercorrelation between the mediators

becomes too large, the usual problems with multicollinearity in regression models begin to take hold and muddle the results, as the paths from each mediator to the outcome are estimated after controlling for all other mediators (Hayes, 2013). In Study II, checks were made for multicollinearity, and the results showed that this was not a problem within the data. Moreover, including correlated mediators in the model makes it possible to disentangle spurious associations from potential causal associations (Hayes, 2013).

A path model is the structural model used in general structural equation modeling (SEM). SEM also includes a measurement model (Byrne, 2012), which represents a CFA model (described below). In Study III, SEM was conducted to investigate whether maternal education and child gender predicted children's self-regulation (HTKS latent factors) in a Norwegian sample and a U.S. sample.

4.5.2.3 Confirmatory factor analysis (CFA) and measurement invariance

Confirmatory factor analysis (CFA) investigates the relationship between the indicators observed and the latent factor(s), which are theoretical constructs that cannot be observed directly (Byrne, 2012). Hence CFA reflects how the construct is theoretically operationalized (van de Schoot, Lugtig, & Hox, 2012a). One advantage of latent-variable models is that they can control measurement error better than observed-variable models (Kline, 2016).

In Study III, CFAs were conducted to investigate the factor structure of the HTKS task in a Norwegian and a U.S. sample. It was first investigated, separately for each sample, how the latent factor(s) could best represent the six sections (three practice and three test sections) of the HTKS task. The results obtained supported a two-factor model for both samples.

Next, tests were performed for measurement invariance, which concerns whether the measurement functions similarly and measures the same underlying meaning across groups (or over time) (Kline, 2016). A series of CFAs were conducted in a stepwise fashion from the least restrictive model (configural invariance) to the most restrictive model (strict invariance) (van de Schoot et al., 2012a). Support was found for strict invariance. Detailed information about testing for measurement invariance is provided in Study III.

Testing latent means across groups. Study III tested whether the average level of the latent factors (using the strong measurement model) of the HTKS task was similar across the Norwegian and U.S. samples. The constraints of Mplus were used, meaning that the first group's factor means were automatically constrained to be zero (van de Schoot, Lugtig, & Hox, 2012b). Then the mean of the second group was estimated; its significance indicated whether the mean differed from zero and hence whether that group differed from the first group. The correlation between the two HTKS factors was compared as between the samples using the MODEL TEST option in Mplus. This syntax provided a Wald test (van de Schoot et al., 2012b).

4.5.2.4 Model fit to the data

Model fit in all three studies in this thesis was tested using a model-test statistic (chi-square test) and several approximate-fit indexes (CFI, TLI, RMSEA, and SRMR). The chi-square test is an accept-support test where the null hypothesis represents the belief that the model is correct (hence, unlike in reject-support testing, if the null hypothesis is rejected, this means that the model is false); $p \geq .05$ supports the model (Kline, 2016). The models in Studies II and III had $p > .05$.

Approximate-fit indexes are not significance tests. Instead, they are intended as continuous measures of model–data correspondence (Kline, 2016). Although these indexes are intended to be continuous measures,

Hu and Bentler (1999) suggest that what is required to conclude that there is a relatively good fit between the hypothesized model and the observed data are values close to .95 or higher for TLI and CFI, values of .08 or lower for SRMR, and values of .06 or lower for RMSEA. The models in Studies II and III showed good overall model fit.

In Study I, the moderation effect (gender by maternal education) was tested through the contrasting of two models. In the first model, maternal education was held equal across gender; in the second, the parameter was free across gender. The model with a constrained path across gender was compared with the model where maternal education on intercept was free. Because of the MLR estimator used, this comparison was made by computing a chi-square difference test using the Satorra–Bentler correction (Bryant & Satorra; Satorra & Bentler, 2010).

In Study III, tests for measurement invariance were conducted with regard to the HTKS task across the Norwegian and U.S. samples. For each step in the series of CFAs, the constraints of the models were increased. Their fit was assessed using the chi-square statistics (Satorra Bentler correction) and approximate-fit indexes described above (Cheung & Rensvold, 2002; Muthén & Muthén, 2018; Satorra & Bentler, 2010) (see Study III for further descriptions).

5 Results

5.1 Main findings of Study I

The growth-curve models indicated that maternal education predicted Norwegian children's vocabulary (β = .23, p < .001) and mathematical skills (β = .33, p < .001) in ECEC. The results showed a small gender difference (favoring girls) in mathematical skills (β = -.16, p < .05) but not in vocabulary (β = -.07, p = .264) in ECEC. Maternal education and gender did not significantly predict the change in vocabulary or mathematical skills from ECEC to first grade. Nor did gender moderate the relationship between maternal education and academic skills in ECEC.

5.2 Main findings of Study II

Path models showed that directly assessed (HTKS task) and teacher-reported (ESAD) self-regulation in ECEC predicted mathematical skills (β = .19, p < .01 and β = .13, p < .05, respectively) but not vocabulary and phonological awareness in first grade. Teacher-reported self-regulation in ECEC indirectly predicted fifth-grade reading comprehension through first-grade teacher-reported self-regulation (β = .13, 95% CI [0.38, 2.91]). Directly assessed self-regulation in ECEC predicted fifth-grade mathematical achievement through mathematical skills (β = .06, 95% CI [0.01, 0.07]) and directly assessed self-regulation (β = .04, 95% CI [0.00, 0.05]) in first grade. After ECEC self-regulation was controlled for, both directly assessed (β = .16, p < .05) and teacher-reported (β = .20, p < .01) first-grade self-regulation predicted fifth-grade reading comprehension while directly assessed first-grade self-regulation (β = .19, p < .01) predicted fifth-grade mathematical achievement.

5.3 Main findings of Study III

In Study III, a series of CFAs indicated that a self-regulation measurement (the HTKS task) functioned similarly (measurement invariance) across a Norwegian and a U.S. sample. More precisely, a two-factor (HTKS1 and HTKS2) solution was supported for both samples. This means that the HTKS task had the same structure across the two samples. Moreover, a series of increasingly restrictive CFAs indicated that the HTKS task measured the same underlying meaning across the Norwegian and U.S. samples. After measurement invariance had been established, results showed that children's levels of self-regulation (average scores on latent HTKS factors) were similar across the Norwegian and U.S. samples. Predictors were included in the analysis, and SEM analyses indicated that maternal education significantly predicted children's self-regulation in the U.S. sample but not in the Norwegian one. A chi-square test indicated that this difference was significant across the samples ($\Delta\chi^2$ (2) = 8.518, p = .014). The results also showed that girls had a significantly higher level of self-regulation than boys in the Norwegian sample but that the corresponding difference was not significant in the U.S. sample. However, the effect of gender on children's self-regulation did not differ significantly between the two samples.

6 Discussion

The Discussion chapter begins with a section dealing separately with *child factors*, followed by one dealing with *social factors*. This is in line with the overarching goals of the thesis (see page 37) and is intended to simplify matters somewhat. Development is indeed complex, and it occurs in real-world settings. This complexity is the main reason why it is so important to conduct studies at different ages and over time and in different groups (e.g., gender and SES), educational settings (e.g., ECEC and first grade), and cultural contexts (e.g., Norway and the U.S.) and to discuss the results in light of the characteristics of those groups, social contexts, etc.

The Bioecological Model of Development advocates research to investigate interaction effects in order to obtain insight into the complexity of development (Bronfenbrenner & Morris, 2006), including to identify culture- or group-specific patterns of associations. The interaction effects investigated in the present thesis were whether the role of maternal education for predicting academic skills differed between boys and girls (Study I) and whether the role of maternal education and child gender for predicting children's self-regulation differed across cultural contexts (Norway vs. the United States) (Study III). The discussion of the interaction effects is found in the social factor section.

6.1 Child factors

6.1.1 The role of early self-regulation for later academic achievement

Study II aimed to investigate pathways from children's early self-regulation to language and mathematical skills in first grade and to reading comprehension and mathematical achievement in fifth grade. The results were consistent with a large body of international evidence

demonstrating that self-regulation is foundational for children's early mathematical performance (Birgisdottir et al., 2020; Hernández et al., 2018; McClelland et al., 2014; Welsh et al., 2010) and for their later reading comprehension and mathematical achievement (Birgisdottir et al., 2020; G. J. Duncan et al., 2007; McClelland et al., 2006).

Study II has many pathways to discuss (see Figures 1 and 2 in Study II). First of all, teacher-reported self-regulation in ECEC predicted mathematical skills in first grade and indirectly (through first-grade teacher-reported self-regulation) predicted reading comprehension in fifth grade (controlling for directly assessed self-regulation and early academic skills). According to the Bioecological Model of Development, the form, power, content, and directions of the proximal processes producing development vary systematically as a joint function of the developing person's characteristics (e.g., self-regulation), the nature of the developmental outcomes (e.g., mathematics vs. reading), and the continuities and changes over time in the environment (e.g., ECEC vs. first grade) (Bronfenbrenner & Morris, 2006). For example, children rated low for self-regulation by their ECEC teacher in the present study could be expected to have had more conflicts with their teacher, would be more likely to have been rejected by peers, and would probably have received more negative feedback (Hamre & Pianta, 2006; Portilla, Ballard, Adler, Boyce, & Obradović, 2014). In contrast, those children who were rated high for self-regulation in ECEC may have found it easier to meet social and learning expectations in formal school contexts, such as raising their hands, sitting at their desks, and working more independently. These behaviors may have led to better relationships (proximal processes) with teachers and peers, more positive feedback, and a higher ranking for self-regulation by first-grade teachers. During the first year (and the subsequent years of formal schooling), those children in the present study who were initially rated high for self-regulation may have focused more strongly on the instruction given, persisted in their work, and completed demanding tasks, despite their

presence in a complex classroom setting, and this may have helped them to perform better than their less self-regulated peers on the mathematics test in first grade and on the reading-comprehension test in fifth grade.

There were also significant pathways from directly assessed self-regulation to academic skills. Directly assessed self-regulation in ECEC predicted first-grade mathematical skills (controlling for teacher-reported self-regulation) and indirectly (through first-grade mathematical skills and directly assessed self-regulation) predicted fifth-grade mathematical achievement (controlling for teacher-reported self-regulation and academic skills). Moreover, directly assessed self-regulation in first grade predicted fifth-grade reading comprehension (controlling for ECEC skills and first-grade teacher-reported self-regulation). These results demonstrate that the cognitive aspects of self-regulation (EF: inhibitory control, cognitive flexibility, and working memory) are also essential to academic learning.

Only the direct assessment (HTKS task) of self-regulation significantly predicted mathematical achievement in fifth grade, indicating that the complex cognitive aspects of self-regulation were more necessary for later mathematical achievement than were the more general behavioral and social aspects targeted by teacher-rated self-regulation. Hence, as the children learned more advanced mathematics throughout elementary school, they were not able to rely on automatized skills but needed strong self-regulation to deal with the new mathematical tasks and concepts introduced in first grade and with further mathematical learning throughout elementary school (Blair et al., 2011; Bull & Lee, 2014; Bull & Scerif, 2001). On a similar note, a recent study conducted in Iceland (whose cultural context and educational system resemble those of Norway) also found that only directly assessed self-regulation (using the HTKS task) in first grade predicted mathematical achievement in fourth grade (Birgisdottir et al., 2020).

The indirect pathways from self-regulation in ECEC to later academic achievement identified in Study II support the notion that children develop their mathematical skills and their self-regulation in parallel, as also suggested by prior evidence (Schmitt et al., 2017).

When it comes to reading comprehension, the results supported prior evidence showing that children also need cognitive aspects of self-regulation (directly assessed) to comprehend a sentence or series of sentences and to draw inferences about what will come next (Blair et al., 2011; Sesma et al., 2009), as well as to distinguish relevant information from irrelevant text and to be flexible in their choice of reading strategies (Butterfuss & Kendeou, 2018). Hence Study II supported the Augmented Simple View of Reading, which represents a broader perspective than the traditional Simple View of Reading (Hjetland et al., 2017).

Self-regulation in ECEC did not significantly predict vocabulary and phonological awareness in first grade. These findings align with those of the above-mentioned Icelandic study (Birgisdottir et al., 2020), where self-regulation in ECEC was found to significantly predict mathematical skills in first grade but not basic reading skills (after other key literacy predictors were controlled for). As argued by Blair et al. (2011), self-regulation is likely to be the most critical for tasks that have not yet been automated. Both vocabulary and phonological awareness have been suggested to represent crystallized knowledge, meaning that self-regulation (EF) plays an important role when they are being acquired in early childhood but is of less importance once they have been acquired and have become automated. The children in Study II and those in the Icelandic study may have reached the age where literacy skills and basic reading skills had become automated, which could explain why self-regulation did not significantly predict vocabulary and phonological awareness in first grade in Study II. Further, the results of Study II confirm previous findings indicating that self-regulation may play a stronger role in early mathematical development than for literacy skills (Birgisdottir et al., 2020; Schmitt et al., 2017) because mathematical

skills may be more strongly related to fluid intelligence (reasoning ability and processing of novel information), which is closely associated with EF (Blair et al., 2011).

Although not a focus of Study II, the results demonstrated that children's vocabulary and mathematical skills in ECEC were of great importance for reading comprehension and mathematical achievement, respectively, in fifth grade. Hence an interesting take-home message is that ECEC centers should strive to support all children's self-regulation *and* their academic skills before they start formal schooling; how this can best be achieved is a suitable topic for discussion and for closer investigation in future research.

Study II adds to existing international research on the foundational role of early self-regulation for predicting academic outcomes in elementary school. The results are especially important in the Norwegian educational context, where self-regulation is not mentioned either in the previous ECEC framework plan or in the current one (2011, 2017).

6.1.2 The role of child gender for academic skills and self-regulation

Study I found a small gender difference (favoring girls) in mathematical skills in (ECEC) but no such difference in vocabulary. There were no gender effects on the change in vocabulary and mathematical skills from the spring of the last year of ECEC to the spring of first grade. In Study III, Norwegian girls were found to have higher self-regulation levels than boys in the last year of ECEC, but no gender differences in self-regulation in the fall of kindergarten were found in the U.S. sample. The discussion below deals with the findings pertaining only to the Norwegian sample, while gender differences in self-regulation across cultural contexts (Norway vs. the United States) are discussed on page 82.

The findings of Study I align with those of some prior research showing gender differences in mathematical skills (Aunio, Hautamäki, et al., 2006; Brandlistuen et al., 2020) but not in vocabulary (Matthews et al., 2009; McTigue et al., 2020). However, inversely, some other studies have found gender differences in language comprehension (Zambrana et al., 2012) but not in mathematical skills (Ginsburg & Pappas, 2004). What is more, prior findings are also mixed regarding gender differences in self-regulation. Some studies found such differences (Matthews et al., 2009), others did not (McClelland et al., 2007; Schmitt et al., 2014). The Bioecological Model of Development suggests that these mixed results may be related to factors such as child age (gender-related differences in maturation), the construct being investigated, and cultural differences between societies and educational settings. In addition, whether a study find gender differences may also be related to the type of assessment tool used. For example, gender differences have been found in teacher-reported self-regulation but not in directly assessed self-regulation (Wanless et al., 2013). Importantly, the mixed findings of previous research may also be related to the fact that girls and boys are more alike than they are different on most psychological variables (Hyde, 2005, 2014).

When it comes to the age factor, previous evidence indicates that gender differences in language skills vary by children's age. Boys typically learn to comprehend and produce language more slowly than girls do in the first two years of life, but after that, boys develop at a faster rate than girls (Bouchard et al., 2009; Zambrana et al., 2012). The children in Study I were about six years old, an age at which boys may have caught up with girls in terms of vocabulary, meaning that no gender differences remain—in line with what was found by another Norwegian study using the same vocabulary assessment as the present thesis (McTigue et al., 2020). Thus, whether a study finds gender differences or not may be related to the age of the study participants.

When it comes to the construct measured, it should be noted that at the age in question, vocabulary primarily develops in a global manner through verbal interactions with adults in everyday situations (McTigue et al., 2020). A social-pedagogical approach to learning which reflects this, is predominant in the Norwegian ECEC. By contrast, the development of mathematical skills may require a more intentional focus and may be more dependent on whether the children engage in activities suitable for this purpose—which is especially relevant in the child-centered Norwegian ECEC, where children largely select their own activities (McTigue et al., 2020). One possible interpretation of the findings of Study I is that girls may have spent more of their ECEC time in groups engaging in teacher-initiated activities than boys, as some prior evidence has in fact shown (Fabes et al., 2003; Stangeland et al., 2018). As a result of this, they may have received more help and support than boys in the development of their mathematical skills. However, the gender difference found for mathematical skills in ECEC was small and must not be overstated.

When it comes to educational settings, the typical focus on instruction seen in first-grade classrooms may explain why boys and girls in Study I did not differ with regard to the change in mathematical skills from the spring of the last year of ECEC to the spring of first grade. In the "instructional" first-grade classrooms, both boys and girls in the present study were expected to carry out mathematical activities, and they received the same teaching experiences. Future research is needed to investigate the learning environments in the child-centered ECEC and the instructional first grade and how they may affect boys' and girls' development differently.

It should be noted that this finding may also be related to the fact that mathematical skills and vocabulary were highly stable from the end of ECEC to the end of first grade. In fact, the estimated variance of the slope factor was not significant for vocabulary and very small for mathematics,

indicating that children did not vary around the mean slopes. Hence there was practically no variance left to be explained by other factors.

Study III found a small difference (favoring girls) in children`s self-regulation in ECEC. Here it may be important to keep in mind the argument put forward by DiPrete and Jennings (2012) to the effect that gender differences in self-regulation and educational outcomes must be considered in context. Their study documented that gender differences in acquiring self-regulation explained a considerable fraction of the gender differences in academic outcomes during elementary school. In the present thesis, Study II showed that self-regulation at the end of ECEC and at the end of first grade was foundational for academic achievement in fifth grade. Hence it is important to consider processes in educational settings (and families) that produce gender differences in early self-regulation, as found in Study III, and how they may exert an impact on later academic performance. For example, teachers in the Norwegian ECEC tend to praise girls for qualities such as being caring, helpful, responsible, and conscientious, and they tend to expect girls to sit still, wait for help, and play quietly (Meland & Kaltvedt, 2017). By contrast, teachers tend to affirm boys' strength and physical characteristics, and they tend to allow boys to be noisy, to climb, and to jump. Such stereotypical gender expectations may partly explain why boys lag behind girls in self-regulation in ECEC (Study III). In turn, gender differences in self-regulation may be part of the reason why girls outscore boys in later academic achievements, such as in PISA at age 15 (DiPrete & Jennings, 2012; OECD, 2015; Weis, Heikamp, & Trommsdorff, 2013).

6.2 Social factors

6.2.1 The role of socioeconomic status for children's academic skills and self-regulation

Study I found that maternal education significantly predicted children's vocabulary and mathematical skills in the spring of the last year of ECEC. However, maternal education was not a significant predictor of children's change in these academic skills to the spring of first grade. Study III found that maternal education significantly predicted children's self-regulation in the U.S. sample but not in the Norwegian one. The discussion below deals with the findings pertaining only to the Norwegian sample, while SES-related differences in self-regulation across cultural contexts (Norway vs. the United States) are discussed on page 83.

According to the Bioecological Model of Development and the social-causation perspective, the characteristics of the environment, such as parents' actions and behaviors, affect the proximal processes. Prior evidence has documented that parental behavior and resources mediate the relationship between SES and child development (Bradley & Corwyn, 2003; Hart & Risley, 1995; Hoff, 2003; Hoff et al., 2012; Saxe et al., 1987). However, the present thesis did not investigate such causal family mechanisms. Instead, it aimed to investigate SES-related differences in children's academic skills in the transition from ECEC to first grade. ECEC and school are social contexts that can have an important role in equalizing SES-related differences, and the discussion below focuses mainly on those two educational institutions.

It is not well understood when SES-related gaps in academic skills emerge and how they evolve from infancy and throughout elementary school (Passaretta & Skopek, 2018). On the one hand, it may be assumed that SES-related differences appear early and increase over the educational career, owing to cumulative processes (Cunha & Heckman,

2007). On the other hand, it may also be assumed that those differences will decrease once children have started school, as a result of the equalization of conditions within the education system. In many countries, formal schooling is specifically designed to reduce differences due to SES. For example, one overarching goal of the Norwegian education system (ECEC and school) is to make SES-related differences as small as possible (e.g., Bakken & Elstad, 2012; Norwegian Ministry of Education and Research, 2017).

Study I supported previous research showing that SES-related gaps in children's vocabulary and mathematical skills are relatively substantial by the age when children enter formal schooling (Aunio, Hautamäki, et al., 2006; Passaretta & Skopek, 2018; Schjølberg et al., 2008; Zambrana et al., 2012)—although Norwegian society is in fact characterized by relatively high social equality, by subsidized and regulated ECEC, and by high rates of ECEC attendance from an early age. It should be noted that the existing SES-related differences may well be smaller than those that would be found if children did not attend ECEC, as some prior Norwegian research has suggested (Havnes & Mogstad, 2011; Schjølberg et al., 2008). There are indeed some indications that the SES-related differences in children's language skills at age five are smaller in Norway than in other European countries, where ECEC enrollment rates tend to be lower (Passaretta & Skopek, 2018).

Maternal education was not found to be related to children's change in vocabulary and mathematical skills from the end of ECEC to the end of first grade. The findings of Study I support previous evidence showing that SES-related differences tend to increase before children enter formal schooling and then persist or increase slightly throughout their time in school (Farkas & Beron, 2004; Passaretta & Skopek, 2018). All children in Study I had attended ECEC from an early age (the median age when starting ECEC was 18 months). In other words, ECEC centers had had substantial time to support all children and reduce SES-related gaps.

One possible interpretation of this finding is that the less-structured Norwegian ECEC is less likely to support all children's academic skills because free play and children's autonomy are highly valued and there is less emphasis on academic and cognitive learning. In first grade, all children are exposed to the same language, reading, and mathematics instruction, meaning that any pre-existing SES-related differences are likely to persist more or less unchanged.

Another possible reason why SES may be more important in early childhood than at school age is that this period is crucial for brain development. For example, the highest rate of vocabulary growth occurs at the ECEC age, whereupon the rate declines for each subsequent age period (Farkas & Beron, 2004), and the situation is similar for self-regulation (Center on the Developing Child at Harvard University, 2011).

However, Study I cannot identify the mechanisms behind the association between SES and children's academic skills. Those mechanisms are complex. The children's family context is crucial, but ECEC/school, the local neighborhood, and society's values and ideologies may also contribute. Moreover, the complexity of real life is such that accumulation and compensation may be at work simultaneously, resulting in persistent SES-related differences in change in academic skills. Finally, the lack of substantial variance in the slope factors caused there to be little variance left to be explained by other factors, such as SES. In summary, the findings of Study I align with previous evidence (e.g., Passaretta & Skopek, 2018) and highlight the importance of the early years of life in reducing SES-related gaps in children's learning outcomes.

Study III found that maternal education was not related to Norwegian children's self-regulation in ECEC as measured by direct assessment (HTKS tasks). Hence it did not support a prior finding from the United States (Montroy et al., 2016) but aligned with a study conducted in

Europe (Gestsdottir et al., 2014). This could be interpreted as reflecting the fact that self-regulation has received little attention both in Norwegian culture in general and in ECEC. While both mathematics and language are highly present in the Norwegian framework plan for ECEC (2011, 2017), the concept of self-regulation is not used there. Hence highly educated Norwegian mothers may be more aware of the importance for children's development of supporting their early mathematical and language development than of the importance of supporting their early self-regulation. In fact, self-regulation was even less focused on in Norwegian society in 2012, when the ECEC data in the Skoleklar project were collected.

This finding may also be related to the aspects of self-regulation assessed and to the type of assessment used. Størksen et al. (2015) found that parental SES was related to teacher-reported self-regulation but not to cognitive processes involved in self-regulation (the HTKS task), suggesting that the reason for this may be that parents with more resources will teach their children to regulate their behavior in social contexts but that parents may not have an equal influence on cognitive self-regulation skills.

The findings of Studies I and III do not explain why maternal education significantly predicted children's academic skills in the spring of the last year of ECEC but not their self-regulation. However, it could be that the related parenting behaviors differ along two key dimensions pertaining to the level of cognitive stimulation (investment perspective) and to the quality of emotional support (family-stress perspective) (see Kalil & Ryan, 2020). Maternal education might then be a better proxy for parenting behaviors fostering cognitive skills (Conger & Donnellan, 2007; Yeung et al., 2002). By contrast, emotional support has been found to be more strongly related to poverty and hence to the family-stress perspective. Research has shown that mothers living in poverty display less sensitivity (e.g., are less likely to perceive their children's signals, interpret those signals correctly, and respond promptly and appropriately

to them) during interactions with their babies than do higher-income mothers (Kalil & Ryan, 2020; Yeung et al., 2002). Family stress and the mothers' consequent lack of sensitivity during interactions may influence children's biological stress systems in ways that affect EF and self-regulation negatively (Blair & Ursache, 2011).

Norway has a low poverty rate compared with the United States and other countries (OECD, 2018), and the correlation between maternal education and income is relatively weak in Norway (r = .26; Størksen et al., 2015). Hence it is more likely in Norway than elsewhere for a person to have a well-paying job but not be highly educated, or vice versa. This means that, for the Norwegian sample in this thesis, maternal education may primarily be an indicator for the tendency to foster children's cognitive skills (parental investment), which is more strongly associated with academic skills than the broader concept of self-regulation is (Yeung et al., 2002). This may, in part, explain why maternal education was found to be significantly related to academic skills (Study I) but not to self-regulation (Study III).

Recent studies have found that Norwegian ECEC centers score at the minimal level for educational/instructional support but moderate to high for emotional support (Bjørnestad, Broekhuizen, Os, & Baustad, 2019; Bjørnestad & Os, 2018; Lisøy, Holme, & Solheim, 2018). These are important findings because educational support is a core aspect of process quality in ECEC and has often proven to influence children's cognitive and language development positively (see Bjørnestad et al., 2019). By contrast, emotional support is believed to be more strongly related to the development of self-regulation. Hence, although self-regulation is not mentioned in the framework plan, Norwegian ECEC may be better at addressing SES-related gaps in self-regulation than in academic skills.

This discussion presents several ideas that may help explain the findings. However, it is hard to give any conclusive explanations of the mechanisms that caused the results, and further research is needed.

6.2.1.1 The role of socioeconomic status for boys' and girls' vocabulary and mathematical skills

It has been argued that, in the investigation of gender differences in academic development, more attention should be devoted to interaction effects between gender and other factors, such as social class (Backe-Hansen et al., 2014). However, Study I found no significant interaction effects between gender and maternal education, indicating that the role of maternal education for predicting vocabulary and mathematical skills in ECEC did not differ between boys and girls. Hence the boys in this sample were not more vulnerable, as a group, than the girls, unlike what some prior research has found (Aunio, Niemivirta, et al., 2006; Autor, Figlio, Karbownik, Roth, & Wasserman, 2016a, 2016b; Entwisle et al., 2007; Fan, Fang, & Markussen, 2015; Zambrana et al., 2012).

6.2.2 The Norwegian and U.S. societies

The Bioecological Model of Development highlights the many relevant factors and processes that need to be considered in the study of child development. The Norwegian and U.S. societies have different macrosystems. The more distal systems indirectly affect proximal processes, such as those taking place in the family and in ECEC (Bronfenbrenner, 1979; Bronfenbrenner & Morris, 2006). For this reason, it is essential to conduct research across countries and to perform comparison studies in order to identify any country-specific associations.

6.2.2.1 Norwegian and U.S. children's level of self-regulation

A recent review documented that East Asians outperformed their Western peers on directly assessed self-regulation from the preschool

age through adolescence (Schirmbeck et al., 2020). The researchers argued that differences in pedagogical approaches and educational settings, parental practice and expectations, and social norms and value systems might influence children's self-regulation differently across Asian and Western cultures. In other words, differences between macrosystems may have yielded differences between microsystems and proximal processes and hence differences in child development.

In Study III, both samples were Western, and the results showed that the Norwegian and U.S. children represented in the study had similar self-regulation levels. Even though the Norwegian and U.S. societies differ (see Study III for an overview of society characteristics), they may both have characteristics that support children's self-regulation development to a similar extent, meaning that different advantages of the two societies may cancel each other out so that there is no overall difference between them. Study III discusses such possible advantages (e.g., high social and economic equality and access to ECEC in Norway versus a more intentional learning environment in the United States). However, it is unclear what mechanisms may underlie the result showing that the children in the two samples had similar levels of self-regulation. Future research, including observations in classroom contexts (and home learning environments) in different cultural contexts, may provide insight into the pathways along which cross-cultural differences or similarities may be created.

One example of a country-specific pattern of associations was found in a recent study (Salminen et al., 2021) examining the association between teacher–child interactions and children's self-regulation in Finnish and Portuguese toddler classrooms. Results showed that the average quality of teacher–child interactions was higher in Finnish classrooms than in Portuguese ones and also that the quality of the interactions was more strongly associated with children's self-regulation in Finland than in Portugal. The researchers suggest that cultural context should be considered more carefully in future studies (Salminen et al., 2021).

6.2.2.2 The role of gender for self-regulation across the Norwegian and U.S. societies

As already discussed (page 74), Study III found that Norwegian girls outperformed boys in directly assessed self-regulation (HTKS task). By contrast, there were no gender differences with regard to self-regulation in the U.S. sample. However, this difference was not significant across the two samples. Most research has either reported that girls have stronger early self-regulation than boys or found no gender differences (Backer-Grøndahl & Nærde, 2017; Wanless et al., 2013). However, those studies reporting gender differences in self-regulation report small differences. Research has shown that gender differences in self-regulation may depend on cultural context (Wanless et al., 2013), although a recent review found that girls generally outperform boys in self-regulation in both Western and Asian samples both with regard to direct assessments and with regard to teacher ratings (Schirmbeck et al., 2020).

The differences between the learning environments found in Norwegian ECEC centers and in U.S. kindergartens may explain why there were no gender differences in the U.S. children's self-regulation while such differences were found for the Norwegian sample. Compared with the play-based and child-centered Norwegian ECEC, U.S. kindergartens are more teacher-centered and emphasize formal teaching and instructions. In kindergarten, boys and girls are expected to adapt to a structured learning environment and are more likely to encounter the same expectations and demands, which will tend to enhance all children's self-regulation. As already discussed, boys and girls encounter different behavioral expectations in the Norwegian ECEC (Meland & Kaltvedt, 2017), and such differences may be especially prominent in unstructured learning environments (Fabes et al., 2003). However, it is important to note that the gender difference found for Norwegian children's self-regulation was small and that the relationship between gender and self-regulation did not differ significantly across the two samples. Moreover,

prior findings are inconsistent with regard to gender differences in self-regulation. Hence it is important not to overstate the present findings.

6.2.2.3 The role of socioeconomic status for children's self-regulation across the Norwegian and U.S. societies

Study III found that maternal education significantly predicted the U.S. children's self-regulation but not that of the Norwegian children and this difference was statistically significant. Although both the United States and Norway are high-income countries that are similar on a number of points, there are also several key differences between them. Compared with the United States, Norway has greater social and economic equality, stronger child and family support, universal access to quality-regulated and subsidized ECEC, and universal state-subsidized healthcare. One possible interpretation of the findings is that these characteristics of Norwegian society will alleviate stressors related to social inequality (and poverty) and hence reduce the importance of maternal education for children's self-regulation development. Indeed, it has been found that children in the United States are more likely to experience high-quality ECEC if they come from high-SES families (NICHD Early Child Care Research Network, 2006; Sohr-Preston et al., 2013), while the corresponding relationship is less strong in Norway (Rege, Solli, Størksen, & Votruba, 2018) and it is found that high-quality ECEC can have an equalizing effect (Sylva, Sammons, Melhuish, Siraj, & Taggart, 2020).

Another possible interpretation of the findings draws upon the assumption that maternal education is an indicator for both parental investment and family stress (poverty) to a greater extent in the U.S. sample than in the Norwegian one. In fact, maternal education and income are strongly associated in the U.S. (r = .68, p < .001; Wanless, McClelland, Tominey, & Acock, 2011), but, as already mentioned, this association is much weaker in Norway (r = .26, p < .001; Størksen et al., 2015). The strong U.S. correlation suggests that mothers in the United

States who have a low level of education are also likely to be poor and may thus display less sensitivity to their children (see Discussion, pages 78-79), which has been shown to be detrimental to children's self-regulation (Yeung et al., 2002).

Again, the results of this thesis highlight the importance of conducting studies across groups and social contexts to understand the complexity of child development. However, to better understand this complexity, future research should include measures of the environment and the proximal processes.

6.3 Practical implications

Emerging evidence highlights the importance of early childhood for brain development and future cognitive, social, emotional, and health outcomes (e.g., Shonkoff & Phillips, 2000). A report from the United Nations Children's Emergency Fund (UNICEF) states that "today's rising generation is the first in which a majority are spending a large part of early childhoods in some form of out-of-home care" (Adamson, 2008, p. 1). Increasing interest is being devoted to the role of ECEC quality for children's development. Hence the practical implications of the present thesis are mostly related to ECEC.

Norway has universal ECEC provision, with most children attending full-time from the age of one to that of five or six years. However, there is variation in the quality of ECEC centers (as measured by children's school-readiness skills) (Rege et al., 2018). Hence there is a potential to make a difference in children's lives and to reduce SES-related disparities in educational outcomes by increasing the quality of less successful ECEC centers. The implications discussed in the following relate mainly to the Norwegian context, although they may also be relevant to the United States.

6.3.1 Practical implications in microsystems (ECEC)

This thesis found that children's early self-regulation (and their academic skills, although this was not covered by the research questions) in ECEC was foundational for their later academic achievement. Results showed there to be substantial SES-related differences in vocabulary and mathematical skills, but not in self-regulation, in the Norwegian ECEC sample. There were gender differences in mathematical skills and self-regulation, but they were small.

ECEC centers in Norway are one of the main microsystems in children's lives. The proximal processes that children experience during their time in ECEC are of great importance for their development, including in terms of vocabulary, mathematical skills, and self-regulation. So is the extent to which gender- and SES-related differences may be equalized. These are both factors focused on in this thesis. The process quality of an ECEC center—such as whether it has warm and responsive teachers providing educational and cognitive support—will affect the proximal processes. Self-regulation, for example, develops most quickly during early childhood. Thus, the period children stay in ECEC appears to be a window of opportunity for scaffolding and supporting this skill.

High process quality in ECEC has been found to contribute to children's future self-regulation and academic achievement—more strongly so for children whose mothers have a low level of education than for children of highly educated mothers (Sylva et al., 2020). This suggests that high-quality ECEC is a prerequisite for the achievement of some overarching goals of the Norwegian educational system, such as the goal of leveling out social differences and giving all children the opportunity to develop in accordance with their potential (Norwegian Ministry of Education and Research, 2017).

Previous research has found that attending universal ECEC (center care) rather than informal care or family daycare is positive for the language development of Norwegian boys and girls (aged one and a half to three

years) (Lekhal, Zachrisson, Wang, Schjølberg, & von Soest, 2011). Moreover, it has been documented that attending Norwegian ECEC rather than being cared for at home may have a positive effect on the language skills of children whose mothers have a low level of education (Schjølberg et al., 2008). These findings indicate that ECEC positively affects children's development and may reduce SES-related differences. However, despite these findings and although Norwegian ECEC has enjoyed a good reputation, recent studies have shown a need to increase the quality of the educational support provided by teachers and other staff (Bjørnestad et al., 2019; Bjørnestad & Os, 2018).

Warm and responsive relationships are, of course, fundamental for children's learning and well-being. However, high-quality educational support and a more intentional focus may benefit children's cognitive and academic development in the Norwegian ECEC. For example, a Norwegian study found that attending ECEC centers with more structured pre-academic activities was positively associated with children's reading skills in first grade, especially if the children had low self-regulation (Zambrana, Ogden, & Zachrisson, 2020). Further, the Agder Project intervention (Størksen et al., 2016) was found to improve children's self-regulation (working memory) in the short term and their mathematical skills both in the short term and one year later (Rege et al., 2019), which aligns with other intervention studies including intentional playful activities and games (McClelland et al., 2019; Schmitt, McClelland, Tominey, & Acock, 2015). In fact, the importance of the social environment, such as adult (or more experienced peers) guidance and scaffolding, has been highlighted from Vygotsky's sociocultural theory (Bodrova & Leong, 2020) to the latest neuroscience (Distefano, Galinsky, & Zelazo, 2020) and of course in the Bioecological Model of Development.

Playful learning, defined as free play and guided play, has been suggested to constitute a sufficient approach when it comes to giving children educational support in academic knowledge and self-regulation

(Hirsh-Pasek, Golinkoff, Berk, & Singer, 2009). Free, unstructured play is a cornerstone of Norwegian ECEC, but there tends to be less focus on guided play, which may foster academic knowledge and self-regulation through play activities and greater involvement by the teachers. During guided play, teachers are goal-oriented but remain sensitive and responsive to the children's behavior. One fundamental tenet of guided play is in fact that children learn best when they are engaged and active in the activities, find them meaningful, and interact with peers and teachers (Hirsh-Pasek et al., 2009). In playful learning, teachers serve as facilitators whose role is to inspire play, create play contexts and play time, adapt to where children are, interact with them, and extend their thinking and ideas (Jensen et al., 2019). However, it is a challenging task to be a good facilitator of children's play. In fact, teachers often switch to instructing directly or to not participating (Jensen et al., 2019). Moreover, striking the appropriate balance between being goal-oriented and being sensitive and responsive to the children's behavior in guided play is not an easy role—and it has not been focused on in Norwegian ECEC.

While structural quality in Norwegian ECEC is very well defined and monitored, process quality—such as whether teachers are good facilitators of play and provide educational support—is not (Engel, Barnett, Anders, & Taguma, 2015). The lack of a structured curriculum for Norwegian ECEC gives teachers a great deal of freedom in translating curriculum and expectations into practice (Engel et al., 2015). In theory, this provides opportunities for individual development and the adaptation of learning opportunities for individual children. However, this presupposes highly qualified teachers, and about half of the Norwegian ECEC workforce lacks a teaching degree. This may give rise to challenges in a situation where the curriculum is free and unstructured. Hence it is essential for children's development that the practice and process quality of all teachers be monitored and that appropriate coaching be provided. Moreover, ECEC teachers need to reflect upon

their own behavior and values in relation to children's play and learning, for instance with regard to the facilitator role.

The present thesis found girls to outperform boys in mathematical skills and self-regulation. A child is (usually) born as a biological boy or girl, but the child's development of gender and the influence exerted by gender on other developmental areas both depend on the characteristics of the social contexts where the child finds him- or herself. According to the framework plan for Norwegian ECEC, boys and girls are to be given the same opportunities. However, observations in everyday ECEC settings have revealed that children are met with stereotyped gender expectations (Meland & Kaltvedt, 2017), even though the teachers do not perceive themselves as contributing to the stereotyping of gender differences (NOU 2019:3, 2019; NOU 2019:19, 2019). For this reason, it is essential to continue paying attention to gender differences, increasing the teachers' knowledge, observing their practice, encouraging them to reflect, coaching them, and investigating issues of gender equality and inequality. In this context, it should be pointed out that a very recent report financed by the Norwegian Directorate for Education and Training introduces methods and tools that ECEC centers can use to promote gender equality (Kjeldsaas, Friis, Johannesen, Renolen, & Emilsen, 2020).

The practical implications of the present thesis mainly concern ECEC. However, it must be kept in mind that SES- and gender-related differences arise during early childhood, at a time when the family is the most important microsystem for most children, which suggests that interventions targeting parents may be appropriate (Bronfenbrenner & Morris, 2006). For example, parents should be encouraged and supported to devote more time to their children's development, use a rich language when interacting with their children, engage in reading- and mathematics-related activities, and provide materials such as books, puzzles, and games for children. When it comes to children's development of self-regulation, parents' child-rearing practices are of

great importance. Scaffolding (e.g., establishing routines, breaking big tasks into smaller chunks) and warm and responsive parent–child relationships (e.g., sensitivity and autonomy support) are examples of child-rearing practices supporting children's development of self-regulation (Center on the Developing Child at Harvard University, 2011).

Parents should also be encouraged to be aware of their role in transmitting traditional gender roles by signaling different expectations of boys and girls. Teachers may facilitate the development of parents' child-rearing practices by providing guidance on the above-mentioned topics. Other relevant groups in this context include school nurses and health-center staff.

Finally, the Bioecological Model of Development suggests that the mesosystem should also be targeted. Relationships between microsystems, such as family and ECEC center, have proven to be important in children's development, and there is a need for a discussion on how best to involve parents in ECEC.

6.3.2 Practical implications at the macrosystem level

It is also necessary to discuss how the macrosystem, such as patterns of values and beliefs underpinning the Norwegian framework plan for ECEC and the pedagogical approach used, may influence the characteristics, quality, and daily practice of ECEC. For example, educational support and guided play may not be particularly well integrated in the framework plan and pedagogical approach, meaning that they may be missing from daily practice. Moreover, as already discussed, self-regulation is not mentioned in the framework plan, which represents a signal from the Norwegian educational authorities to the effect that this is not an important aspect of early childhood development—even though research clearly indicates that it is.

The pedagogical approach used in Norwegian ECEC stands out with its emphasis on free play and autonomy, its aim for holistic learning, its focus on children's current well-being, and its embracing of the intrinsic value of childhood (Tuastad et al., 2019). However, Norwegian children devote 60% of their time in ECEC to free play, and teachers have been found to be absent for 45.5% of the time when children engage in free play (Karlsen & Lekhal, 2019), meaning that the children may not receive the scaffolding and educational support that they need. In particular, children who are low on self-regulation or have language difficulties may suffer under these circumstances. Hence there is a need to discuss ECEC quality at the macrosystem level in Norway in order to align national ECEC practices with research findings related to adult scaffolding during early years (e.g., Center on the Developing Child at Harvard University, 2011; Hirsh-Pasek et al., 2009; Shonkoff & Phillips, 2000).

The Agder Project (see pages 7-8) challenged the existing pedagogical approach and practice. It triggered a great deal of debate in Norway, where a group of teacher trainers who defended the traditional ways accused the project of threatening the play-based approach (child-centered model) by emphasizing a school-readiness approach (investment model or teacher-centered model) (Tuastad et al., 2019). Such debate is needed in order to develop the field: it will always be necessary to evaluate existing practice. Tuastad et al. (2019) suggest that researchers, practitioners, and teacher trainers consider these two pedagogical approaches as complementary rather than as competing approaches. It may be useful to combine the best aims and insights of both pedagogical approaches in order to increase the future quality of Norwegian ECEC. Another way of seeing this is that it may be a good idea to preserve the values on which Norwegian ECEC is based but at the same time develop teachers' competence in the field of guided play and teach them how to be good play facilitators in order to give all children educational support.

Finally, another prerequisite for enhancing the quality of Norwegian ECEC is to gather the necessary knowledge through quantitative and qualitative studies. Research projects such as the Agder Project can shed light on the importance of high-quality ECEC for children's development, give new perspectives, increase knowledge, and lead to debates, all of which are essential factors for increasing quality further. Teacher training plays an essential role in bridging the gap between research and practice and in familiarizing future teachers with different pedagogical approaches so that they will have the knowledge, competence, awareness, and responsibility they are going to need when caring for and educating young children.

Many social contexts influence children's development. The present thesis mainly focused on ECEC. However, values, ideology, and the organization of other social institutions will also affect SES differences in societies.

6.4 Methodological considerations

In each of the studies included in this thesis (Studies I, II, and III), several methodological limitations were mentioned and discussed. A more general methodological discussion is presented in this section. As is often the case in measurement and research-design contexts, it will focus on validity—first in relation to measurements and then in relation to research designs.

6.4.1 Validity relating to measurements

6.4.1.1 Construct validity

Some aspects (content, structural, generalizability, external, consequential) of Messick's (1995) construct-validity framework were described on pages 47-48. Importantly, what needs to be valid are the

meaning or interpretation of test scores and the attendant implications in terms of actions to be taken; this is what is discussed in this section.

The developers of all assessments used in this thesis evaluated the *content* aspect of validity using theoretical and conceptual analyses of the test items and content (see Measures, pages 49-56).

The Skoleklar project directly assessed children's academic skills (vocabulary, phonological awareness, and mathematics) in ECEC and first grade as well as their reading comprehension and mathematical achievement in fifth grade. The construct validity of the assessments used to measure these academic skills has been thoroughly evaluated in prior work, using the same Norwegian sample as this thesis or national samples (Norwegian Directorate for Education and Training, 2018; Solheim et al., 2013; Størksen & Mosvold, 2013; ten Braak & Størksen, 2021). Therefore, these measures are not focused on in the further discussion.

The self-regulation construct measured in ECEC and first grade in the Skoleklar data had two different operationalizations in that two types of assessments were used: a direct, performance-based assessment (HTKS task; McClelland et al., 2014) and an assessment based on teacher reports (ESAD; Rimm-Kaufman, 2005). Both assessments were used in Study II, while only the direct assessment was used in Study III. Study III also used the HTKS task as measured in a U.S. project. Self-regulation is one of the most widely invoked constructs in cognitive science (Toplak et al., 2013), but there are numerous conceptualizations and definitions of it (and of EF), involving multiple perspectives (McClelland & Cameron, 2012). As a result, there are also many different measures. The discussion below about construct validity, therefore, focuses mainly on the self-regulation assessments, especially on the HTKS task, because this was also used in the comparative study.

The HTKS task has been validated and has shown good psychometric properties across SES groups and societies (Gestsdottir et al., 2014;

McClelland et al., 2014; Wanless et al., 2013). Study III investigated whether the HTKS task functioned similarly across the Norwegian and U.S. samples, an issue which has not been investigated previously. A confirmatory factor analysis (CFA) established that the HTKS task had the same general underlying structure for both samples. A series of more restricted CFAs were conducted, establishing strong measurement invariance. This means that if a Norwegian and a U.S. child had the same underlying level of self-regulation, they were likely to obtain the same score on the assessment (Kline, 2016). Hence the HTKS task was found to be *generalizable* across these two samples, representing different cultural contexts. Ideally, measurement invariance should also have been investigated across gender and SES groups. Previous studies have looked thoroughly at gender- and SES-related differences using the HTKS task (e.g., Montroy et al., 2016), but the issue of measurement invariance across gender and SES groups has not been investigated, suggesting that future research should have a closer look at it.

Another concern relating to *generalizability* is that children develop rapidly during early childhood, making it a challenging task to find assessments that represent a construct well over time. For example, the present thesis used the same assessments in ECEC and first grade, which yielded a ceiling effect for the phonological-awareness assessment in first grade. Such an effect may limit opportunities for generalization with regard to children at the high end of the ability spectrum because there was variance only for children with lower scores.

McClelland et al. (2014) found the HTKS task to be related to assessments of components of traditional executive function (EF), namely inhibitory control, cognitive flexibility, and working memory, which suggests convergent validity (*external* aspect). In younger children (preschoolers), the HTKS task was found to be most strongly related to inhibitory control and cognitive flexibility, but in older children (kindergarten students), it was more strongly related to cognitive flexibility and working memory. This finding is conceptually

consistent with the demands of the task as children progress through it, because the second and third parts require them to remember newly introduced rules (second part) and then to turn those rules on their head (third part).

The teacher-report assessment (ESAD) used in Study II has been found to be highly correlated (r = -.69, p < .001; negative because they did not reverse the ESAD items as Study II did) with teacher-reported self-control (15 items representing behavioral and cognitive aspects of self-control) (Cameron Ponitz et al., 2009), which supports its convergent validity (*external* aspect).

Most prior studies have used a sum score for the HTKS task, as was done in Study II. The HTKS task (sum score) has also been found to load onto one EF factor together with other assessments of EF components for children aged four to five years (Schmitt et al., 2017). In contrast, Study III found the HTKS task to load onto two latent factors. This relates to the *structural* aspect of the relationship between the internal structure of the assessment used and the internal structure of the construct domain it represents (Messick, 1995). One possible interpretation of the two-factor model used in Study III is that the first latent factor (consisting of the first two parts of the task) mainly represented inhibitory control and attentional or cognitive flexibility. In contrast, the second latent factor may have represented working memory, well in line with the findings of McClelland et al. (2014). There is evidence that EF is best described as a unitary construct for young children (four to six years old) (Hughes, Ensor, Wilson, & Graham, 2009; Wiebe, Espy, & Charak, 2008). There is also evidence that EF becomes more differentiated over time (e.g., at seven years of age) (Huizinga, Dolan, & van der Molen, 2006; Miyake et al., 2000). In Study III, the children were almost six years old, meaning that it is possible that EF had become more differentiated in them. Older children are indeed more likely to meet the cutoff for moving on to the third part of the HTKS task. This may be due to a substantive difference

in EF differentiation, or it may simply reflect a difficulty factor in third part of the HTKS task (Gonzales et al., 2021).

The results of Study II showed a strong correlation for teacher-reported self-regulation (ESAD) between ECEC and first grade. Scores on the HTKS task in ECEC and first grade were moderately correlated. These issues are discussed in Study II. Further, Study II found that the HTKS task and the teacher-report measure (ESAD) correlated: $r = .32$, $p < .001$ in ECEC and $r = .34$, $p < .001$ in first grade, which is in line with other studies using both performance-based and teacher-reported measures of self-regulation (Allan et al., 2014). Study II also showed that both self-regulation measures predicted academic achievement over and above each other, indicating that even though they were both operationalized to measure self-regulation, they in fact assessed different facets of the construct. This is supported by Toplak et al. (2013), who suggested, after thoroughly investigating performance-based and rating-based measures of self-regulation (EF), that those types of measures assess different aspects of cognitive and behavioral functioning which contribute independently to a person's adjustment to the environment, achievement of goals, and academic learning. Study II includes a more thorough discussion of the meaning of the direct-assessment and teacher-report scores and the results as well as the implications for actions that this meaning entails.

Construct underrepresentation and construct-irrelevant variance are two sources of construct *in*validity, and they are important to consider when evaluating *consequences* for score interpretation (Messick, 1995). In the present study, both the direct assessment and the teacher report may have failed to include other dimensions or facets of the constructs that they were intended to measure. Hence it is possible that the construct representation was too narrow (construct underrepresentation). However, it is perhaps more likely that both assessments captured something that did not belong to the relevant construct, indicating that they were too broad (construct-irrelevant variance). For example, the

research assistant gave verbal instructions during the HTKS task, meaning that scores were also dependent on the children's language comprehension. However, given that the instructions were simple and asked children to touch their head or toes, knees or shoulders, it is not very likely that language comprehension was an issue for most children. Indeed, the results showed that immigrant status in the Norwegian sample was moderately correlated with vocabulary but did not significantly correlate with scores on the HTKS task (see Table 2 in Study II). Hence it is unlikely that difficulty with language comprehension is an issue of concern.

Similarly, the teacher-report assessment (ESAD) may also have measured children's social skills (which are highly related to their self-regulation). Assessments developed to measure self-regulation tend to have large overlaps across many other social-emotional subdomains and may not distinguish the targeted subdomains sufficiently (Campbell et al., 2016). However, the purpose of the measure was to assess children's self-regulation and adjustment in classroom contexts. Classroom contexts include children's behavior in real-world settings where behaviors may reflect multiple constructs of interest, making it difficult to isolate behavior into specific subdomains when rating children's behavior in classrooms. Such "task-impurity problems" are highly relevant in self-regulation and EF research because the manifestations of those constructs involve other cognitive processes as well (Toplak et al., 2013). One way to limit task impurity is to include multiple assessments of self-regulation (EF) and use a latent-factors approach (CFA) to extract the variance common to those tasks. The data used in the present thesis included only one performance-based and one teacher-rated self-regulation assessment, making that method unavailable, but future research should include multiple measures to address this issue better.

As Messick (1995) noted, the validation process must combine scientific inquiry with rational arguments. The above represents an attempt to do so, to which should be added that the present thesis used well-established

and validated assessments whose scores have been found to be reliable and valid.

6.4.1.2 Statistical validity

Statistical validity concerns the validity of inferences about covariation between variables (Shadish, Cook, & Campbell, 2002). Kleven (2008) states that it is simply about whether a tendency should be considered substantial enough to be worthy of an interpretation. In line with most quantitative research, the present thesis used statistical methods (e.g., tests of significance and estimates of effect size) to make decisions about a tendency being trivial or not.

Some of the results in this thesis must be interpreted with caution. As discussed previously, the gender differences found were small. Moreover, gender differences in mean scores on the ABMT could be related to aspects other than children's mathematical skills (ten Braak & Størksen, 2021). The indirect effects found in Study II were also small. Although they were statistically significant, it may be questioned whether they were substantial enough to be meaningful in practice. Several mediators were included in the path models in Study II, which may influence the magnitude of the indirect effects (Hayes, 2013). Moreover, indirect effects are usually small because of the mathematical nature of indirect effects (X*M). Although some of the estimates were small, they were supported by theory and aligned with some prior evidence.

As already mentioned, future research should include multiple measures of self-regulation, and the same applies to academic measures. Then latent variables could be used to correct for measurement error affecting the task scores (task impurity) and the association with other variables.

Covariation may be inaccurate if the variables measured are unreliable, which was discussed in the section on construct validity. Restrictions to ranges (e.g., ceiling or floor effects) reduce power and attenuate bivariate

correlations (Shadish et al., 2002). As mentioned earlier, the phonological-awareness measure had a slight ceiling effect in first grade, which may have led to the underestimation of effects.

6.4.2 Validity relating to study design

The results in the present thesis are based on quantitative designs. Studies I and II had a longitudinal design, while the cross-cultural Study III had a cross-sectional design. Both internal and external validity, of course, depend on valid interpretations of test scores and their implications (construct validity) as well as on statistical validity.

6.4.2.1 Internal validity

Internal validity is the validity of the inference from an observed covariation to a causal interpretation (Kleven, 2008; Shadish et al., 2002). Internal validity is important whenever an inference is made to the effect that something influences something else. The data used in the present thesis were correlational and so represent a sufficient logical basis for prediction (when they are longitudinal, as in Skoleklar), although the correlational design precludes firm conclusions (Kleven, 2008).

Experimental designs have been recommended to eliminate possible threats to internal validity (Shadish et al., 2002). Kleven (2008) has suggested that although studies do not have an experimental design and cannot state causality, researchers should carefully discuss *possible* causal relationships between variables. However, inferring possible causation from correlation requires an approach that considers theory, design, data replication, and causal assumptions, only some of which are empirically verifiable (Kline, 2016).

The analytical models used in the three Studies in this thesis were specified by theory and previous findings (Kline, 2016), which is important because, for example, a path model may be wrong even if it

fits the data very well (at least in a non-experimental design) (Kleven, 2008). Thus, even if the design of this thesis could not state causality, the studies could give support to theory and previous evidence. Moreover, Study II had a longitudinal design and investigated indirect effects, controlled for prior skills and covariates, and included several mediators. For example, it found that self-regulation in ECEC predicted mathematical skills in first grade (controlling for ECEC mathematics), which in turn predicted fifth-grade mathematical achievement. According to Hayes (2013), including correlated mediators in the model makes it possible to disentangle spurious associations from potential causal associations.

In regression analyses and path analyses, controlling for other relevant variables is important to get closer to a possible causal interpretation. Thus, omitted variables may be a potential for bias. Depending on the correlations between measured and unmeasured variables, estimates of direct effects can be too high or too low (Kline, 2016). In the path analysis for reading comprehensions (Study II), for example, the predictors explained 35% (R^2 = .35) of the variance, suggesting the critical importance of other (omitted) variables, such as listening comprehension, rapid-naming speed, and intelligence. Thus, other variables that were not included in the models may have biased the results.

Theoretically, the observed effect of gender and SES on children`s skills (Studies I and III) are assumed to not work in the opposite direction. However, the present thesis could not and did not aim to uncover the causal mechanism underlying the effect of, for example, maternal education on child outcomes. Instead, it aimed to investigate the role of maternal education in predicting children`s academic skills in the transition from ECEC to first grade. This thesis did not have measures of parenting or teacher behavior or any proximal processes. As such, it could not examine any possible mediating mechanism. Instead, the results were discussed in light of theory and previous evidence.

Internal validity is always local. Any possible causal conclusions drawn are limited to the particular context studied (Kleven, 2008). Whether such possible conclusions can be generalized or transferred to other contexts is a matter of external validity, which is discussed below.

6.4.2.2 External validity

External validity concerns the validity of inferences made from the context of a study to a wider context or other contexts (Kleven, 2008; Shadish et al., 2002). Generalization over situations, groups, and persons is dependent mainly on similarities and differences between the situations or persons studied and the situations or persons with regard to which inferences are drawn.

The present thesis is based on a convenience-sample approach. Data in both samples were collected in rural counties, which were not nationally representative. For example, the Norwegian sample had few children with immigrant status, especially in the fifth-grade data. In the U.S. sample, all children had attended preschool (because they were recruited through preschools), whereas only 46% of children in Oregon aged three or four years were enrolled in a preschool in 2016 (Early Care and Education Profiles, 2018).

Some general advice with regard to generalization has been given (Cronbach, 1975; Kleven, 2008). First, it is suggested that results (knowledge claims) should be considered context-bound. This is in line with the framework of the Bioecological Model of Development. In fact, children's developmental outcomes vary systematically based on context characteristics, meaning that results must be discussed in relation to their context. In the present thesis, an effort has been made to heed this advice. Second, generalization should be considered as a working hypothesis rather than as a conclusion. The third suggestion is to study the same phenomenon in other contexts to see whether the same results are obtained there. This is fundamental to the present thesis. Not much

quantitative research into young children's development has been conducted in the Norwegian cultural context, and it is important to investigate whether results found in this context align with prior evidence using other samples from other cultural contexts. For example, prior international studies have found early self-regulation to be foundational for later academic achievement. Study II investigated this association in a Norwegian educational and social context. Finally, it is important to pay attention to exceptions as well as to results confirming "the rule," as exceptions may indicate context-specific conditions. For example, Study III did not find maternal education to significantly predict children's self-regulation in the Norwegian sample, contrary to most prior findings using U.S. samples.

6.5 Limitations and future directions

There are, of course, several limitations to the present thesis. Some methodological issues have been discussed above, and limitations are also discussed in the three studies. The present section focuses mainly on limitations relating to the theory used, namely the Bioecological Model of Development (Bronfenbrenner & Morris, 2006). Within this model, development emerges through the interaction between a person and the context over time. Some characteristics of the child (e.g., gender and self-regulation) and of the social context (e.g., SES and society) have been studied in this thesis. What is more, certain interaction effects have been studied (SES x gender, SES x society, and gender x society).

However, there are several characteristics of the contexts discussed in this thesis that are not directly measured. For example, there are no measures of ECEC quality or of characteristics of pedagogical approaches. Further, maternal education is used as an indicator for socioeconomic status (SES), and parenting as such is not measured. However, prior research has documented that SES is a good proxy for parenting practices and for the home learning environment, which both affect child development (Conger & Donnellan, 2007), and it was

beyond the scope of this thesis to look directly at those factors—but they should be included in future research.

Tudge et al. (2016) are critical of how the Bioecological Model of Development is used in most research, accusing researchers of misusing the model as a set of hangers where each of their variables can be hung rather than as a theoretical model of development to be tested. They also argue that there is a lack of focus on relevant proximal processes. The present thesis cannot refute this criticism. However, the Bioecological Model of Development was used to inform the studies and to define the research questions. Moreover, it was used to highlight the complexity of development and discuss the findings.

In line with the Bioecological Model of Development, this thesis assumed that the proximal processes differed based on the characteristics of the person and contexts as well as over time. For example, the proximal processes are probably different in the child-centered ECEC setting, where children spend much time outdoors and on outings without play tools, and in the teacher-centered educational setting (U.S. kindergarten and Norwegian and U.S. first grade), where children spend most time indoors engaging in adult-guided activities and receiving instruction from adults.

Future research should bring in measures of the relevant proximal processes that are hypothesized to be involved in the developmental outcomes of interest (Tudge et al., 2016). For example, it would have been interesting to measure the proximal processes (emotional support, classroom organization, and instructional/educational support) using the Classroom Assessment Scoring System (CLASS; see, for example, Teachstone Training, 2015) in Norwegian ECEC and U.S. kindergartens when comparing the self-regulation scores of the two samples in Study III (e.g., Salminen et al., 2021). CLASS could also be used in future research to evaluate proximal processes across ECEC and school

contexts as well as associations with self-regulation and academic-skills development.

However, this thesis did cover other elements of the Bioecological Model of Development. For example, it examined interaction effects, such as gender x SES in Study I and gender and SES x Norwegian and U.S. culture in Study III. Moreover, Studies I and II were longitudinal—time is also an element of the PPCT model.

Finally, the present thesis used only maternal education as an indicator of SES. Although empirical findings have shown that maternal education is the best single indicator of SES in predicting child outcomes, each aspect of SES may exert an important independent influence on how children are raised and how they develop. Thus, further research should use several indicators of SES. Conger and Donnellan (2007) recommend using separate education, income, and occupation measures and investigating the unique associations each of them has with child development. In line with this, a recent study (Conway, Waldfogel, & Wang, 2018) found that both parental education and parental income made unique and independent contributions to self-regulation—but the contribution of parental education was greater than that of income.

In summary, the present thesis added a piece of research to the larger research picture of child development. Each piece of research will help us understand the complexity of development across groups, contexts, situations, and time.

7 Conclusion

The present thesis found that Norwegian children's early self-regulation is foundational for their later reading comprehension and mathematical achievement. There was a small gender difference (favoring girls) in mathematical skills in the spring of the last year of ECEC, but no gender difference either in vocabulary or in the change seen in these academic skills from ECEC to the spring of first grade. Further, there were SES-related differences in Norwegian children's vocabulary and mathematical skills in ECEC, but not in the change in those skills from ECEC to first grade.

ECEC children's average level of self-regulation did not differ significantly between the Norwegian and U.S. samples studied. Norwegian girls did have higher self-regulation scores than boys, but there were no gender differences among the U.S. children. However, this difference between the samples was not significant. By contrast, maternal education significantly predicted self-regulation in U.S. but not Norwegian children, and this difference was statistically significant.

The results have been interpreted in light of the Bioecological Model of Development, previous evidence, and the social contexts from which the samples derive. The potential implications, especially for ECEC, have been thoroughly discussed. The present thesis adds a little piece to the big picture, and it highlights the importance of conducting studies across groups and social contexts to understand the complexity of child development. Moreover, it emphasizes the importance of bringing self-regulation as a concept into Norwegian ECEC. In research and practice across the world, self-regulation is seen as foundational for early-childhood learning and development, but this concept is not even mentioned in the Norwegian framework plan for ECEC, which may affect pedagogical practices negatively.

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Study I

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

Ragnhild Lenes[a]*, Ingunn Størksen[a], Megan McClelland[b], and Thormod Idsøe[ac]

[a]*Norwegian Centre for Learning Environment and Behavioural Research in Education, University of Stavanger, Stavanger, Norway* [b]*Human Development and Family Sciences, Oregon State University, Corvallis, OR, United States,* [c]*The Norwegian Center for Child Behavioral Development, Oslo, Norway*

Ragnhild Lenes, Norwegian Centre for Learning Environment and Behavioral Research in Education, University of Stavanger, Postboks 8600 Forus, 4036 Stavanger, Norway, e-mail: ragnhild.lenes@uis.no * corresponding author

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Study II

Early Childhood Research Quarterly 53 (2020) 612–624

Contents lists available at ScienceDirect

Early Childhood Research Quarterly

Direct and indirect pathways from children's early self-regulation to academic achievement in fifth grade in Norway

Ragnhild Lenes[a,*], Megan M. McClelland[b], Dieuwer ten Braak[a], Thormod Idsøe[a,c], Ingunn Størksen[a]

[a] Norwegian Centre for Learning Environment and Behavioural Research in Education, University of Stavanger, Postboks 8600 Forus, 4036 Stavanger, Norway
[b] Human Development and Family Sciences, Oregon State University, 125 Hallie Ford Center for Healthy Children and Families, Oregon State University, Corvallis, OR 97330, United States
[c] The Norwegian Center for Child Behavioral Development, Postboks 7053 Majorstuen, 0306 Oslo, Norway

ARTICLE INFO

Article history:
Received 19 April 2019
Received in revised form 25 June 2020
Accepted 9 July 2020
Available online 5 August 2020

Keywords:
Self-regulation
Classroom behavior
School readiness
Longitudinal effects
Academic achievement

ABSTRACT

A large body of research has documented the role of self-regulation in academic skill development for young children. However, few studies have investigated longitudinal and indirect effects from kindergarten through later elementary school. In this longitudinal Norwegian study, we investigated pathways from children's self-regulation in kindergarten (M_{age} = 5.8; N = 243, 49% girls), to language and math skills in first grade (N = 240) and reading comprehension and math achievement in fifth grade (N = 160). Self-regulation was measured with direct and teacher-reported assessments. Path models showed that both directly assessed and teacher-reported self-regulation in kindergarten predicted math skills but not vocabulary and phonological awareness skills in first grade. Teacher-reported self-regulation indirectly predicted fifth grade reading comprehension through first grade teacher-reported self-regulation, and directly assessed self-regulation predicted fifth grade math achievement through math skills and directly assessed self-regulation in first grade. When controlling for kindergarten self-regulation, both self-regulation measures in first grade predicted fifth grade reading and directly assessed self-regulation predicted math achievement. Findings elucidate the foundational role of early self-regulation for later academic achievement and the differential effects of directly assessed versus teacher-reported self-regulation in a Norwegian sample.

1. Introduction

When children enter formal schooling, they often move from a relatively unstructured childcare setting to a more structured learning environment, with greater expectations for behaviors such as paying attention, cooperating, and following instructions. These behaviors depend on children's ability to self-regulate (McClelland & Cameron, 2012). Research has indicated that children's self-regulation provides a foundation for their academic skills because children need to demonstrate self-control to benefit from learning opportunities (Blair & Raver, 2015; McClelland & Cameron, 2019; Raver, Jones, Li-Grining, Bub, & Pressler, 2011). Although the literature on self-regulation and its relationship with academic outcomes is extensive, relatively few studies have examined the role of early self-regulation on academic achievement in the later elementary school years (G. J. Duncan et al., 2007; McClelland, Acock, & Morrison, 2006). Moreover, self-regulation may not only directly predict later outcomes, but also contribute to later academic achievement through its role in early academic skills (von Suchodoletz & Gunzenhauser, 2013). Understanding the indirect developmental pathways from self-regulation to later skills is important because academic skills are essential prerequisites for learning (G. J. Duncan et al., 2007; Gurlitt & Renkl, 2010). Finally, most studies have assessed self-regulation with either direct assessments (e.g., McClelland et al., 2014) or with teacher reports (e.g., McClelland et al., 2006). The additive contribution of direct assessments over teacher reports, and vice versa, remains less known.

The present study is conducted in the Norwegian context that includes generous welfare systems, low rates of poverty,

* Corresponding author.
E-mail addresses: ragnhild.lenes@uis.no (R. Lenes), megan.mcclelland@oregonstate.edu (M.M. McClelland), dieuwer.t.braak@uis.no (D. ten Braak), thormod.idsoe@nubu.no (T. Idsøe), ingunn.storksen@uis.no (I. Størksen).

https://doi.org/10.1016/j.ecresq.2020.07.005

and universal access to regulated and subsidized Early Childhood Education and Care (ECEC), which is based on a play-based pedagogical approach. In this setting, we investigate the longitudinal and unique effects from children's directly assessed and teacher-reported self-regulation in the spring of kindergarten[1] (5–6 years) to vocabulary, phonological awareness and, math skills in the spring of first grade (6–7 years). We also examine direct effects from children's self-regulation in kindergarten and first grade (controlling for kindergarten self-regulation) to reading comprehension and math achievement in fifth grade (9–10 years). Finally, we investigate indirect effects from self-regulation in kindergarten to reading comprehension and math achievement in fifth grade, through academic skills and self-regulation in first grade.

1.1. Conceptual and empirical understandings of self-regulation

Self-regulatory skills help children control their thoughts and behavior, solve problems, plan, and complete tasks (McClelland & Cameron, 2019), which in turn helps them to adapt to the demands and expectations in the classroom. Self-regulation is a multidimensional construct that broadly refers to the regulation of emotions, cognition, and behavior (McClelland, Ponitz, Messersmith, & Tominey, 2010), and it is understood to be composed of interrelated top-down and bottom-up components (Blair & Raver, 2012). The bottom-up components are automatic, stimulus-driven, rapid, and do not require mental capacity, while the top-down components are related to executive functioning (EF) (Blair & Raver, 2012; Nigg, 2017). EF, which is a term often used in cognitive disciplines (McClelland & Cameron, 2012), is a high-level set of processes that include attentional or cognitive flexibility, working memory, and inhibitory control (Blair, 2002).

EF is related to, but not synonymous with, self-regulation. Nigg (2017) suggests that EF is a set of cognitive capacities that, when implemented, enables self-regulation and self-regulated behavior. This is in line with research on the connection between EF and self-regulation, which argues that the components of EF subserve successful self-regulation and that temporary reductions in EF underlie many of the situational risk factors identified in the social psychological research on self-regulation (Hofmann, Schmeichel, & Baddeley, 2012).

1.1.1. Measuring self-regulation

Self-regulation can be measured with direct assessments, such as the Head-Toes-Knees-Shoulder task (HTKS; McClelland et al., 2014) used in the present study or ratings by teachers or caregivers. However, although direct assessments and questionnaire-based measures of self-regulation are significantly associated (Gestsdottir et al., 2014; Matthews, Cameron Ponitz, & Morrison, 2009; von Suchodoletz et al., 2013; Wanless et al., 2013), they are not synonymous.

Direct assessments of self-regulation can provide information about children's skills in highly structured one-to-one situations and are more likely to assess cognitive processes (e.g., EF components) involved in self-regulation (Allan, Hume, Allan, Farrington, & Lonigan, 2014). For example, the HTKS task has been found to be related to all three EF components (McClelland et al., 2014). However, direct assessments may not adequately reflect children's ability to regulate their behavior in a social classroom context over time (Toplak, West, & Stanovich, 2013). It is suggested that a child might score well on an individually administered self-regulation measure, such as the HTKS task, but he or she might not be able to pay attention in the classroom or work situation, which includes many distractions and extraneous situations (McClelland et al., 2010). Furthermore, direct assessments are typically used at one point in time, which only gives assessors a snapshot of a child's skills and may also capture factors unrelated to a child's self-regulation (e.g., time of testing, the test situation, child fatigue) (Allan et al., 2014).

In contrast, teacher ratings capture children's ability to apply their self-regulation in everyday tasks, across classroom contexts and over time (Campbell et al., 2016; Wanless et al., 2013), but they may be hampered by rater subjectivity and history between the child and the rater (Allan et al., 2014). Although teacher-reported measurements may target the cognitive processes included in EF, they may, to a larger degree, reflect the behavioral and social manifestations of these skills in the environment (Toplak et al., 2013). Thus, teacher-reports often focus on self-regulation more broadly and may not focus on specific processes such as inhibitory control, flexible attention, and working memory (Schmitt, Pratt, & McClelland, 2014).

Both methods of assessing self-regulation have been significantly related to academic achievement (e.g., Allan et al., 2014; Nathanson, Rimm-Kaufman, & Brock, 2009; Robson, Allen, & Howard, 2020; Wanless et al., 2011). In a recent meta-analysis, results showed no statistically significant differences in the associations between children's early self-regulation and later academic skills when self-regulation was measured using direct assessment or teacher-report (Robson et al., 2020). However, across both methods of assessing self-regulation, they found that self-regulation was more strongly associated with math skills than with early literacy skills. Some evidence suggests directly assessed self-regulation (using the HTKS task) to be an equal or better predictor of mathematics and literacy skills compared with teacher ratings (Matthews et al., 2009). Moreover, both methods of assessing self-regulation in preschool have been reported to predict reading comprehension two years later (Birgisdóttir, Gestsdóttir, & Thorsdóttir, 2015). Another study found that teacher-reported self-regulation was more strongly associated with early language, literacy, and reading skills, compared to directly assessed self-regulation (using the HTKS task), meanwhile, directly assessed self-regulation was the strongest predictor of math skills (Schmitt et al., 2014). These results provide some indications that direct assessments are more consistently related to children's math skills, and that both types of measurements are related to language skills and reading comprehension.

The two self-regulation assessments may represent different aspects of children's cognitive and behavioral functioning in different environments (Allan et al., 2014; Hofmann et al., 2012; Toplak et al., 2013). Thus, it may be useful to differentiate between these measurements as they may predict unique variance in academic outcomes.

1.2. Self-regulation, early language skills, and reading achievement

Self-regulation is related to knowledge acquisition more broadly but also to specific aspects of early language skills. For example, self-regulation facilitates the acquisition of phonological awareness and vocabulary knowledge in the early years by helping children focus, pay attention, and remember the meaning of sounds and words (Blair, Protzko, & Ursache, 2011; McClelland & Cameron, 2019). These early language skills, in turn, support the development of reading comprehension (Storch & Whitehurst, 2002).

Studies using direct assessment or teacher-report have demonstrated that early self-regulation predicts vocabulary (Bohlmann & Downer, 2016; Gestsdottir et al., 2014; Weiland, Barata, &

[1] In Norway, children attend Early Childhood Education and Care (ECEC) centers until they are six years old. Although Norwegian children do not attend kindergarten as it is known in the United States, for simplicity we use the name kindergarten as this study includes only the eldest children from the ECECs.

Yoshikawa, 2014), early literacy skills (Blair & Razza, 2007; Matthews et al., 2009; Schmitt et al., 2014; Welsh, Nix, Blair, Bierman, & Nelson, 2010), and early reading achievement (Birgisdóttir et al., 2015; Hernández et al., 2018; Welsh et al., 2010). However, others have not found effects from directly assessed self-regulation to vocabulary (Cameron Ponitz, McClelland, Matthews, & Morrison, 2009; Fuhs & Day, 2011), or early literacy skills (Cameron Ponitz et al., 2009; Hubert, Guimard, Florin, & Tracy, 2015; Schmitt, Geldhof, Purpura, Duncan, & McClelland, 2017), and nor from teacher-reported self-regulation to vocabulary (von Suchodoletz et al., 2013), or some early literacy skills (Blair & Razza, 2007). Thus, prior findings are inconsistent, which might be caused by study-specific factors such as choice of measurements, differences in aspects of early literacy, number and choice of control variables, and characteristics of the sample (e.g., age, socioeconomic background, and culture).

As children gain experience with reading in the early to mid-elementary grades, the cognitive demands, such as self-regulation, for reading words and sentences lessen as it is supported by already acquired and automated aspects of reading (e.g., vocabulary knowledge and phonological awareness) (Blair et al., 2011). However, to comprehend a series of sentences, hold the already-read text in short-term memory while drawing inferences for what may come next, may still, in addition to the acquired and automated aspects of reading require self-regulation (Blair & Razza, 2007; Blair et al., 2011; Sesma, Mahone, Levine, Eason, & Cutting, 2009). A few studies have found that teacher-reported self-regulation in kindergarten predicted reading achievement later in elementary school (G. J. Duncan et al., 2007; McClelland et al., 2006).

Considering that self-regulation may provide a foundation for learning vocabulary and phonological awareness skills, self-regulation may have an indirect effect on later reading comprehension through these skills (Blair & Razza, 2007; Bohlmann & Downer, 2016; G. J. Duncan et al., 2007; Gurlitt & Renkl, 2010; McClelland et al., 2014; Welsh et al., 2010). Some studies (ten Braak, Kleemans, Størksen, Verhoeven, & Segers, 2018; van de Sande, Segers, & Verhoeven, 2013) have found that phonological awareness mediated the relation between directly assessed self-regulation and later reading skills whereas others have not (e.g., Hubert et al., 2015).

Taken together, research points to a predictive role of early self-regulation for future vocabulary, phonological awareness skills, and reading achievement, but results from previous studies are mixed and may have depended on the type of task that has been used (direct vs. teacher-reported). Moreover, few studies have investigated the unique direct and indirect pathways from directly assessed and teacher-reported early self-regulation, to reading achievement measured later in elementary school.

1.3. Self-regulation, early math skills, and math achievement

Demonstrating proficiency in math achievement requires consistent and ongoing demands on self-regulation. For example, partial results must be stored in working memory and retrieved or replaced when necessary (Bull & Lee, 2014; Van der Ven, Kroesbergen, Boom, & Leseman, 2012). Further, inhibitory control may suppress inappropriate strategies, such as the use of addition when subtraction is required, and cognitive flexibility may help to shift between operations, solution strategies, quantity ranges, and notations (Bull & Lee, 2014). Neuro-scientific work has demonstrated that similar brain regions (e.g., prefrontal cortex) are important for solving math problems and completing self-regulation tasks (Blair & Razza, 2007).

Previous research found that various aspects of directly assessed self-regulation positively predicts children's math skills in preschool (McClelland et al., 2014), kindergarten (Blair & Razza, 2007; Brock, Rimm-Kaufman, Nathanson, & Grimm, 2009; Cameron Ponitz et al., 2009; McClelland et al., 2014; Welsh et al., 2010), and first grade (Hernández et al., 2018; ten Braak et al., 2018). Teacher-reported self-regulation has also been found to significantly predict math skills in kindergarten (Blair & Razza, 2007; Matthews et al., 2009) and first grade (Gestsdottir et al., 2014). A meta-analysis (Allan et al., 2014) showed that across all methods of measuring self-regulation, self-regulation was strongly associated with mathematics among children in preschool and kindergarten age. Moreover, studies using teacher-reported self-regulation, have demonstrated that self-regulation in kindergarten is a significant predictor of math achievement later in elementary school (G. J. Duncan et al., 2007; McClelland et al., 2006). Few studies, however, have investigated whether early self-regulation predicts math achievement more than four years after school entry and whether directly assessed and teacher-reported self-regulation shows unique associations over and above the other.

Self-regulation may also contribute to the development of later math achievement, partly through its initial effect on early math skills. Studies investigating indirect effects show contradictory findings. One study (ten Braak et al., 2018) found a direct effect from directly assessed self-regulation in kindergarten on mathematics in first grade, but no significant indirect effect via math skills in kindergarten. In contrast, another study only found an indirect effect from directly assessed self-regulation in preschool on first grade math skills through preschool math skills (Hubert et al., 2015). So although evidence for a direct pathway between self-regulation and mathematics has been found in previous research, results regarding indirect pathways are inconclusive.

1.4. The Norwegian context

Different cultural and educational settings may affect children's development and learning (Bronfenbrenner & Morris, 2006). Norway and other Nordic countries have a high priority on social welfare and education policies regarding childhood and early education. In Norway, children attend Early Childhood Education and Care (ECEC) centers from one-to-two years of age and stay until the year they turn six years old and enter first grade. All children have the right to attend ECEC from age one year, and in 2011, 97% of the five-year-olds were in ECEC centers for six to eight hours per day, five days a week (Statistics Norway, 2012).

Norwegian ECEC is regulated by the *Framework Plan for the Content and Tasks of Kindergartens* (Norwegian Ministry of Education & Research, 2011). The Framework Plan reflects a play-based approach, which emphasizes holistic learning and children's desire and curiosity for learning (OECD, 2006). Children spend considerable time in outdoor play, 70% during the summer, and 31% during the winter (Moser & Martinsen, 2010). There is little emphasis on formal preparation for academic learning or self-regulation. In fact, the Norwegian Framework plan does not mention self-regulation as a concept. These characteristics in the Norwegian ECEC create a fairly abrupt transition for children who move from a play-based and relatively unstructured environment to a highly structured learning environment in first grade (OECD, 2006). For example, when children enter first grade, they are faced with formal instructions and are expected to work independently, stay on tasks, follow instructions, focus on academic tasks, and have goal-directed behavior. When the structure and the expectations vary as much as they do between kindergarten and first grade, the transition to school may be particularly challenging (McClelland et al., 2010; OECD, 2006) and require stronger self-regulation compared to kindergarten.

There is little research in Norway on children's self-regulation and later academic achievement. A recent study (ten Braak, Størksen, Idsoe, & McClelland, 2019), assessing the direction of

relations between directly assessed self-regulation and academic skills, showed that self-regulation and mathematics were bidirectionally related across the transition from kindergarten to first grade. Another study (Backer-Grøndahl, Nærde, & Idsoe, 2018) found that directly assessed self-regulation at four years predicted academic competence (sum score of math and reading) in first grade (6.4 years) and second grade (7.4 years) (controlling for first grade academic competence and relevant background variables). Results also indicated indirect effects as early self-regulation predicted academic competence in second grade through first grade academic competence. However, these studies did not investigate the role of early self-regulation on academic achievement later in elementary school, and did not include teacher-reported self-regulation.

1.5. The present study

The present study focused on the following research questions:

1) Do directly assessed and teacher-reported measures of self-regulation at the end of kindergarten (age 5–6 years) uniquely predict vocabulary, phonological awareness, and early math at the end of first grade (6–7 years), and do these measures of self-regulation in kindergarten and first grade uniquely predict reading comprehension and math achievement in fifth grade (9–10 years)?
2) Do directly assessed and teacher-reported measures of self-regulation at the end of kindergarten have unique indirect effects on reading comprehension and math achievement in fifth grade through first grade academic skills and measures of self-regulation?

First, although prior research is mixed on relations between directly assessed and teacher-rated measures of self-regulation and early language skills, we expected that both types of measures would uniquely predict children's language skills and reading comprehension in first and fifth grade, respectively (e.g., Birgisdóttir et al., 2015; Blair & Razza, 2007; Gestsdottir et al., 2014). Based on prior studies showing that directly assessed self-regulation is often a stronger predictor of math skills, compared to teacher-reports we expected that directly assessed self-regulation would account for more unique variance in first and fifth grade mathematics (Matthews et al., 2009; Schmitt et al., 2014). Second, we expected that children's self-regulation in kindergarten would indirectly predict reading comprehension and math achievement in fifth grade through first grade achievement. We also expected both self-regulation measures in kindergarten to indirectly predict reading comprehension in fifth grade through first grade skills but only the direct assessment of self-regulation to indirectly predict math achievement in fifth grade.

2. Method

2.1. Participants

Data in this study derive from the Skoleklar [School readiness] research project. The project was approved by the Norwegian Centre for Research Data (NSD). All children (N = 287) who were in their last year of kindergarten in a municipality in the Norwegian west coast were invited to participate. A total of 243 children (84.7%) had parental consent to participate. Among these, there were 119 girls (49%) and 124 boys (51%), attending 19 kindergarten centers. For more details of this sample, see previous description (Størksen, Ellingsen, Wanless, & McClelland, 2015). The mean age of the children at the first data collection point (spring of the last year of kindergarten; 2012) was 5.8 years, ranging from 5.3 to 6.3 years (SD = 0.29). Mothers had a median education level of 3 at the first data collection point, which was one-to-two years of college/university. Mother's education was reported as follows: 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%), 5 = more than three years of college/university education (25.4%). 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, which suggests that our sample was relatively representative of the Norwegian population (Statistics Norway, 2015). In this sample, parents were born in 21 different countries in addition to Norway. Thirteen children (5.3%) had a background where both parents were born in another country than Norway. These were coded as immigrants, and they included five children (2.0%), whose both parents were born in the EU/EEA, USA, Canada, Australia or New Zealand, and eight children (3.3%) whose both 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. All children had attended kindergarten for at least one year and spoke Norwegian. Mothers with immigrant status had a mean education level of 2.46 compared to a mean level of 3.32 for the other mothers.

The present study had three time points of data collection. The first data collection was during the spring of kindergarten, the second was during the spring of first grade, and the third was during the fall of fifth grade. After the first data collection point, three children moved, leaving a sample of 240 children at the second data collection point. At the third data collection point, we collected new parental consents, which resulted in some attrition from the study and left a sample size of 160 (see attrition analyses below), attending eight different schools.

2.2. Missing data

In this study, there was a very close collaboration with the municipality, the kindergarten centers, and the schools in the first two data collection points. The close collaboration ensured that the rate of missing data was low, from 0.0 to 4.1 % for all variables from kindergarten to first grade. During fall 2016, we extended the dataset with National assessment scores in reading comprehension and math achievement from fifth grade. Reading comprehension in fifth grade had 34.6% missing data and math achievement 34.2%. The new parent consent before the fifth grade data collection explains most of this attrition. We separated the missing and complete cases, and we examined group means differences in all variables included in the models. The examination indicated some systematic attrition. Children with missing values in fifth grade had significantly lower mean scores in math skills and vocabulary in kindergarten and phonological awareness skills, vocabulary, and teacher-reported self-regulation in first grade. Furthermore, children were less likely to remain in the study if they had parents reporting immigrant status, partly because some of these children lived in a neighboring municipality. In the kindergarten data collection, there were 13 children with immigrant status, and in fifth grade, only three of them were left.

Attrition can lead to biased parameter estimates. Thus, to account for missing data and to produce estimates with less bias and greater power, variables that were related to attrition were included in the model as predictors, control variables, or as auxiliary variables. Based on this, missing data were assumed to be missing at random (MAR). Additionally, we used full information maximum likelihood estimators (FIML) (Enders, 2010).

2.3. Procedure

In the two first data collections points (spring kindergarten and spring first grade), the test battery was administered individually with the use of computer tablets. The testing was carried out by testers (trained in a two-day course), and all tests were conducted in Norwegian. The parents reported education level, immigrant status, child age, and gender on a questionnaire in spring in the last year of kindergarten. Teachers in kindergarten and first grade completed questionnaires for individual children, including the Survey of Early Schools Adjustment Difficulty (Rimm-Kaufman, 2005), that was used to assess children's self-regulation in the classroom. Scores in reading comprehension and math achievement in the third data collection point, derived from National assessments that were carried out by the schools in collaboration with The Norwegian Directorate for Education and Training.

2.4. Measures

2.4.1. Self-regulation in kindergarten and first grade

2.4.1.1. Directly assessed self-regulation. Self-regulation was directly assessed with the Head-Toes-Knees-Shoulders task (HTKS; McClelland et al., 2014). The test is a short game appropriate for children age 4–8 years and includes three parts, each with ten items. The first part requires children to touch the opposite body part of what is presented to the child. For example, when the instructor says, "touch your toes," the child must touch his or her head and vice versa. In the second part, knees and shoulders are added, and in the third part, the rules are switched. This task requires children to integrate several executive function skills, namely (1) paying attention to the instructions, (2) using working memory to remember and execute new rules, and (3) using inhibitory control through inhibiting the natural response to the instructor's command (McClelland et al., 2014). The scoring system is 2 points for a correct response, 1 point for a self-correct response, and 0 for an incorrect response. In the present study, we only had the sum scores of the three different parts; thus, it was not possible to calculate the reliability. However, the HTKS has shown good psychometric properties in previous studies conducted in the U.S., Asia, and Europe (Cameron Ponitz et al., 2009; von Suchodoletz et al., 2013; Wanless et al., 2013), with Cronbach's alpha reliability ranging from .92 to .94 (McClelland et al., 2014). It has also been used in a previous Norwegian study investigating the influence of parental socioeconomic background and gender on 5-year olds self-regulation (Størksen et al., 2015). Scores ranged from 0 to 60 (including 30 test questions and, each scored 0–2 points).

2.4.1.2. Teacher-reported self-regulation. Self-regulation was also assessed through teacher-report on the Survey of Early Schools Adjustment Difficulty (ESAD; Rimm-Kaufman, 2005). This scale contains 11 items and is designed to assess children's adjustment to the classroom environment. Thus, the survey is broadly focused on self-regulation in the classroom over time and does not explicitly focus on working memory, attention, and inhibitory control. Statement examples are; "this child has shown difficulty following directions," and "this child has shown difficulty taking turns or waiting until his/her turn to speak." Teachers responded to these statements for each child using a 5-point scale ranging from 1 (no, not at all true) to 3 (sometimes true) to 5 (yes, very true). The reliability (Cronbach's alpha) was .91 in kindergarten and .93 in first grade. In order to have a scale that reflected positive self-regulation in the classroom, we reversed all items after the data were entered. Teacher-reported self-regulation (ESAD) and directly assessed self-regulation (HTKS) correlated significantly in kindergarten (r = .32, p < .001) and first grade (r = .34, p < .001).

2.4.2. Academic skills in kindergarten and first grade

2.4.2.1. Vocabulary. Expressive vocabulary was tested with the Norwegian Vocabulary Test (NVT; Størksen, Ellingsen, Tvedt, & Idsøe, 2013) in kindergarten and first grade. NVT is a naming test where an illustration appeared on the tablet computer screen, and the child was subsequently asked to name it. The test has 45 items, and the reliability was α = .84 in kindergarten and α = .82 in first grade.

2.4.2.2. Phonological awareness. This skill was assessed in kindergarten and first grade using a blending test taken from the official screening battery from Norwegian Directorate for Education and Training (2012a). The test has 12 items of increasing difficulty and was automatically discontinued after three following errors. Children were required to blend separately pronounced phonemes into the corresponding whole word. For example, "here you see an illustration of /h u s/ - /m u r/ - /m u s/ - /p u s/ (house, wall, mouse, cat in English). Your task is to touch one of these illustrations after I tell you which one. I am going to say the word in a strange way because I pronounce one sound at a time. Listen carefully and touch the illustration that goes with /p/-/u/-/s/." Reliability (Cronbach's alpha) for this task is α = .75 (Solheim, Brønnvik, & Walgermo, 2013).

2.4.2.3. Early math. Math skills in kindergarten and first grade were assessed with the Ani Banani Math Test (ABMT; Størksen & Mosvold, 2013). The test is administered on a tablet and has 18 items, which include 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. It assesses three overlapping math areas: problem-solving, geometry, and numeracy. Reliability was satisfactory, with α = .73 in kindergarten and α = .68 in first grade. The task has shown strong psychometric properties (Størksen & Mosvold, 2013) and correlated r = .74 (unpublished data) with another validated early numeracy task, the Early Numeracy Test (Van Luit & Van De Rijt, 2009) in kindergarten and r = .69 (unpublished data) with an existing teacher administered math assessment in first grade (Norwegian Directorate for Education & Training, 2012b).

2.4.3. Academic achievement in fifth grade

2.4.3.1. Reading comprehension. Reading comprehension was assessed in fall 2016 by a mandatory National assessment of reading comprehension (Norwegian Directorate for Education & Training, 2016b). The test is conducted on a computer, and it is constructed to assess how students use reading in different academic contexts and everyday situations. Students are given ample time (90 min) to complete the assessment. The questions are designed to assess three different reading skills: (1) Find information in texts, (2) Interpret and compare information, and (3) Reflect on and evaluate the form and content of the texts. The test has five texts, and each text is followed by multiple-choice on a computer. There are five to seven items per text, with a total of 30 items.

2.4.3.2. Math achievement. Math achievement was assessed in fall 2016 by a mandatory National assessment (Norwegian Directorate for Education & Training, 2016a). This test has 45 items (90 min) and focuses on how students use math skills in academic and everyday contexts and assesses three different math aspects: (1) Numeracy, and how students manage to use the four arithmetical operations, (2) Measuring and geometry (e.g., length, area, volume, angle, mass, time, and scale), and (3) Statistics (e.g., ability to organize, analyze, present and evaluate data, tables, and charts.

Table 1
Descriptive statistics.

Measure	N	M	SD	Skewness	Kurtosis	Min	Max
Child age, years T1	242	5.79	0.29	.06	−1.16	5.29	6.30
Percent of male	241	50.2%					
Mother's education level	240	3.28	1.30	.09	−1.54	1	5
Percent of immigrants	237	5.3%					
Phonological awareness[a] T1	240	3.66	3.39	.59	−.91	0	12
Phonological awareness[a] T2	233	10.21	1.92	−1.75	3.98	1	12
Expressive vocabulary[b] T1	241	26.35	5.70	−.42	−.16	10	39
Expressive vocabulary[b] T2	239	30.72	4.97	−.63	.44	14	42
Mathematics[c] T1	241	10.62	3.13	−.32	−.19	2	18
Mathematics[c] T2	239	14.52	2.57	−1.01	1.18	5	18
Self-regulation, directly assessed[d] T1	241	34.46	15.67	−.62	−.40	0	60
Self-regulation, directly assessed[d] T2	239	47.48	9.83	−1.73	5.31	0	60
Self-regulation, teacher-reported[e] T1	243	4.32	.83	−1.35	.97	1.64	5.00
Self-regulation, teacher-reported[e] T2	240	4.39	.86	−1.57	1.84	1.18	5.00
Reading comprehension[f] T3	159	49.89	9.94	.13	−.65	26	74
Mathematical achievement[g] T3	160	50.88	9.75	.26	−.24	28	78

Note: T1 = kindergarten, T2 = first grade, T3 = fifth grade. Mother's education was coded: 1 = junior high school, 2 = senior high school, 3 = 1–2 years of college/university, 4 = 3 years of college/university education, 5 = more than 3 years of college/university education. Immigrant status was coded: 1 = children with both parents born in another country than Norway, and 0 = all other children.

[a] Norwegian Blending Test.
[b] Norwegian Vocabulary Test.
[c] Ani Banani Math Test.
[d] Head-Toes-Knees-Shoulder Task.
[e] Survey of Early School Adjustment Difficulty (reversed).
[f] National Assessment on Reading Comprehension.
[g] National Assessment on Mathematical achievement.

2.4.4. Demographics

2.4.4.1. Covariates and auxiliary variables. These variables included mother's education level, immigrant status, gender, and age reported through a parental questionnaire in kindergarten. The mean score of the mother's education level was 3.28 at the first data collection point. Immigrant status was used as an auxiliary variable and coded as 1 = children with both parents born in another country than Norway (5.3%), and 0 = all other children.

2.5. Analytic strategy

Children were nested in eight different schools, so we calculated intra-class coefficients (ICC). ICCs represent the proportion of the total variability in the outcome that is attributable to the classes (Geiser, 2013). Phonological awareness in first grade had an ICC of .06. For all other variables, the ICCs ranged between 0.00−0.04. As the ICC was not substantial (Hox, 2002), analyses adjusting for potential nested effects were not considered. We estimated path models using Mplus software Version 7.3 (Muthén & Muthén, 1998-2015Muthén & Muthén, 1998-2015). The path models included variables from all three data collection points, and separate models were conducted for the content areas of reading comprehension and math achievement. Because previous research (Hernández et al., 2018; McKinnon & Blair, 2018; ten Braak et al., 2019) suggests the possibility of bidirectional effects between self-regulation and early language and math skills across the transition from kindergarten to first grade, all variables were set as predictors of the outcome variables in first and fifth grade. Thus, initially, we estimated saturated path models in which all exogenous variables and covariates were allowed to affect one another and the outcome variables. Covariances between the exogenous variables, and residual covariances between the intermediate variables were included in model estimation. For the sake of parsimony, we eliminated one by one, all paths that were not statistically significant at the .05 probability level. We evaluated the fit of the models after the trimming, and the following fit indices and criteria were used: p-value $\chi^2 > .05$, CFI, and TLI $\geq .95$, RMSEA $\leq .06$ and SRMR $\leq .08$ (Hu & Bentler, 1999). The reduced path model was compared to the saturated model by using a chi-square difference test. The indirect effects were tested using the model indirect command in Mplus and bootstrapping process procedure (Hayes, 2012).

3. Results

The present study investigated pathways from children's early self-regulation to first grade and fifth grade academic achievement. Table 1 and Table 2 presents descriptive statistics and correlations, respectively, for all variables. As can be seen in Table 1, the shape of the distribution of the data was not severely non-normal (Kline, 2016). Robust maximum likelihood (MLR) was used to deal with outliers and non-normal distributions in the data in the further path analyses in Mplus (Muthén & Muthén, 1998-2015Muthén & Muthén, 1998-2015). The variance inflation factor values were all below ten, indicating that multicollinearity was not a problem within the data (Field, 2013).

The self-regulation measures in kindergarten were positively correlated with all first grade academic skills (Table 2). The weakest correlation was between teacher-reported self-regulation in kindergarten and phonological awareness in first grade (r = .28, p < .001), and the strongest was between directly assessed self-regulation in kindergarten and math scores in first grade (r = .48, p < .001). The self-regulation measures in kindergarten and first grade all correlated with fifth grade achievement, ranging from r = .32, p < .001 for the correlations between directly assessed self-regulation in kindergarten and fifth grade reading comprehension and math achievement, to r = .48, p < .001 for the correlation between directly assessed self-regulation in first grade and fifth grade math achievement.

3.1. Self-regulation, early language skills, and reading achievement

The fit of the trimmed model for reading comprehension (Fig. 1)[2] was good, χ^2 (22) = 19.74, p = .60, RMSEA = .000, CFI = 1.000, TLI =

[2] Nonsignificant paths are excluded and significant covariates are not displayed in Fig. 1 and Fig. 2

Table 2
Correlations for all study variables. N = 243.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.
1. Child age	–															
2. Gender	−.03	–														
3. Mother's education level	.04	−.07	–													
4. Immigrant status	−.01	.09	−.15*	–												
5. Phono. awareness[a] T1	.20**	−.28***	.20**	−.09	–											
6. Expressive voc.[b] T1	.14*	−.12	.28***	−.41***	.41***	–										
7. Mathematics[c] T1	.18**	−.17**	.29***	−.07	.40***	.46***	–									
8. SR, directly assessed[d] T1	.14*	−.23***	.13*	−.06	.38***	.33***	.48***	–								
9. SR, teacher-reported[e] T1	.13*	−.30***	.23***	−.12	.28***	.30***	.36***	.32***	–							
10. Phono. awareness[a] T2	.07	−.27***	.17*	−.14*	.40***	.40***	.35***	.31***	.23**	–						
11. Expressive voc.[b] T2	.12*	−.11	.31***	−.40***	.34***	.82***	.43***	.30***	.24***	.35***	–					
12. Mathematics[c] T2	.12	−.16*	.32***	−.05	.41***	.40***	.67***	.48***	.39***	.37***	.40***	–				
13. SR, directly assessed[d] T2	.06	−.08	.20***	.05	.20***	.32***	.44***	.38***	.30***	.31***	.30***	.46***	–			
14. SR, teacher-reported[e] T2	.11	−.30***	.22**	−.13	.23***	.24***	.41***	.32***	.70***	.24**	.19**	.43***	.34***	–		
15. Reading[f] T3	.03	−.14	.35***	−.23***	.34***	.50***	.51***	.32***	.36***	.27**	.44***	.50***	.38***	.40***	–	
16. Mathematics[g] T3	.01	−.07	.32***	.04	.26***	.37***	.61***	.32***	.39***	.27***	.35***	.62***	.48***	.36***	.67***	–

Note. T1 = kindergarten, T2 = first grade, T3 = fifth grade, SR = self-regulation. Gender was coded: 1 = girls, and 2 = boys. Immigrant status was coded: 1 = children with both parents born in another country than Norway, and 0 = all other children.

* $p < .05$.
** $p < .01$.
*** $p < .001$.
[a] Norwegian Blending Test.
[b] Norwegian Vocabulary Test.
[c] Ani Banani Math Test.
[d] Head-Toes-Knees-Shoulder Task.
[e] Survey of Early School Adjustment Difficulty (reversed).
[f] National Assessment on Reading Comprehension.
[g] National Assessment on Math achievement.

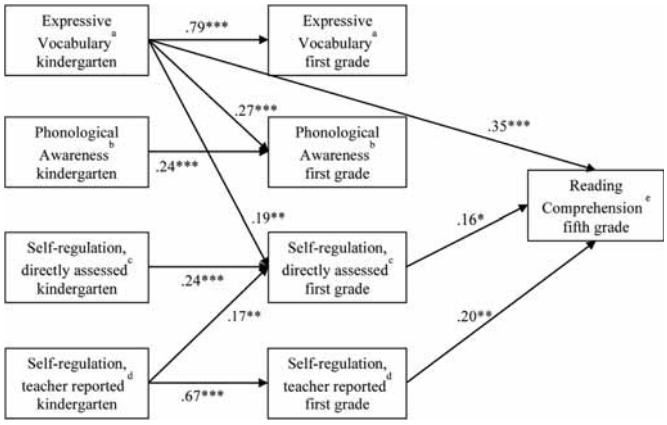

Fig. 1. Directly assessed and teacher-reported self-regulation predicting first grade vocabulary and phonological awareness, and fifth grade reading comprehension when accounted for all other factors in the model (including covariates). [a] Norwegian Vocabulary Test, [b] Norwegian Blending Test, [c] Head-Toes-Knees-Shoulder Task, [d] Survey of Early School Adjustment Difficulty (reversed), [e] National Assessment on Reading Comprehension. Covariates: age, gender, and mother's education are included in the model but are not displayed for reasons of clarity. Covariances between the exogenous variables and residual covariances between the intermediate variables were included in model estimation. All paths that were not statistically significant at the .05 probability level were eliminated from the model. Auxiliary variable: Immigrant status.

1.007, SRMR = .044. The chi-square difference test, using Satorra-Bentler correction due to the MLR estimator (Muthén & Muthén, 2018), showed that the trimmed model did not have a significantly worse fit compared to the saturated model, $\Delta\chi^2$ (22) = 19.74, p = .599. Directly assessed and teacher-reported self-regulation in kindergarten did not significantly predict first grade vocabulary or phonological awareness, and they had no significant direct effects on fifth grade reading comprehension. However, teacher-reported self-regulation in kindergarten had a significant indirect effect on fifth grade reading comprehension through teacher-reported self-regulation in first grade (β = .13, 95% CI [0.38, 2.91]). Finally, directly assessed (β = .16, p = .015) and teacher-reported self-regulation (β = .20, p = .004) in first grade were significant predictors of reading comprehension in fifth grade, while controlling for all other variables in the model.

Regarding covariates, child age did not significantly predict any of the variables and was therefore excluded from the model. Being a boy had significantly negative effect on kindergarten phonological awareness (β = −.24, p < .001), directly assessed (β = −.20, p = .001) and teacher-reported (β = −.27, p < .001) self-regulation, first grade phonological awareness (β = −.18, p < .001) and teacher-reported self-regulation (β = −.10, p = .028). Mother's education had a significant positive effect on kindergarten phonological awareness (β = .15, p = .010), vocabulary (β = .25, p < .001), teacher-reported self-

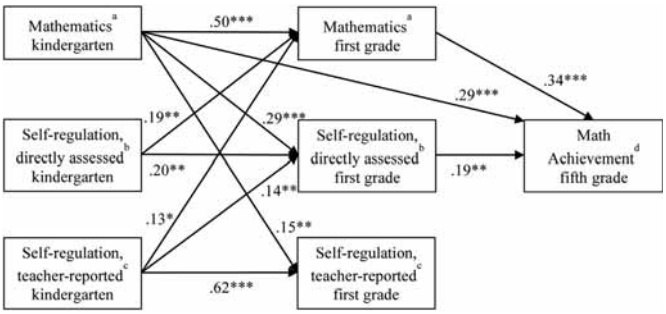

Fig. 2. Directly assessed and teacher-reported self-regulation predicting first grade math skills and fifth grade math achievement when accounted for all other factors in the model (including covariates). [a] Ani Banani Math Test, [b] Head-Toes-Knees-Shoulder Task, [c] Survey of Early School Adjustment Difficulty (reversed), [d] National Assessment on Math Achievement. Covariates: age, gender, and mother's education are included in the model but are not displayed for reasons of clarity. Covariances between the exogenous variables and residual covariances between the intermediate variables were included in model estimation. All paths that were not statistically significant at the .05 probability level were eliminated from the model. Auxiliary variable: Immigrant status.

regulation (β = .19, p < .001), first grade vocabulary (β = .09, p = .021) and fifth grade reading comprehension (β = .21, p = .002).

3.2. Self-regulation, early math skills, and math achievement

The fit of the trimmed model for math achievement (Fig. 2) was good, χ^2 (11) = 14.38, p = .21, RMSEA = .036, CFI = .995, TLI = .983, SRMR = .040. The trimmed model did not have a significantly worse fit compared to the saturated model, $\Delta\chi^2$ (11) = 14.38, p = .213 (Muthén & Muthén, 2018). Directly assessed (β = .19, p = .001) and teacher-reported self-regulation (β = .13, p = .019) in kindergarten significantly predicted first grade math skills, while controlling for kindergarten mathematics. None of the self-regulation measures in kindergarten had a significant direct effect on fifth grade math scores. However, directly assessed self-regulation in kindergarten had a significant indirect effect on math achievement in fifth grade, through math skills (β = .06, 95% CI [0.01, 0.07]), and directly assessed self-regulation (β = .04, 95% CI [0.00, 0.05]) in first grade. Moreover, directly assessed self-regulation in first grade (β = .19, p = .002), but not teacher-reported self-regulation, significantly predicted math achievement in fifth grade, while all other variables in the model were accounted for (Fig. 2).

After the trimming procedure, child age did not significantly predict any of the variables and thus, was excluded from the model. Boys had significantly lower math scores (β = −.15, p = .015), directly assessed (β = −.23, p < .001) and teacher-reported (β = −.29, p < .001) self-regulation in kindergarten, and teacher-reported self-regulation (β = −.09, p = .044) in first grade. Mother's education had a significant positive effect on kindergarten math skills (β = .24, p < .001), teacher-reported self-regulation (β = .19, p < .001), and on first grade math skills (β = .11, p = .024).

4. Discussion

The present study examined pathways from directly assessed and teacher-reported self-regulation to vocabulary, phonological awareness, and math skills in first grade, and reading comprehension and math achievement in fifth grade. The study was conducted in a society with a play-based pedagogical approach in kindergarten, where the transition to a structured learning environment in first grade may require strong demands on children's self-regulation. Path models showed that children's self-regulation in kindergarten significantly predicted math skills in first grade, and self-regulation in first grade predicted reading comprehension and math achievement in fifth grade. Indirect effects were also found where associations between self-regulation and academic skills were dependent on the type of self-regulation measure and outcome domain.

4.1. Self-regulation, early language skills, and reading achievement

Consistent with previous literature, we found that directly assessed, and teacher-reported self-regulation in first grade uniquely predicted fifth grade reading comprehension while controlling for prior self-regulation, background variables, and previous academic skills (Birgisdóttir et al., 2015; G. J. Duncan et al., 2007; McClelland et al., 2006). Although both self-regulation measures in kindergarten were significantly associated with fifth grade reading comprehension, there were no significant direct effects on reading comprehension in fifth grade. The inclusion of first grade self-regulation and academic skills in the path model may explain the lack of significant paths because previous research has shown that skills measured later are better predictors (G. J. Duncan et al., 2007; Welsh et al., 2010). However, we did find an indirect effect from teacher-reported self-regulation in kindergarten to reading comprehension through first grade teacher-reported self-regulation. Neither directly assessed nor teacher-reported self-regulation in kindergarten uniquely predicted vocabulary and phonological awareness in first grade, when controlling for prior language skills and covariates.

Regarding the indirect effect from teacher-reported self-regulation to reading comprehension through first grade teacher-reported self-regulation, one interpretation may be that children performing high on teacher-reported self-regulation in the play-based and less structured kindergartens adapted more easily to the structured learning environment in first grade. Children's ability to regulate their behavior in the first grade classroom context may, in turn, have led to higher teacher-reported self-regulation at the end of first grade, compared to their less self-regulated peers. It is also possible that children's early self-regulation predicted later self-regulation in a knowledge begets knowledge way. Thus, early self-regulation helped children do better on subsequent self-regulation. When children are highly regulated in the classroom, they, for example, work independently, execute goals and stay on tasks, and do not get distracted by peers. Thus, it is easier for children to focus and persist on reading tasks during subsequent school years, including doing better on reading comprehension in fifth grade. Prior research has reported that children low on teacher-reported self-regulation also had less school engagement, which in

turn led to lower academic outcomes (Portilla, Ballard, Adler, Boyce, & Obradović, 2014).

In line with prior research (Birgisdóttir et al., 2015) and our hypotheses, both self-regulation assessments in first grade uniquely predicted fifth grade reading comprehension. These results suggest that in addition to children's ability to regulate their behavior in the social classroom context over time, the cognitive demands of the HTKS task were likely needed for reading comprehension. These cognitive processes, including attentional or cognitive flexibility, working memory, and inhibitory control, may help children comprehend a sentence or series of sentences and draw inferences for what may come next (Blair et al., 2011; Sesma et al., 2009). For example, a recent review suggested that working memory supports the reader's comprehension by maintaining the activation of relevant information in working memory, inhibitory control supports it by suppressing the activation of irrelevant text information, and cognitive flexibility supports comprehension by flexible allocating attention to features of the text and reading strategies (Butterfuss & Kendeou, 2018).

Contrary to our expectations based on prior findings showing that both types of self-regulation assessments have predicted early language skills (Blair & Razza, 2007; Bohlmann & Downer, 2016; Gestsdottir et al., 2014; Matthews et al., 2009; Weiland et al., 2014), we found no significant effects from directly assessed and teacher-reported self-regulation in kindergarten to first grade vocabulary and phonological awareness. However, our results are in line with some prior studies (Fuhs & Day, 2011; McClelland et al., 2007), finding that the predictive role of self-regulation for vocabulary and early literacy skills became nonsignificant when controlling for prior achievement.

Our findings may suggest that children's vocabulary and phonological awareness become more automatized by the end of first grade and requires less self-regulation (Blair et al., 2011). However, the lack of significant paths from self-regulation in kindergarten to vocabulary in first grade may also reflect that children's vocabulary was highly stable from kindergarten to first grade, which left little variance to be accounted for by other variables, such as self-regulation. The strong stability between vocabulary in kindergarten and first grade means that the rank-order was already established in kindergarten, which may also explain why vocabulary in first grade (e.g., residual change) did not significantly predict reading comprehension in fifth grade over and above vocabulary in kindergarten. This was supported by further examinations showing that first grade vocabulary significantly predicted fifth grade reading comprehension without kindergarten vocabulary in the model.

In terms of phonological awareness, another possible explanation for the lack of significant paths is that the phonological awareness measure in first grade had a slight ceiling effect and a more restricted range. This may, in turn, lead to underestimated effects (Hessling, Traxel, & Schmidt, 2004). Moreover, we controlled for age, gender, and maternal education because previous research has shown that they are related to children's self-regulation and academic outcomes (McClelland et al., 2014; Størksen et al., 2015). However, controlling for these variables may have also controlled for true sources of variance in self-regulation. For example, controlling for gender may have attenuated the effect of self-regulation in kindergarten on first grade phonological awareness because girls have both better self-regulation in kindergarten and better phonological awareness in first grade. In line with recent research in Norway (ten Braak et al., 2019), the inclusion of vocabulary in the model may have attenuated how both types of self-regulation in kindergarten predicted phonological awareness in first grade. The models in the present study were based on previous research and a priori predictions, but these issues should be investigated in future research.

4.2. Self-regulation, early math skills, and math achievement

Consistent with prior research (Allan et al., 2014; Blair & Razza, 2007; Brock et al., 2009; Gestsdottir et al., 2014; Matthews et al., 2009), results showed that both measures of self-regulation in kindergarten were significant predictors of first grade math skills. The direct assessment of self-regulation also had an indirect effect on fifth grade math achievement through first grade mathematics and directly assessed self-regulation. Moreover, directly assessed self-regulation in first grade significantly predicted fifth grade math achievement while controlling for prior self-regulation, background variables, and previous math skills.

Contrary to the results for first grade language skills, both self-regulation assessments in kindergarten uniquely contributed to math skills in first grade. These results are consistent with prior research showing that self-regulation (both directly assessed and teacher-reported) is significantly more strongly associated with math skills than language skills in preschool and kindergarten age (Allan et al., 2014). The fact that both methods of assessing self-regulation predicted first grade mathematics over and above each other, may indicate that children's cognitive capacity, as well as their adjustment to the learning environment in first grade, are essential for acquiring math skills. The unique contribution from teacher-reported self-regulation, even when the direct assessment was included in the model, may be related to the structural changes and new social expectations that children experience in the transition from the play-based environment in kindergarten to the structured learning environment in first grade. Children with weak self-regulation may struggle to meet these new demands in school (e.g., to raise their hand, wait for a turn, and to be less physically active). In contrast, highly self-regulated children may adapt more easily to first grade, which in turn helps them take advantage of instruction in mathematics.

Having the cognitive self-regulatory abilities, as measured by the direct assessment, may be especially important in the transition from kindergarten to first grade in Norway since planned math activities are not highly prioritized in kindergarten (Østrem et al., 2009). Thus, the differences in academic focus in kindergarten and first grade may require high levels of the cognitive processes involved in self-regulation to cope with new math tasks and concepts introduced in first grade. It is critical to acquire math skills during first grade because these skills tend to be stable over time (G. J. Duncan et al., 2007).

In line with prior research (Hubert et al., 2015), we found that children with high scores on directly assessed self-regulation in kindergarten performed better on the math task and directly assessed self-regulation in first grade, which in turn led to higher scores in fifth grade mathematics. This supports other research suggesting the importance of early self-regulation for later achievement where self-regulation may give children the skills they need to be strong in math in first and fifth grade. For example, mathematics likely makes consistent, ongoing demands on higher-order reasoning ability where children cannot rely on automatized skills (Blair et al., 2011) and therefore require strong self-regulation (Bull & Scerif, 2001).

Our findings also support research reporting that links between self-regulation and mathematics were stronger for directly assessed self-regulation than for teacher-reported self-regulation (Schmitt et al., 2014). The lack of significant paths from children's teacher-reported self-regulation in the classroom on fifth grade mathematics suggests that the complex cognitive abilities (e.g., higher demands on working memory) tapped by the direct assessment were most related to later math achievement (Matthews et al., 2009; Schmitt et al., 2014). The complex cognitive skills, as measured in the HTKS task, are similar skills to what is needed to solve math problems, that is, to pay attention to the problem,

remember mathematical rules and concepts, keep information in mind, inhibit wrong strategies, and quickly switch to the right strategies (Bull & Scerif, 2001; Schmitt et al., 2014).

4.3. Unique contributions from directly assessed and teacher-reported self-regulation

The present study found that directly assessed and teacher-reported self-regulation uniquely predicted later academic outcomes. The unique contributions from the two self-regulation assessments may be related to the assessment contexts (Allan et al., 2014). Our results show that the direct assessment of self-regulation primarily captures the cognitive processes (EF) involved in self-regulation. In contrast, the teacher-report, to a greater extent, captures the multidimensional self-regulation construct that is needed when adjusting to a complex classroom context (Allan et al., 2014; McClelland et al., 2014; Toplak et al., 2013). Thus, it is essential to differentiate between these methods as they provide unique information about different aspects of children's self-regulation. However, further research is needed to extend the knowledge of the potential mechanisms related to how self-regulation assessments are related to different academic domains at different ages.

4.4. Practical implications

The present study indicates that promoting children's self-regulation in the Norwegian kindergarten and first grade, in addition to academic skills, may provide an important basis for the successful development of reading comprehension and math achievement throughout elementary school. Specifically, results from the present study suggest that it is essential to teach young children strategies to use their self-regulation in the social context of the classroom to promote their ability to benefit from math instructions in first grade and work independently and focus on reading tasks. Furthermore, children who struggle with mathematics and reading comprehension may benefit from a focus on working memory, inhibition, and shifting abilities as a means of improving their skills. Thus, teachers need knowledge and competence that enables them to enhance children's self-regulation in their classrooms, provide scaffolding for those who are less self-regulated, and organize engaging self-regulation games and activities (e.g., McClelland & Tominey, 2015). Prior research from samples with a school readiness approach has found that an intervention including games targeting self-regulation led to improvements in self-regulation and early academic outcomes in preschool children (R. J. Duncan, Schmitt, Burke, & McClelland, 2018; McClelland et al., 2019; Schmitt, McClelland, Tominey, & Acock, 2015; Tominey & McClelland, 2011).

The results of the present study are especially important in countries promoting play-based approaches like Norway because self-regulation is not highly emphasized in the Norwegian educational system. For example, The Framework Plan for Kindergartens in Norway (Norwegian Directorate for Education & Training, 2017; Norwegian Ministry of Education & Research, 2011) does not mention the concept of self-regulation. The plan has a child-directed approach and emphasizes free play, children's right to active participation, and their right to choose their activities, which are all essential factors for self-regulation (Center on the Developing Child at Harvard University, 2011; Engel, Barnett, Anders, & Taguma, 2015; Vygotsky, 1978). Still, this system may be most beneficial for highly self-regulated children because a certain level of self-regulation is needed to engage in meaningful learning activities and play with other children. Thus, it is essential to include the concept of self-regulation in guidelines to promote children's school success and encourage teacher education institutions to emphasize the importance of self-regulation.

It is also important, especially for children with weak self-regulation in kindergarten, and in countries with a play-based ECEC approach, that kindergartens and elementary schools collaborate to make the transition less challenging (Schleicher, 2019). One possibility is to develop early childhood curricula that emphasize school readiness skills, such as self-regulation and playful learning (Fisher, Hirsh-Pasek, Golinkoff, Dinger, & Berk, 2011; Lerkkanen et al., 2012; Rege et al., 2019). This can help bridge the gap from kindergarten to the first grade classrooms context, which is heavily based on teacher-directed practices.

4.5. Limitations and future directions

Overall, the present study extends existing research in several ways. First, it relies on a longitudinal data set spanning almost five years, with three assessment time points. This allows for the examination of long term direct and indirect associations between early self-regulation and later academic achievement. Second, the study includes two measures of self-regulation relying on two sources (direct assessment and teacher-report) that may capture different but related aspects of self-regulation. For example, the teacher-reported self-regulation was highly stable in the present study, even if it was rated by different teachers in kindergarten and first grade. This high stability suggests that the ability to regulate behaviors in complex real-life situations are relatively stable over time and across contexts. Finally, this study adds to our understanding of the role of self-regulation for later academic achievement in an educational system based on a play-based pedagogical approach in kindergarten.

There were, however, several limitations. First, although the longitudinal nature of the study was a strength, it led to some attrition, particularly between first and fifth grade. We accounted for missing data. Still, the results could be affected by attrition. Second, there were negatively skewed distributions on teacher-reported self-regulation in kindergarten and first grade and directly assessed self-regulation and phonological awareness in first grade. However, distributions were not severely skewed (skewness < 3), and robust methods were used to deal with violations of non-normality (Hessling et al., 2004).

Third, the stability of directly assessed self-regulation was relatively low compared to other studies using the same measurement on a similar age group (e.g., McClelland et al., 2014). However, the time elapsed from the first to second data collection point was 12 months, whereas it was six months in other studies (e.g., McClelland et al., 2014; Schmitt et al., 2017). The low stability could also reflect the inconsistent demand of children's self-regulation during a transition from an unstructured kindergarten environment to a much more structured first grade classroom.

Fourth, this study relied on a convenience sample. The sample was representative of the Norwegian population in terms of the mother's education level and children's academic skills in fifth grade. However, it was relatively homogenous in terms of ethnicity compared to many other western countries. It is important to keep this in mind as it may limit the generalizability of findings to more diverse populations. Finally, although our model represents causal pathways, it does not allow us to determine causality. We were interested in examining direct and indirect effects from early self-regulation to later academic skills. However, prior research (Bohlmann, Maier, & Palacios, 2015; Fuhs, Nesbitt, Farran, & Dong, 2014; Schmitt et al., 2017) and our recent work (ten Braak et al., 2019) has shown bidirectionality in self-regulation and certain academic skills across early childhood, and for this reason, we controlled for bidirectional pathways between kindergarten and first grade. In this study, self-regulation was not assessed in fifth grade,

and we can therefore not rule out the possibility that the association between self-regulation and academic skills may be bidirectional between first and fifth grade as well. Moreover, other factors not included in this study (e.g., listening comprehension) may account for some of the pathways between self-regulation and academic achievement. Research utilizing randomized control trials is needed to test the causal relationships between self-regulation and academic achievement.

4.6. Conclusion

Findings from the present study suggest that early self-regulation significantly predicts children's math skills in first grade, and their reading comprehension and math achievement in fifth grade. Our results indicate that the associations between self-regulation and academic skills were dependent on assessment timing, type of self-regulation measure, and outcome domain. The study highlights the importance of using both directly assessed and teacher-reported measures of self-regulation to better capture different aspects of self-regulation. Overall, our findings suggest that fostering the development of self-regulation in kindergarten and during first grade, in addition to early academic skills, can be important for later academic success.

Declaration of interest

None.

CRediT authorship contribution statement

Ragnhild Lenes: Conceptualization, Methodology, Formal analysis, Investigation, Writing - original draft, Writing - review & editing. **Megan M. McClelland:** Writing - review & editing, Supervision. **Dieuwer ten Braak:** Investigation, Writing - review & editing. **Thormod Idsøe:** Methodology, Formal analysis, Writing - review & editing. **Ingunn Størksen:** Funding acquisition, Conceptualization, Investigation, Writing - review & editing, Software, Data curation, Supervision.

Acknowledgments

This work was supported by the Norwegian Research Council through Grants 203326 and 237973. We are thankful to all children, parents and teachers who participated in this study.

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Study III

frontiers in Psychology

ORIGINAL RESEARCH
published: 29 September 2020
doi: 10.3389/fpsyg.2020.566208

Children's Self-Regulation in Norway and the United States: The Role of Mother's Education and Child Gender Across Cultural Contexts

Ragnhild Lenes[1], Christopher R. Gonzales[2], Ingunn Størksen[1] and Megan M. McClelland[3]*

[1]Norwegian Centre for Learning Environment and Behavioural Research in Education, University of Stavanger, Stavanger, Norway, [2]Center for Mind and Brain, University of California, Davis, Davis, CA, United States, [3]Human Development and Family Sciences, Oregon State University, Corvallis, OR, United States

Self-regulation develops rapidly during the years before formal schooling, and it helps lay the foundation for children's later social, academic, and educational outcomes. However, children's self-regulation may be influenced by cultural contexts, sociodemographic factors, and characteristics of the child. The present study investigates whether children's levels of self-regulation, as measured by the Head-Toes-Knees-Shoulders (HTKS) task, are the same in samples from Norway (M_{age} = 5.79; N = 243, 49.4% girls) and the United States (U.S.) (M_{age} = 5.65; N = 264, 50.8% girls) and whether the role of mother's education level and child gender on children's self-regulation differ across the two samples. Results showed that Norwegian and U.S. children had similar levels of self-regulation. Mother's education level significantly predicted children's self-regulation in the U.S. sample but not in the Norwegian sample, and this difference across samples was significant. Girls had a significantly higher level of self-regulation than boys in the Norwegian sample, but there were no gender differences in the U.S. sample. However, the effect of child gender on self-regulation did not differ significantly across the two samples. Results highlight the importance of cross-cultural studies of self-regulation.

Keywords: cross-cultural, self-regulation, school readiness, measurement, maternal education level, gender

OPEN ACCESS

Edited by:
Nicola K. Ferdinand, University of Wuppertal, Germany

Reviewed by:
Mariela Resches, Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Argentina
Maria Von Salisch, Leuphana University, Germany

****Correspondence:***
Ragnhild Lenes
ragnhild.lenes@uis.no

Specialty section:
This article was submitted to Developmental Psychology, a section of the journal Frontiers in Psychology

Received: *27 May 2020*
Accepted: *04 September 2020*
Published: *29 September 2020*

Citation:
Lenes R, Gonzales CR, Størksen I and McClelland MM (2020) Children's Self-Regulation in Norway and the United States: The Role of Mother's Education and Child Gender Across Cultural Contexts. Front. Psychol. 11:566208. doi: 10.3389/fpsyg.2020.566208

INTRODUCTION

In early childhood education and care (ECEC) contexts, children are socialized with peers through activities, such as social play, circle time, or waiting for a turn, which help them prepare for formal schooling. In these settings, children need to plan, cooperate, pay attention, inhibit impulses, and follow instructions. These behaviors depend on children's self-regulation, which is the capability of controlling or directing one's attention, thoughts, emotions, and actions (McClelland and Cameron, 2012). Self-regulation develops rapidly during the years before formal schooling (Center on the Developing Child at Harvard University, 2011), and children's early self-regulation is critical for the transition to school and future academic achievement (Blair and Razza, 2007; Duncan et al., 2007; Welsh et al., 2010; von Suchodoletz et al., 2013; McClelland et al., 2014; ten Braak et al., 2018), as well as long-term health and

educational outcomes (Moffitt et al., 2011; McClelland et al., 2013), income, and crime (Moffitt et al., 2011).

Most researchers suggest that children's development consists of complex and bidirectional interactions between the child and the social context over time (e.g., Shonkoff and Phillips, 2000; Sameroff, 2009). The bioecological model of development (Bronfenbrenner, 1979; Bronfenbrenner and Morris, 2006) is one of the prevailing theoretical frameworks (Bornstein and Leventhal, 2015) that help provide a foundation for understanding these interactions. These interactions are influenced by individual differences in the development of children's self-regulation, which can be explained by child characteristics (e.g., gender), socialization experiences, and sociodemographic factors (e.g., maternal education) (Eisenberg et al., 2014). Thus, for children growing up in different cultural contexts, such as Norway and the United States (U.S.), with different welfare systems, economic equality, availability of affordable ECEC, and a play-based vs. school readiness ECEC approach, the social experiences and the influence of maternal education and child gender may differ, which in turn may affect children's development (Bronfenbrenner and Morris, 2006; Trommsdorff, 2009). Most prior cross-cultural studies of self-regulation have compared Western and Asian cultures (e.g., Oh and Lewis, 2008; Wanless et al., 2011a; Schirmbeck et al., 2020). The present study contributes by comparing self-regulation in Norway and the U.S. Both countries are characterized by high-income with Western individualistic cultures but offer different organization of the welfare state and different perspectives on the ECEC (ten Braak et al., 2019).

Conceptual and Empirical Understandings of Self-Regulation

Different disciplines have taken a variety of approaches when investigating self-regulation and its related constructs (McClelland et al., 2014). Self-regulation is a multidimensional construct that broadly refers to the regulation of emotions, cognition, and behavior (McClelland et al., 2010). Moreover, self-regulation is understood to be composed of interrelated top-down and bottom-up components (Blair and Ursache, 2011; Blair and Raver, 2012). The bottom-up components are automatic, rapid, stimulus-driven reactivity and they do not require mental capacity, while the top-down components are related to executive functioning (EF) (Blair and Ursache, 2011; Blair and Raver, 2012; Nigg, 2017). EF is a high-level set of processes that include attentional or cognitive flexibility, working memory, and inhibitory control (Blair, 2002), and is often used and studied in cognitive disciplines (McClelland and Cameron, 2012). These higher-order cognitive processes are essential for goal-directed problem-solving in new situations and planning (Yeniad et al., 2013). EF is not synonymous with self-regulation; however, the EF components are cognitive processes that assist a child in broader aspects of self-regulation (Blair and Ursache, 2011). The Head-Toes-Knees-Shoulders (HTKS) task used in the present study has been found to be related to all three EF components in a behavioral self-regulation task (McClelland et al., 2014). Although EF processes have often been examined using materials and responses appropriate to the laboratory, the HTKS task measures the manifestation of those EF processes in real-world behavior (in an ecological setting) (McClelland and Cameron, 2012). This is consistent with the distinction of EF as a top-down cognitive process that enables self-regulation of a more automatic, bottom-up set of processes, such as the behavior a child would demonstrate in the HTKS task or in a social setting like a classroom.

Development of Self-Regulation Across Cultures

The distinct role that culture plays in children's development is of importance and aligns with the bioecological model of development (Bronfenbrenner and Morris, 2006). The bioecological model emphasizes the role of both proximal (micro-system factors) and distal (meso-, exo-, and macro-systems factors) systems of development. For example, the macro system in the bioecological model includes beliefs, values, and ideologies of the culture. Different beliefs, values, and ideologies may lead to different structural and socioeconomic organizations across cultures, such as the organization of the welfare and ECEC systems and the prevailing pedagogical approach. These differences across cultures may, in turn, affect the socialization practices (e.g., parents' and teachers' goals and expectations), the influence of sociodemographic factors (e.g., maternal education), and child characteristics (e.g., gender), and thus children's development, including their self-regulation (Bronfenbrenner and Morris, 2006; Trommsdorff, 2009; Gestsdottir et al., 2014; McClelland et al., 2015). Country and culture are not synonymous, but for the current study, we refer to the participants' shared nationality as their cultural context. However, we acknowledge that there is considerable cultural variation within a country as well (Minkov, 2013).

Children's level of self-regulation may vary across socio-cultural orientations (e.g., child-rearing practices: independence and interdependence). For example, in cultures emphasizing an interdependent self (e.g., Asian collectivistic cultures), the goal of self-regulation may be tied on community ethics, including having harmonious relationships and the values of duty, respect, and obligation (Trommsdorff, 2009). For cultures emphasizing an independent self (e.g., Western cultures), the goal of self-regulation may be focused on autonomy and related independent identity (Trommsdorff, 2009). A recent review on self-regulation (EF) across cultures (nations) found that from preschool age through adolescence, East Asians outperformed Western counterparts on direct assessments of self-regulation (Schirmbeck et al., 2020). Less research, however, has examined and compared children's self-regulation and the role of sociodemographic factors and child characteristics among children in cultures that focus on independence but differ in other important structural and philosophical ways. For example, Norway and the U.S., both Western cultures, are assumed to have more similar child-rearing practices but have different structural organizations and perspectives on ECEC and family policy.

Because differences in cultural contexts can also affect the way psychological assessments function (Oh and Lewis, 2008; Kline, 2016), is it important to establish that a measure of

self-regulation (e.g., HTKS task; McClelland et al., 2014) possesses similar psychometric properties among 5-year-old children from Norway and the U.S. Thus, the present study first established measurement invariance across the two samples, which enabled a better comparison of whether mean levels of self-regulation and the influence of maternal education and child gender differed across cultural contexts (e.g., Kline, 2016).

Early Childhood Contexts in Norway and the U.S.

Norway and the U.S. are high-income countries with a number of similarities. They are both individualistic cultures valuing independence, autonomy, human rights, and democracy. However, there are also several key differences that may influence the development of children's self-regulation. For example, we know that economic equality and mobility are higher in Norway compared to the U.S. (Esping-Andersen, 2007; OECD, 2019). Wilkinson and Pickett (2009) have documented that countries with higher economic equality also have better mental and psychical health and higher academic outcomes. In 2013, only 6.8% of Norwegian children lived in poverty while the poverty rate was 21% in the U.S. (OECD, 2018), and poverty is known to be negatively related to self-regulation (Wanless et al., 2011b; Fitzpatrick et al., 2014; Blair and Raver, 2015). Moreover, Norway spends 3.3% of the gross national product on family benefits (child allowances, childcare support, income support during leave, and sole parent payments) while the U.S. spends 0.6% (OECD, 2017). For the purposes of the current study, we focused on differences in welfare systems and economic equality, availability of affordable ECEC, and a play-based approach prevalent in Norway that values unstructured play and social development, compared to a school readiness ECEC approach prevalent in the U.S. that includes a more structured approach to play and early academic achievement (OECD, 2006; Bennett, 2008).

The Cultural Context of Norway

Norway is a social-democratic country with a well-developed welfare system, including generous support for families, and a high priority on ECEC to promote social equality (Bambra, 2007; Norwegian Ministry of Education and Research, 2011, 2017; OECD, 2017). For example, parents have the right to share 12 months of paid parental leave after childbirth and adoption. Furthermore, the government highly subsidizes public and private ECEC, and families only pay 14% of annual ECEC expenditures (Lunder and Eika, 2017). Children aged 1–5 have the right to attend ECEC centers, and enrollment is very high. In 2012, 80.2% of the 1–2-year-olds were in ECEC centers, and 96.6% of the 3–5-year-olds (Statistics Norway, 2013). Most children (96%) go full time, which is up to 41 h a week.

Norwegian ECEC (public and private) is regulated by the *Framework Plan for the Content and Tasks of Kindergartens* (Norwegian Ministry of Education and Research, 2011, 2017). The framework plan reflects a play-based and child-centered approach (also called a social pedagogical or Nordic tradition), which emphasizes holistic learning based on children's desire and curiosity for learning (OECD, 2006). The heart of this approach includes a focus on children's current well-being and the intrinsic value of childhood. Early childhood is not merely a period in life that prepares children for education and adulthood (Tuastad et al., 2019). Free play and children's autonomy are highly valued, and there is less emphasis on formal training for academic learning or self-regulation. The framework plan does not mention children's need to develop self-regulation, and it contains no benchmarks for school readiness progress. Children spend considerable time in outdoor play in ECEC centers, 70% during the summer and 31% during the winter (Moser and Martinsen, 2010). A recent Norwegian study showed that children in ECEC centers spent 60% of the time on free play, and during free play, teachers were absent 45.5% of the time (Karlsen and Lekhal, 2019). The ECEC centers are usually organized in groups of nine children aged 1–2-years and groups of 18 children for the 3–5-year-olds. The groups' main staff is one teacher with a bachelor's degree and two assistants. Children attend the same ECEC center until they start first grade of formal schooling at the end of August the year they turn 6 (the cut-off date is January 1st).

Characteristics of the Norwegian society, such as the well-developed welfare system with a strong family service orientation, social and economic equality, and availability of affordable ECEC, as well as a play-based and child-centered approach, may promote opportunities for the Norwegian children to develop self-regulation (Esping-Andersen, 2007; Wilkinson and Pickett, 2009). According to Esping-Andersen (2007), high-quality ECEC is one way to help ensure that all children receive a strong foundation prior to school. Moreover, researchers argue that free play (especially social pretend play) and the autonomy that is common in the play-based approach are important for the development of self-regulation (Vygotsky, 1978; Diamond et al., 2007; Center on the Developing Child at Harvard University, 2011; Diamond and Lee, 2011; Engel et al., 2015). For example, during pretend play, children must remember their own and other's roles, inhibit acting out of the character and flexibly adjust to their playmates' improvisations (Diamond and Lee, 2011). Thus, these activities challenge and promote EF processes and self-regulation abilities.

The Cultural Context of the U.S.

The U.S. is a democratic country, where the state or federal provision of welfare is minimal (Bambra, 2007). The country has a liberal market economy, which approaches the daycare (especially under three years) as a private responsibility for parents and not a public responsibility (Bennett, 2008). The use of care and education depends on the age of children, employment status of parents, household income, and access to free or subsidized care (Early Care and Education Profiles, 2018). The country has a two-tier organization of the services: child care for children from 0 to 3 years, followed by a pre-primary education for the 3–5-year-olds (Bennett, 2008). ECEC institutions differ greatly in their requirements, operational procedures, regulatory frameworks, staff-training, and qualifications. ECEC is expensive for families, and they have to fund as much as

72% of annual childcare expenditures (in states where the U.S. data were collected; Early Care and Education Profiles, 2018). However, there are some programs providing support to low-income families. Head Start is an example of a free federal preschool program for children aged 3–5 years. According to the Early Care and Education Profiles (2018) report, only 18% of the children under age 3 attended daycare, and 46% of the children aged 3-and-4 years were enrolled in preschool in 2016.

Overall, there are large variations in the experiences that young children receive in the U.S., although many ECEC programs have a school readiness approach, which focuses on teaching cognitive and pre-academic skills (OECD, 2006; Bennett, 2008). Moreover, compared to the Norwegian ECEC system, they spend less time on free play (30%; Chien et al., 2010). Children's self-regulation may be more systematically supported in a school readiness approach compared to a play-based approach. This may be because of an intentional focus on activities that promote self-regulation, such as having to pay attention to and remember instructions and demonstrate self-control (Gestsdottir et al., 2014). In addition, in the U.S., most children start formal schooling in kindergarten when they are 5 years old (the cut-off date for children in the current study was September 1st), which has a stronger focus on school readiness and academic learning, whereas in Norway children do not enter formal schooling until they are 6 years old. Based on the pedagogical approach in the ECEC context and the earlier transition to formal schooling in the U. S. compared to Norway, there may be greater opportunities to practice self-regulation in the U.S. compared to Norway. This may be especially true for children who are low in self-regulation and who may benefit from structured activities prior to school entry (Zambrana et al., 2020). Thus, it may be that each culture has different characteristics that help promote self-regulation.

Predictors of Children's Self-Regulation

According to the bioecological model of development, children's cultural contexts also influence the role of children's socioeconomic background and gender in children's socialization processes (Bronfenbrenner and Morris, 2006). Prior research has found that children's self-regulation is related to maternal education and child gender (Kishiyama et al., 2009; Matthews et al., 2009; Sektnan et al., 2010; Wanless et al., 2011b, 2013; DiPrete and Jennings, 2012; Størksen et al., 2015; Backer-Grøndahl and Nærde, 2017). However, it is unclear whether the influence of these factors on children's self-regulation differs across cultural contexts.

Socioeconomic Background

Socioeconomic background affects children's socialization, which leads to variations in their social, emotional, cognitive, and physical functioning (Conger and Donnellan, 2007). Parental socioeconomic status (SES) is indicated by income, education, and occupation (Conger and Donnellan, 2007). In particular, maternal education has been a good indicator of SES in studies of child development (Bornstein et al., 2003; Hoff et al., 2012). For example, parents with higher education levels may place a stronger priority on activities, goods, and services that foster academic and social competence, compared to parents with lower education levels (Conger and Donnellan, 2007; Conger and Dogan, 2014). Research has indicated that children in poorer home environments, as measured by the home literacy environment, have significantly lower self-regulation than their peers (McClelland et al., 2000). Prior research has also found that parent's stimulation mediates the relationship between parental education and child competence (Bradley and Corwyn, 2003). Thus, the relation between maternal education and children's self-regulation may reflect the number of opportunities (e.g., in everyday interactions and pre-academic-, music-, and outdoor-activities) children receive to practice their self-regulation.

Prior research conducted in the U.S. has reported that children's socioeconomic background predicts their self-regulatory skills (Sektnan et al., 2010; Wanless et al., 2011b; Conway et al., 2018). One study with samples from the U.S. investigated the effect of maternal education on children's self-regulation trajectories (using the HTKS task) and found that early developers generally had mothers with higher education levels (Montroy et al., 2016). Another study with samples from France, Iceland, and Germany found that maternal education did not predict children's self-regulation in any samples, using the HTKS task (Gestsdottir et al., 2014). Even though Norway has relatively little poverty and economic and social equality is high, the socioeconomic background is an important predictor of school achievement (Bakken and Elstad, 2012). Moreover, two prior Norwegian studies have found some evidence for associations between socioeconomic background and children's self-regulation. Backer-Grøndahl and Nærde (2017) found that socioeconomic background (parent education level and whether families live in poorer housing) predicted cool (cognitive aspects of self-regulation) but not hot (emotional aspects of self-regulation) self-regulation. In contrast, Størksen et al. (2015) documented that socioeconomic background (parent's education level and income) predicted teacher reported self-regulation in children, but only predicted directly assessed self-regulation (e.g., HTKS task) for girls and not boys. Although socioeconomic background has predicted children's self-regulation in Norway and the U.S, research has not examined if this relationship is significantly different across the cultures.

Child Gender

Research in Norway and the U.S. has demonstrated that girls tend to have higher self-regulation than boys in preschool and kindergarten (Matthews et al., 2009; DiPrete and Jennings, 2012; Størksen et al., 2015; Backer-Grøndahl and Nærde, 2017), although some findings from the U.S. using the HTKS task are inconsistent (McClelland et al., 2007; Schmitt et al., 2014). Moreover, some differences have been detected in research across various cultures. One study showed gender differences in self-regulation, as measured by the HTKS task, in the U.S. sample, but no significant gender differences the samples from the Asian cultures (Taiwan, China, or South Korea) (Wanless et al., 2013). Another European study also

using the HTKS task found that girls scored higher than boys on self-regulation in an Icelandic sample but this was not found in the French and German samples (Gestsdottir et al., 2014). However, a German study found that although 4-year-old girls showed higher self-regulation on the HTKS task, boys caught up the following 2 years (Gunzenhauser and von Suchodoletz, 2015). In line with these results, a U.S. study found that girls were associated with earlier development trajectories of self-regulation while there were more boys in the later developers' group (Montroy et al., 2016). Finally, a recent review investigating similarities and distinctions across countries in the development of self-regulation and EF found that girls performed better than boys on direct assessment and teacher and parent ratings in both Western and East Asian samples (Schirmbeck et al., 2020).

Many gender theories acknowledge that a combination of biological and social factors influence gender development (Leaper and Friedman, 2007; Reilly et al., 2018). The influence of culture on gender differences may be seen in different expectations for self-regulatory behavior among boys and girls across cultures, and through different socialization processes (Gestsdottir et al., 2014). Norway and the U.S. are Western cultures that emphasize gender equality. In spite of this, in both countries, there is evidence that girls and boys experience different expectations based on traditional gender patterns (Chick et al., 2002; Meland and Kaltvedt, 2017). One Norwegian study found that girls were praised for characteristics, such as being caring, helpful, responsible, and conscientious, while the staff affirmed boys' strength and physical characteristics (Meland and Kaltvedt, 2017). Teachers expected girls to sit still, wait for help, and play quietly, while the boys were allowed to be noisy, climb, and jump. A study conducted in a U.S. preschool found similar differences in staff expectations for girls and boys (Chick et al., 2002), as found in the Norwegian study. Thus, ECEC staff in both countries may expect girls to behave in a more self-regulated manner compared to boys (Chick et al., 2002; Matthews et al., 2009; Størksen et al., 2015; Meland and Kaltvedt, 2017).

Measuring Self-Regulation Across Cultural Contexts

In order to have a valid group comparison, it is important to establish that the measurement functions similarly across groups. This is more generally referred to as measurement invariance (van de Schoot et al., 2012; Kline, 2016). There are four levels of measurement invariance, which get more restrictive for each level and help establish how similar the measurement functions in each group (Kline, 2016). The least restrictive level, configural invariance, establishes that the measure consists of the same general underlying structure *via* confirmatory factor analysis (CFA). In the next levels, factor loadings (weak invariance), intercepts (strong invariance), and finally, residual variances (strict invariance) in the CFA are constrained to be equal across groups (see "Analytic Strategy" section for further descriptions). Strong measure invariance is required in order to have meaningful interpretations when comparing differences between groups (van de Schoot et al., 2012; Kline, 2016). When strong invariance is established, it means that if two children from two different groups have the same underlying levels of self-regulation, they are also more likely to obtain the same score on the measure (Kline, 2016). In addition to measurement invariance, research suggests that when nationally representative samples are not possible, having matched samples that are as similar as possible help ensure a valid group comparison in cross-cultural studies (Minkov, 2013). This helps ensure that differences found across the samples are not due to sample-specific characteristics.

The Present Study

The main goals of this study were to investigate (1) children's level of self-regulation (using the HTKS task) across a Norwegian and a U.S. sample and (2) the influence of mother's education level and child gender on children's self-regulation across the two samples.

Prior studies have reported that the HTKS task has shown strong psychometric properties across cultural contexts (Wanless et al., 2011a; Gestsdottir et al., 2014; McClelland et al., 2014; Størksen et al., 2015). However, strong measurement invariance is required to compare group means (van de Schoot et al., 2012; Kline, 2016), so we first examined measurement invariance for the HTKS task across the two samples.

No prior studies have directly compared Norwegian and U.S. children's self-regulation. We expected that both cultures had characteristics that would promote children's self-regulation in different ways. For example, Norway emphasizes free play in ECEC, which for some children, can be beneficial in developing self-regulation. Moreover, there is low child poverty and economic inequality, a well-developed social democratic welfare system, a strong family service orientation, and earlier and higher attendance to ECEC in Norway compared to the U.S., all of which can promote Norwegian children's self-regulation (OECD, 2016, 2019; Lunder and Eika, 2017; Early Care and Education Profiles, 2018). In the U.S., there is some evidence that children have opportunities to practice self-regulation because of the predominant school readiness approach in ECEC and kindergarten, compared to children in unstructured play-based ECECs in Norway (Gestsdottir et al., 2014). Thus, we did not expect significant differences in self-regulation across the cultures.

There is some evidence to expect maternal education to significantly predict children's self-regulation in both cultures (e.g., Sektnan et al., 2010; Backer-Grøndahl and Nærde, 2017). However, due to the sociopolitical differences across the two cultures, we expected maternal education to be a significantly stronger predictor for the U.S. children's self-regulation than for the Norwegian. Finally, based on prior evidence (Chick et al., 2002; Matthews et al., 2009; Størksen et al., 2015; Meland and Kaltvedt, 2017), we expected girls to score higher on the self-regulation measure compared to boys in both societies and the influence of gender on self-regulation to be equal across the two samples.

MATERIALS AND METHODS

Participants

In the present study, we used samples from research projects in Norway (243 children) and the U.S. (264 children). To get the samples as similar as possible in age, we used data from the spring of the last year of ECEC in the Norwegian sample and from the fall of kindergarten in the U.S. sample. The mean age in the Norwegian sample was 5.79 years (*SD* = 0.29), and the mean age in the U.S. sample was 5.65 years (*SD* = 0.31). Thus, the samples on average differed only about one and a half months in mean age.

Norway

Data from the Norwegian sample derived from the Skoleklar [School readiness] research project. The sample of children and families were from a primarily rural county in Norway. All children (*N* = 287) who were in their last year of ECEC in 2011 in a municipality in the Norwegian west coast were invited to participate, using a convenience sampling approach. A total of 243 children (84.7%) had parental consent to participate. Among these, there were 119 girls (49.4%) and 124 boys (50.6%). Data used in the present study derived from 19 centers and were collected in spring 2012, the last year children attended ECEC. The median age of starting in ECEC was 18 months. For more details of this sample, see previous descriptions in Størksen et al. (2015).

The sample had no group assessed in another language than Norwegian, but 13 children (5.3%) had an immigrant background where both parents were born in another country than Norway (11 different countries). These children had a mean sum score of 45.58 (*SD* = 24.74) on the HTKS task, which was not significantly different from the scores of children that had both or one parent born in Norway (*M* = 52.51, *SD* = 20.04).

The United States

Data from the U.S. sample derived from children recruited from 17 local preschools in a rural area in the Pacific Northwest as part of a larger study (Touch your toes! Devleoping a new Measure of Behavioral Regulation), examining children's self-regulation in the transition to kindergarten. The principal investigator contacted preschool directors *via* telephone, e-mail, and individual meetings to invite them to be a part of the study using a convenience sampling approach (i.e., preschools that were accessible and willing to participate in the study). For more details of this sample, see previous descriptions in McClelland et al. (2014) and Schmitt et al. (2017). The data used in the present study were collected in the fall of kindergarten (2012) and included 310 children attending 38 schools.

At fall in kindergarten, 46 children (15%) were identified as English language learners (ELL) and were assessed in Spanish. Preliminary analyses showed that these children had significantly lower scores on the HTKS task compared to children tested in English (*M* = 28.80, *SD* = 28.14, and *M* = 53.24, *SD* = 21.58 respectively). To ensure a more valid comparison and because the Norwegian and the U.S. samples were convenience samples, rather than nationally representative samples, samples were matched on key variables of interest (Minkov, 2013). In other words, to ensure that self-regulation differences were not due to characteristics of the subgroup of children assessed in Spanish (ELL) in the U.S. sample (Banks et al., 2006), we excluded these 46 children, which left a total U.S. sample size of 264 children. Among the 264 children, 111 children (42%) were enrolled in Head Start. The sample included 49.2% of boys and 50.8% of girls. The median of months in daycare (0–3) among the 264 children was 5 months, and 90 children had no daycare experience. Furthermore, the median of months in preschool was 12 months.

Demographic Information

Parents completed demographic surveys in both samples. An education level of a high school diploma or less was scored as zero (NO = 42.9%, U.S. = 31.3%). Some college or an associate's degree was scored as one (NO = 8.6%, U.S. = 13.5%). A bachelor college degree (BA, BS, etc.) was scored as a two (NO = 22.9%, U.S. = 26.9%), and advanced degree (MA, MS, MD, Ph.D., etc.) was scored as a three (NO = 25.4%, U.S. = 28.4%). Mother's median education level in the Norwegian sample was some college or an associate's degree (*M* = 1.31, *SD* = 1.26). In the U.S. sample, the mother's median education level was a bachelor's college degree (*M* = 1.53, *SD* = 1.20) when ELL children were excluded. Overall, the U.S. sample had a higher maternal education than the Norwegian sample with (*M* = 1.41, *SD* = 1.22) or without ELL children included.

In the Norwegian sample, parents reported their minority status by indicating their country of birth. Parents reported being born in 21 different countries in addition to Norway. If one of the parents (5.8%) or both (5.3%) were born in another country than Norway (or Scandinavia), children were scored as minority status (11.1%). In the U.S. sample, parents reported their child as White (69.7%), African American (0.4%), Latino/Hispanic (4.9%) Asian/Pacific Islander (3.4%), Middle Eastern (0.8%), more than one race or ethnicity (14.4%) or other (0.8%). All categories, except White, were scored as minority status (24.6%).

Mothers with minority status in the Norwegian sample had a median education level of some college or an associate's degree (*M* = 1.15, *SD* = 1.29), while the median education level of those not being a minority was between some college or an associate's degree and a bachelor college degree (*M* = 1.32, *SD* = 1.26). In the U.S. sample, mothers with minority status had a median education level of some college or an associate's degree (*M* = 1.30, *SD* = 1.23), and mothers not having minority status had a median educational level of a bachelor college degree (*M* = 1.59, *SD* = 1.19).

Missing Data

The Norwegian sample had 0.8% missing on the HTKS task, and the U.S. sample had 1.5–1.9% missing on the HTKS. The Norwegian sample had 2.9% missing on the minority status variable, while the U.S. sample had 5.7%.

Maternal education had 21.2% (*N* = 56 cases) missing in the U.S. sample. We conducted *t*-tests and found that there

were significantly more children with minority status that were missing on maternal education. Moreover, those with missing data on maternal education had significantly lower mean sum scores on the HTKS task compared to those that had reported on this variable (respectively: M = 45.48, SD = 23.07, and M = 55.22, SD = 20.78; see below for methods of dealing with missing data). The Norwegian sample had only 1.3% (three cases) missing on maternal education, and there were no significant differences between those with and without data on the variable.

Procedure

Norway

A test battery of school readiness assessments was administered individually with the use of computer tablets. In addition to the HTKS task, the battery consisted of one additional self-regulation measure (teacher report) and academic measures (vocabulary, math, and phonological awareness). Results from these other tasks are outside the scope of the current study but are reported elsewhere (Lens et al., 2020). Children were tested in Norwegian in a one on one session with a research assistant in an adjacent room in their ECEC center to reduce any excess distraction during testing. Children completed the test battery in one test session, and it took 30–40 min. The parents reported their education level and country of birth, date of the child's birth, and gender on a questionnaire. The questionnaires were organized by the ECEC centers in collaboration with the project administrators.

The United States

Children were assessed individually on a battery of school readiness assessments in their schools in a one on one session with a research assistant. In addition to the HTKS task, the battery consisted of other self-regulation measures (the Day-Night and DCCS) and academic measures (the Woodcock-Johnson tests). Descriptive results from these measures are reported elsewhere (McClelland et al., 2014; Schmitt et al., 2017). Children completed the battery of assessments over two to three 15-min sessions within 2 weeks. All sessions were conducted in a quiet corner or an adjacent room or hallway to the classroom. Parents were sent demographic questionnaires *via* the mail and were asked to return them by the completion of the study.

Measures

Self-Regulation

Self-regulation in both samples was assessed with the HTKS (McClelland et al., 2014). The test is a short game appropriate for children aged 4–8 years and includes three parts. Each of the three parts has one practice section (four items) and one following test section (10 items). In the present study, we incorporated both the practice sections and the test sections. There are a total of 12 practice items and 30 test items with scores of 2 points for a correct response, 1 point for a self-correct response, and 0 for an incorrect response. For each of the three parts, children do not move onto the next part of the test if they do not receive at least four (out of twenty) points on the test section.

In the first part of the HTKS task, children are asked to touch the opposite body part of what is presented to the child. In the second part, two additional body parts are added, and in the third part, the rules are switched. The HTKS task requires children to integrate several executive function skills, namely (1) paying attention to the instructions, (2) using working memory to remember and execute new rules, (3) using inhibitory control through inhibiting the natural response to the instructor's command, and (4) use cognitive flexibility and working memory when rules are switched (Cameron Ponitz et al., 2009a; McClelland et al., 2014).

In the Norwegian sample, the item level data of the HTKS task were not available. We, therefore, only had sum scores for the practice and test sections of the measure and could not calculate the Cronbach's alpha reliability. In the U.S. data, where the item-level data were available, the reliability was $\alpha = 0.96$ (42 items). The HTKS task has shown good psychometric properties in previous studies conducted in the U.S., Asia, and Europe (Cameron Ponitz et al., 2009a; von Suchodoletz et al., 2013; Wanless et al., 2013), with Cronbach's alpha reliability ranging from 0.92 to 0.94 (McClelland et al., 2014). In data from a recent Norwegian research project (Rege et al., 2019), with a similar age group, the HTKS task showed a Cronbach's alpha of α = 0.87 (30 test items).

Analytic Strategy

Because children were nested in different ECEC centers and schools in the two samples, we calculated intra-class coefficients (ICC; the proportion of the total variability in the outcome that is attributable to the classes; Geiser, 2013). The average cluster size was 11.48 in the Norwegian sample, and ICCs ranged between 0.001 and 0.046 for all the HTKS practice and test sections, and it was 0.034 for the sum score of the HTKS task. In the U.S. sample, the average cluster size was 6.68 and ICCs ranged between 0.018 and 0.079 for all the HTKS practice and test sections, and it was 0.063 for the sum score of the HTKS task. As the ICCs were not substantial in the two samples (Hox, 2002), analyses adjusting for potential nested effects were not conducted.

Maternal education in the U.S. sample had 21.2% missing. As missing on this variable was predicted by the minority status variable, we included minority status as a covariate in the further analyses. Furthermore, to appropriately deal with missingness, we used full information maximum likelihood estimators (FIML), which can provide more optimal solutions compared to traditional missing data handling techniques (Enders, 2010).

To test the measurement invariance of the HTKS task across the two samples, we conducted a series of CFAs using Mplus version 7.3 (Muthén and Muthén, 1998–2015). Children's sum scores for the practice and test items subsections in the three parts of the HTKS task were used as individual indicators in the CFAs; thus, there were six indicators. We proceeded in a stepwise fashion from the least restrictive model (configural invariance) to the most restrictive model (strict invariance; van de Schoot et al., 2012; Kline, 2016). Configural invariance was tested by constraining the latent structure to be equal across the Norwegian and the U.S. samples. Factor means were

fixed to 0, and factor variances were fixed to 1. Weak invariance was tested by also equating the unstandardized factor, strong invariance by equating unstandardized intercepts, and, finally, strict invariance by equating unstandardized residual errors.

For each step in the analyses, the model fit was assessed using the Chi-square statistics, the comparative fit index (CFI and TLI; a value greater than 0.95), the root-mean-square error of approximation (RMSEA; a value less than 0.05) and the root-mean-square residuals (SRMR; a value less than 0.10; Hox and Bechger, 1999; Kline, 2016). Because the models we tested were nested, Chi-square difference tests were used to compare the models. We used the Satorra Bentler correction due to the MLR estimator used (Satorra and Bentler, 2010; Muthén and Muthén, 2018). In the case of no significant Chi-square test, the more restrictive model was favored. We also tested that the more restricted model did not decrease more than 0.01 in the CFI value compared to the less restricted model (Cheung and Rensvold, 2002).

If strong measurement invariance is established, we can compare group scores on the latent variable (van de Schoot et al., 2012; Kline, 2016). To investigate whether children's levels of self-regulation was significantly different across the samples, we tested if latent factor means and the correlation between them differed significantly across Norwegian and U.S. children. Factor means and variances were allowed to vary freely, and the first factor loading for each of the factors was fixed to one. The U.S. sample was the reference group, and the factor means in the Norwegian sample were compared to the U.S. means. The correlation between the two factors was compared between the samples using a Wald test.

We examined whether maternal education and child gender predicted children's self-regulation differently across the two samples by contrasting two models (structural equation modeling; SEM). In the first model, maternal education was allowed to vary freely in predicting the HTKS factors across the samples. In the second model, the parameters were constrained to be equal across the samples. The model with constrained paths across the samples was compared to the model where maternal education was free by computing a Chi-square difference test (Satorra Bentler correction). We repeated this procedure for gender as a predictor of the HTKS factors. Child age and minority status were used as covariates.

RESULTS

Descriptive Statistics

To check for potential bias due to outliers (van de Schoot et al., 2012), data were screened by looking at histograms and boxplots in SPSS, and by checking in Mplus if any cases had a Cook's distance greater than 1 (Cohen et al., 2003; Field, 2013) or if the value of Mahalanobis distance was $p < 0.001$ (Tabachnick and Fidell, 2014). Cases that had values indicating they were outliers were investigated further. We also did the analyses with outliers excluded. However, the results did not differ; thus, outliers were included in further analyses.

Descriptive statistics for the two samples are reported in **Table 1**. For both samples, the mean performance on the three test sections of the HTSK decreased between part one and part three. In the Norwegian sample, 87.7% of the children advanced to test part two, while 86.4% of the children in the U.S. sample advanced. Furthermore, 71.6% of the Norwegian children and 67.4% U.S. children advanced to test part three.

Although we had not yet established measurement invariance, we tested mean-level differences between the Norwegian and U.S. samples on the subsections of the HTKS task in the preliminary analyses by conducting independent samples *t*-tests. Results showed that none of the practice or test sections in the HTKS task differed significantly between the groups (see **Table 1**).

Moreover, there was no significant difference in maternal education, $\chi(3) = 7.390$, $p = 0.060$ between the two samples, but there was a significant difference in the proportion of minority status between the groups, $\chi(1) = 17.126$, $p < 0.001$.

TABLE 1 | Descriptive for all study variables.

	NO M(*SD*)	US M(*SD*)	*ES*	NO skewness/ kurtosis	US skewness/ kurtosis	NO% floor/ ceiling	US% floor/ ceiling
Age T1 NO = 242, US = 264	5.79 (0.29)	5.65 (0.30)	0.47***				
Percent male NO = 241, US = 264	50.6	49.2	0.03 ns[a]				
Percent minority NO = 237, US = 249	11.4	26.1	0.39***, [a]				
Mother's education NO = 240, US = 208	1.31 (1.26) Median = 1	1.52 (1.20) Median = 2	–0.17 ns[a]	0.17/–1.64	–0.11/–1.54	42.9/25.4	31.3/28.4
HTKS P1 NO = 241, US = 260	6.91 (1.71)	6.90 (2.10)	0.01 ns	–2.39/6.33	–2.32/ 4.54	2.5/52.3	5.4/62.7
HTKS T1 NO = 241, US = 260	15.14 (5.61)	15.57 (5.78)	–0.08 ns	–1.47/1.14	–1.70/1.69	5.4/15.4	6.2/18.8
HTKS P2 NO = 241, US = 260	6.47 (2.43)	6.39 (2.44)	0.03 ns	–1.79/1.99	–1.82/2.08	8.7/53.1	10.0/45.4
HTKS T2 NO = 241, US = 260	11.78 (6.38)	12.52 (6.26)	–0.12 ns	–0.62/–0.94	–0.90/–0.42	11.6/5.0	12.3/5.8
HTKS P3 NO = 241, US = 259	4.38 (2.77)	4.26 (2.82)	0.04 ns	–0.42/–1.09	–0.27/–1.23	20.7/15.8	20.5/17.4
HTKS T3 NO = 241, US = 259	7.54 (6.99)	7.58 (7.03)	–0.01 ns	0.41/–1.30	0.34/–1.40	27.8/5.0	31.3/4.6
HTKS total score NO = 241, US = 259	52.22 (20.18)	53.24 (21.61)	–0.05 ns	–0.93/0.28	–1.08/0.51	1.7/0.0	4.2/0.4

NO sample, Norwegian sample; US sample, United States sample; HTKS, Head-Toes-Knees-Shoulders task; P1, sum of practice items part 1; T1, sum of test items part 1; P2, sum of practice items part 2; T2, sum of test items part 2; P3, sum practice items part 3; T3, sum of test items part 3, and HTKS total score, sum of all practice and test items; ES, Cohen's D.

[a]*Pearson's Chi-square test.*

***$p < 0.001$.

However, independent sample t-tests showed no significant differences in scores in the HTKS subsections between children having minority status or not in either of the samples. Moreover, maternal education did not significantly differ between being minority status or not, in the U.S. sample $\chi(3) = 2.464$, $p = 0.483$, or the Norwegian sample $\chi(3) = 7.019$, $p = 0.071$. The small mean age difference ($M = 1.8$ months) between the two samples was statistically significant, $t(504) = -5.123$, $p < 0.000$.

As shown in **Table 2**, gender correlated significantly with five of six of the HTKS subsections in the Norwegian sample. In contrast, gender did not correlate significantly with any of the HTKS subsections in the U.S. sample. In the U.S. sample, maternal education correlated significantly to all HTKS subsections. However, this was not the case with the Norwegian sample, where there were no significant correlations between the HTKS subsections and maternal education. Minority status did not correlate significantly with any of the HTKS subsections in the two samples.

Establishing Measurement Invariance

When investigating the initial factor structure of the HTKS task, preliminary analyses indicated that a one-factor solution did not adequately fit the data [χ^2 (18) = 154.08, $p < 0.001$, RMSEA = 0.173, CFI = 0.913, TLI = 0.855, SRMR = 0.055]. We continued by investigating a two-factor solution that prior research has also supported. As children get older, the HTKS task shows a greater differentiation because children also manage to advance to the harder sections of the task, which places additional demands on children's cognitive flexibility and working memory (McClelland et al., 2014). As a result, easier, early parts of the HTKS task, which primarily taps children's inhibitory control, tended to load significantly onto the first latent factor (HTKS1), whereas the harder, later parts of the measure, which have additional requirements on children's cognitive flexibility and working memory, loaded significantly onto the second latent factor (HTKS2). Results from the CFA analysis showed that the same underlying two-factor structure was valid for the Norwegian and U.S. samples and showed good overall model fit (see **Table 3**, Model 1; Configural invariance). Thus, we utilized the two-factor (HTKS1 and HTKS2) model for all subsequent analyses. **Figure 1** shows that all factor loadings for all indicators of the HTKS factors were statistically significant. As shown in **Table 3**, the more strict models did not have statistically significantly worse fit to the data (see $\chi^2 diff$), and CFI did not decrease more than 0.01 when comparing them to the less strict models (e.g., weak vs. configural and strong vs. weak). Thus, measurement invariance was established, and we could have a valid comparison of the two samples in further analyses.

TABLE 2 | Correlations for all study variables. The Norwegian sample above the diagonal in the top panel and the U.S. sample below.

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.
1. Child age	-	–0.04	0.04	0.00	0.04	0.13*	0.10	0.14*	0.10	0.09	0.14*
2. Child gender	0.09	-	–0.07	0.04	–0.11	–0.14*	–0.29***	–0.16*	–0.20**	–0.26***	–0.25***
3. Mother's education	–0.04	–0.02	-	–0.04	0.10	0.10	0.01	0.11	0.11	0.11	0.12
4. Minority	–0.10	–0.09	–0.10	-	–0.09	–0.05	–0.00	–0.12	–0.07	0.00	–0.07
5. HTKS P1	0.05	–0.09	0.27***	–0.09	-	0.47***	0.42***	0.36***	0.35***	0.18**	0.49***
6. HTKS T1	0.09	–0.02	0.25***	–0.07	0.64***	-	0.66***	0.63***	0.47***	0.39***	0.80***
7. HTKS P2	0.04	–0.04	0.24***	–0.05	0.68***	0.77***	-	0.62***	0.51***	0.41***	0.75***
8. HTKS T2	0.14*	–0.03	0.24***	–0.05	0.58***	0.72***	0.69***	-	0.63***	0.55***	0.87***
9. HTKS P3	0.07	–0.06	0.24**	0.03	0.49***	0.59***	0.55***	0.70***	-	0.57***	0.76***
10. HTKS T3	0.14*	–0.04	0.17*	–0.07	0.38***	0.44***	0.39***	0.55***	0.65***	-	0.77***
11. HTKS total score	0.13*	–0.05	0.28***	–0.06	0.70***	0.85***	0.79***	0.89***	0.81***	0.77***	-

HTKS, Head-Toes-Knees-Shoulders task; P1, sum of practice items part 1; T1, sum of test items part 1; P2, sum of practice items part 2; T2, sum of test items part 2; P3, sum practice items part 3; T3, sum of test items part 3, and HTKS total score, sum of all practice and test items.
$^*p < 0.05$; $^{**}p < 0.01$; $^{***}p < 0.001$.

TABLE 3 | Test of measurement invariance for a two-factor solution of the Head-Toes-Knees-Shoulders task across the Norwegian and U.S. samples.

	χ^2	*p*	*df*	Model comparison	$\chi^2 diff^*$	Δdf	RMSEA	SRMR	CFI	TLI
Single group Solution										
NO (*n* = 241)	13.538		7				0.062	0.023	0.989	0.977
US (*n* = 262)	6.559		7				0.000	0.012	1.000	1.001
Model 1. Configural	19.295	0.154	14				0.039	0.018	0.996	0.992
Model 2. Weak[a]	33.796	0.038	21	2 vs. 1	13.219, $p = 0.067$	7	0.049	0.100	0.991	0.987
Model 3. Strong[a, b]	42.238	0.031	27	3 vs. 2	8.388, $p = 0.211$	6	0.047	0.100	0.989	0.988
Model 4. Strict[a, b, c]	55.030	0.009	33	4 vs. 3	12.052, $p = 0.061$	6	0.052	0.099	0.984	0.986

NO sample, Norwegian sample; US sample, United States sample.
[a]All factor loadings are equal across samples.
[b]All intercepts are equal across samples.
[c]All residuals are equal across samples.
[*]Satorra Bentler Correction for chi-square difference tests was used when comparing the models due to the MLR estimator used.

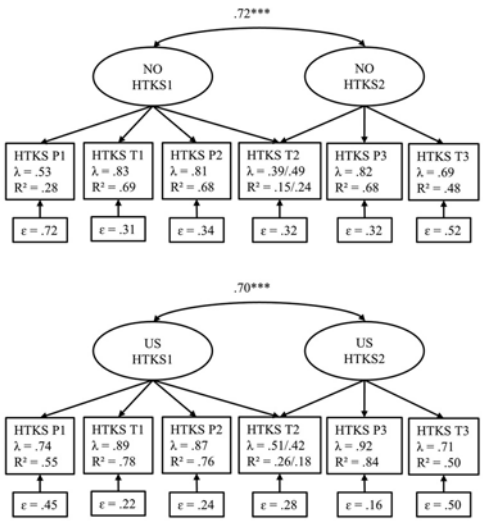

FIGURE 1 | Standardized parameter estimates for self-regulation (HTKS1 and HTKS2) in Norwegian and US samples using configural model. Factor variances were fixed to 1, and factor means fixed to 0. All factor loadings estimated freely for each sample. NO sample, Norwegian sample; US sample, United States sample; HTKS, Head-Toes-Knees-Shoulders task; P1, sum of practice items part 1; T1, sum of test items part 1; P2, sum of practice items part 2; T2, sum of test items part 2; P3, sum practice items part 3; T3, sum of test items part 3. $^{***}p < 0.001$.

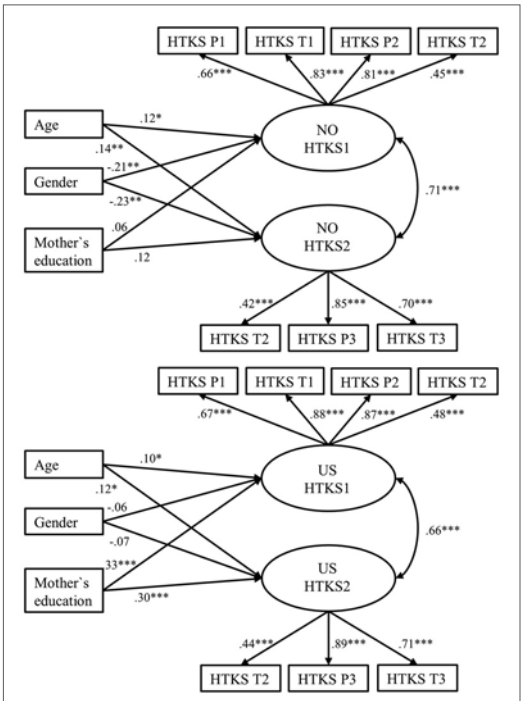

FIGURE 2 | Mother's education level and child gender predicting self-regulation using the strong MI model. Factor variances were fixed to 1, and factor means fixed to 0. The models show standardized parameter estimates. NO sample, Norwegian sample; US sample, United States sample; HTKS, Head-Toes-Knees-Shoulders task; P1, sum of practice items part 1; T1, sum of test items part 1; P2, sum of practice items part 2; T2, sum of test items part 2; P3, sum practice items part 3, and T3, sum of test items part 3. Minority status was included as a covariate, but none of the paths were significant, and they are not displayed for reasons of clarity. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$.

Children's Levels of Self-Regulation Across a Norwegian and a U.S. Sample

In the Norwegian sample, the mean of the HTKS1 factor was 0.064 lower, (p = 0.600) compared to the mean in the U.S. sample, and the mean of the HTKS2 factor was 0.015 higher (p = 0.957; using the strong invariance model; see **Figure 1** for an overview over subsections included in the HTKS1 and HTKS2 latent factors). Thus, we found no significant differences between the sample means on either of the HTKS1 and HTKS2 latent factors. A Wald test [0.783(1), p = 0.376] showed that neither the correlation between the HTKS1 and the HTKS2 factors differed significantly between the two samples. In other words, children's levels of self-regulation on the HTKS task were not significantly different in the Norwegian and U.S. samples.

The Influence of Mother's Education and Child Gender on Children's Self-Regulation Across a Norwegian and a U.S. Sample

Figure 2 shows that in accordance with the correlation results, maternal education was significantly and positively related to both of the latent HTKS factors in the U.S. sample. In contrast, maternal education had a smaller, non-significant relation with the latent HTKS factors in the Norwegian sample. In other words, U.S. children whose mothers had higher education had significantly higher self-regulation as measured across all parts of the HTKS compared to children whose mothers had lower education. In contrast, maternal education was not significantly related to Norwegian children's self-regulation. The model showed good overall fit χ^2 (67) = 89.731, p = 0.033, RMSEA = 0.037, CFI = 0.985, TLI = 0.982, SRMR = 0.066.

To test whether the effect of maternal education on children's self-regulation significantly differed between the two samples, we first constrained the effect of maternal education to be equal across the two samples with each of the latent HTKS factors. We compared the constrained models to the freely estimated model. The Chi-square test (Satorra Bentler corrections) showed that the effect of maternal education on HTKS1 significantly differed between the two samples [$\Delta\chi^2$ (1) = 9.411, p = 0.002], indicating that maternal education predicted HTKS scores in the U.S. sample but not in the Norwegian. For the second factor (HTKS2), maternal education significantly predicted U.S.

children's HTKS scores but not Norwegian children's scores. There was a trend for maternal education to predict HTKS scores differently in the two samples, but this was not statistically significant [$\Delta\chi^2$ (1) = 3.482, p = 0.062]. Thus, the effect of maternal education on the earlier parts of the HTKS task, as represented by the first latent factor (HTKS1), was greater in the U.S. sample compared to the Norwegian sample. For the second latent factor (HTKS2), although not significant, there was a trend toward a difference in the effect of maternal education on the later parts of the HTKS task between the two samples.

Second, we constrained the effect of maternal education to be equal across the two samples on both HTKS factors in the same model. Results indicated that the effect of maternal education on the HTKS factors significantly differed in the Norwegian and U.S. samples [$\Delta\chi^2$ (2) = 8.518, p = 0.014]. Thus, overall, maternal education influenced U.S. children's levels of self-regulation, but not for Norwegian children, and this difference was significant between the two samples.

The results (**Figure 2**) showed that gender significantly predicted self-regulation (HTKS1: β = −0.21, p = 0.001 and HTKS2: β = −0.23, p = 0.001) in the Norwegian sample. In other words, girls had significantly higher scores on both of the HTKS factors compared to boys. In the U.S. sample, girls trended toward having higher self-regulation scores compared to boys, but this difference was not significant. When constraining the effect of gender on self-regulation to be equal across the two samples and comparing it to the freely estimated model, the Chi-square test (Satorra Bentler corrections) showed that there were no significant differences with the effect of gender and self-regulation between the Norwegian and U.S. samples [HTKS1, $\Delta\chi^2$ (1) = 2.320, p = 0.128, and HTKS2, $\Delta\chi^2$ (1) = 2.514, p = 0.113].

DISCUSSION

The present study investigated cross-cultural differences in children's self-regulation as measured by the HTKS task and in the predictors of children's self-regulation skills. We found that children's levels of self-regulation were similar across Norwegian and U.S. samples. Maternal education influenced children's self-regulation significantly different across the two samples. That is, maternal education significantly predicted children's self-regulation in the U.S. sample but not in the Norwegian sample. Furthermore, the results showed that girls had a higher level of self-regulation than boys in the Norwegian sample, but this difference was not significant in the U.S. sample. Finally, the effect of gender on children's self-regulation did not significantly differ across the two samples.

Results supported the notion that the HTKS task measured a similar underlying construct of self-regulation across the Norwegian and U.S. samples, which strengthened and validated the comparison of the two samples (van de Schoot et al., 2012; Kline, 2016). Our results were in line with recent findings, showing that the HTKS task has shown strong psychometric properties across cultural contexts (Wanless et al., 2011a; Gestsdottir et al., 2014).

Children's Levels of Self-Regulation Across a Norwegian and a U.S. Sample

Results indicated that the latent factor means on the HTKS task did not significantly differ across the Norwegian and U.S. samples. Thus, the Norwegian and U.S. children represented in the present study did not have significantly different levels of self-regulation between 5 and 6 years.

The bioecological model of development emphasizes that both proximal (micro-system factors) and distal (meso-, exo-, and macro-systems factors) systems, as well as child characteristics, influence development. Characteristics of the Norwegian and U.S. cultures may support children's self-regulation in different ways. For example, higher social and economic equality, lower child poverty, and access to ECEC and high attendance from an early age are distal factors of the Norwegian culture that influence proximal processes, which in turn might support children's development of self-regulation. However, the Norwegian framework plan (Norwegian Ministry of Education and Research, 2011, 2017) does not mention the concept of self-regulation, which may give practitioners the impression that these skills are not important. It thus may influence practices and proximal processes that are less supportive of self-regulation. In contrast, the framework plan has a child-directed approach and emphasizes free play, child participation, and their right to choose their activities, which might be important for the development of self-regulation (Vygotsky, 1978; Center on the Developing Child at Harvard University, 2011; Engel et al., 2015). In spite of this, the Norwegian pedagogical approach may mainly benefit self-regulated children since a certain level of self-regulation is needed to engage in meaningful learning activities and play with other children without adult support (Zambrana et al., 2020).

The school readiness approach in the U.S. may also support children's self-regulation. For example, this approach provides opportunities for children to practice self-regulation in structured and intentional ways compared to an unstructured play-based approach that is predominant in Norwegian ECECs (Gestsdottir et al., 2014). In addition, although they were of similar ages, children in the U.S. sample had made the transition to kindergarten and formal schooling, which is characterized by a more structured learning environment and a stronger emphasis on self-regulation and academic learning compared to children in the Norwegian samples who were still in a less structured ECEC setting. Thus, overall, Norway's supportive system of families and the school readiness approach in the U.S. might have explained the non-significant differences in self-regulation.

The Influence of Mother's Education and Child Gender on Children's Self-Regulation Across a Norwegian and a U.S. Sample

Mother's Education Level

Based on prior research conducted in Norway and the U.S. (Wanless et al., 2011b; Backer-Grøndahl and Nærde, 2017), we expected maternal education to significantly predict children's self-regulation in both samples, although we expected maternal education to be a significantly stronger predictor for U.S.

children's self-regulation than for Norwegian children's self-regulation. Results partly confirmed our expectations and showed that maternal education significantly predicted children's self-regulation in the U.S. sample but not in the Norwegian sample. Furthermore, maternal education was a significantly stronger predictor of U.S. children's self-regulation than for Norwegian children, which is in line with prior findings showing that socioeconomic background explains a higher percentage of variation in U.S. students' PISA performance and drop-out compared to Norwegian students' (Lundetræ, 2011; OECD, 2016).

Maternal education significantly predicted both HTKS factors in the measure in the U.S. sample but not in the Norwegian sample. For the HTKS factors, there was a significant difference between the U.S. and Norwegian samples on the first and easiest part of the HTKS task (HTKS1 factor) and a trend toward a significant difference on the second part of the HTKS task (HTKS2 factor). Thus, the results were largely similar between the two HTKS factors suggesting that maternal education was a predictor of HTKS scores in the U.S. sample but less so in the Norwegian.

Sociodemographic factors may explain individual differences in children's self-regulation, together with child characteristics and socialization experiences (Eisenberg et al., 2014). Examining the same measure across cultures can shed light on whether sociodemographic factors influence self-regulation differently across cultures and contexts (McClelland et al., 2010). There are differences in distal factors in Norway and the U.S. that may explain why maternal education was more important for the U.S. children's self-regulation than for the Norwegian children. For example, it might be that the structural organization of the Norwegian society, such as a well-functioning welfare system and relatively high social and economic equality allowed Norwegian children's development of self-regulation to be less dependent on family socioeconomic status, compared to the children growing up in the U.S. Prior evidence has shown that in rich countries, economic inequality, rather than the average income is related to children's well-being (Wilkinson and Pickett, 2009).

The difference between the Norwegian and U.S. ECEC contexts may also be a reason for our results. Access to affordable and high-quality childcare is one way to promote healthy development in children from lower socioeconomic backgrounds and thus to reduce inequalities (Esping-Andersen, 2007; Yoshikawa et al., 2012; Hall et al., 2013). Although we did not measure ECEC quality in the present study, research has found that children in the U.S. are more likely to experience high-quality ECEC if they are from families with higher socioeconomic status (NICHD Early Child Care Research Network, 2006; Sohr-Preston et al., 2013). In contrast, Norway has universal access to state-regulated and subsidized ECEC, and most children stay fulltime in ECEC centers from age 1 year until they start formal schooling. There is also little evidence that children from families with higher socioeconomic status select differentially into better ECEC centers (Rege et al., 2018). Prior research has found that the introduction of universal ECEC in Norway had positive long-term effects on children's educational attainment and labor market participation (Havnes and Mogstad, 2011).

Child Gender

In the present study, Norwegian girls had significantly higher levels of self-regulation than boys, but there were no significant gender differences in the U.S. sample. Gender differences in children's self-regulation did not significantly differ across the two samples. Our results are in line with prior studies conducted in Norway and the U.S. reporting gender differences in favor of girls or no gender differences (McClelland et al., 2007; Matthews et al., 2009; Wanless et al., 2013; Størksen et al., 2015; Backer-Grøndahl and Nærde, 2017). Findings across other cultures are also inconsistent, which may be due to different educational approaches and assessment tools (e.g., directly assessed vs. teacher-report; Wanless et al., 2013; Gestsdottir et al., 2014; McClelland et al., 2015). For example, other cultures (e.g., France, Germany, and Asia) that have a structured learning environment and place more emphasis on academic achievement may also systematically support children's self-regulatory skills from an early age. Thus, it may be that a structured learning environment allows both boys and girls to develop self-regulation, resulting in smaller gender differences on these skills (Wanless et al., 2013; Gestsdottir et al., 2014).

The gender differences found in the Norwegian sample might be explained by different expectations for girls' and boys' self-regulation (Chick et al., 2002; Meland and Kaltvedt, 2017). Different gender expectations may be overrepresented in unstructured learning environments, such as in the Norwegian ECEC system. For example, when activities are unstructured and when adults are not involved in children's play, children spend the majority of their social interactions with members of the same gender in preschool (Fabes et al., 2003). The experiences that girls and boys get in their segregated groups differently contribute to their development, and girls' interactions are more likely to be cooperative and less active than boys' interactions. Girls are also more likely to select activities and engage in behaviors that are adult structured and governed by social rules. Thus, girls may have more exposure to regulated styles of play, whereas boys may have more exposure to unregulated styles of play (Fabes et al., 2003). There is also some evidence that boys can be more sensitive to environmental experiences, including chaos, that might appear in an unstructured environment (Cameron Ponitz et al., 2009b). However, it is important to note that the gender differences in children's self-regulation in Norway were small, and gender differences did not significantly differ between the Norwegian and U.S. sample.

Practical Implications

Prior studies have shown that self-regulation is related to school readiness and later academic achievement across cultures (Duncan et al., 2007; Wanless et al., 2013; Gestsdottir et al., 2014; Backer-Grøndahl et al., 2018), which emphasize teacher's responsibility to facilitate the learning environment so that children receive opportunities to develop self-regulation in the early years.

There are many ways to stimulate children's early self-regulation, and prior research has shown that social play (Center on the Developing Child at Harvard University, 2011) as well as teacher-initiated games targeting self-regulation improves children's self-regulation (McClelland et al., 2019). However, as girls and boys are likely to select different activities when the learning environment is unstructured, the varying experiences could promote self-regulation differently in girls compared to boys. Tuastad et al. (2019) suggested combining aims and insights from the best of the two pedagogical worlds. Thus, a combination of the play-based and child-centered approach and the school readiness approach with systematic training over time may be the best way to promote gender and social equality.

In the U.S., only about half of the children attend ECEC from age 3 to 4 years, and for the youngest children, it is only 18%. High-quality ECEC can be especially beneficial for disadvantaged children (e.g., Yoshikawa et al., 2012). Thus, policy-makers can focus on ways to ensure better access to high-quality ECEC for all children at an early age in the matter to reduce inequalities among children in the U.S. (Esping-Andersen, 2005, 2006).

Limitations and Future Directions

In the present study, the Norwegian and U.S. children were drawn from convenience samples, which only included children with prior preschool experience. Thus, the samples matched each other in several ways (Minkov, 2013). However, they may not be representative of the populations in the U.S. or Norway. Although the sample from Norway was largely representative of the typical educational experiences of children from that culture (i.e., attending an ECEC), children in the U.S. sample consisted only of children who attended at least 1 year of preschool, which is a minority (46%) of the total population (Early Care and Education Profiles, 2018). There is some evidence that attending high-quality preschool has the potential to support children's development of cognitive and self-regulatory abilities and to combat the effects of social and economic inequalities (Hall et al., 2013).

In addition, children tested in Spanish in the U.S. sample were excluded from analyses because the current Norwegian sample did not include a similar group. ELL children in the U.S. can differ from the larger population in many ways that have important implications for children's development (Wanless et al., 2011b; Han, 2012; McClelland and Wanless, 2012). Thus, there might be larger cultural differences than were adequately captured by the current data. Future research should investigate this topic more broadly with larger national representative samples, which would allow for the possibility to investigate more fine-grained similarities and differences across different subgroups of children in each population (Minkov, 2013).

In addition, in the present study, there was a large proportion of missing data on maternal education in the U.S. sample. Missingness on this variable was associated with a higher likelihood of minority status and lower scores on the HTKS task. Even though these auxiliary variables were included as covariates in all subsequent analyses, the significant association found between maternal education and children's self-regulation in the U.S. sample might still be underestimated. Different patterns of missing data can influence results in the way that it can partially mask or underestimate associations between variables, which can be difficult to account for in observed variables alone (Enders, 2010). Thus, even though a significant effect was found between maternal education and self-regulation in the U.S. sample, the result might larger than what the current estimates provide.

Many studies use the country as a proxy for culture (Wanless et al., 2011a; Minkov, 2013). In the present study, we also investigated the influence of gender and mother's education level on children's self-regulation across two Western cultures. Vélez-Agosto et al. (2017) postulated that differences between cultures are evinced at a micro-level and that culture is not a separate system operating from a macro level but is within every action. Thus, culture manifests itself within everyday practices of social groups, such as families or classes. This has implications for research focusing on child development because it highlights the relevance of considering specific daily practices within communities or institutions, like families, ECEC centers, and schools. Global cultural influences are by no means irrelevant; however, future research would benefit from also examining the influence of other contextual factors at the micro-level across cultures (e.g., expectations on children's self-regulation and structural and process quality in ECEC) on the development of children's self-regulation.

According to the bioecological model of development (Bronfenbrenner, 1979; Bronfenbrenner and Morris, 2006), development occurs in an interaction between the child and the social context over time (chronosystem). Thus, future research should be conducted with samples of younger children, children not attending ECEC and school-aged children. Finally, future studies should use more than one direct measure of self-regulation, and they should also include measures that differ in terms of method of assessment (e.g., teacher-ratings) because prior research has shown that the relations between the HTKS task and teacher-rated self-regulation differ across countries (Wanless et al., 2011a). Although the present study used a behavioral self-regulation task, future studies could profit from including other aspects of self-regulation, such as emotional and more cognitive self-regulation tasks. For example, maternal education has been found to significantly predict the cognitive aspect of self-regulation [cool effortful control (EC)] but not the emotional aspect of self-regulation (hot EC) (Backer-Grøndahl and Nærde, 2017). Although cognitive and emotional aspects of self-regulation are related, examining differences in the factors that influence them is an important avenue for future research.

CONCLUSION

Findings from the present study suggest that children's levels of self-regulation, as measured by the HTKS task, were not significantly different between samples from Norway and the U.S. Furthermore, results indicate that maternal education level was related to U.S. children's self-regulation but not to Norwegian children's self-regulation. We also found gender differences

(favoring girls) in the Norwegian sample but not in the U.S. sample, although effects were small in the Norwegian sample and the influence of gender did not significantly differ across the two samples. The present study highlights the importance of cross-cultural studies, as results from one cultural context may not be valid for other cultural contexts.

DATA AVAILABILITY STATEMENT

The data analyzed in this study is subject to the following licenses/restrictions: We are not allowed to share data outside the key personnel for the grant by the Norwegian Centre for Research Data (NSD) and the Internal Review Board (IRB) at Oregon State University. Requests to access these datasets should be directed to RL, ragnhild.lenes@uis.no.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by Norwegian Centre for Research Data (NSD) and the Internal Review Board (IRB) at Oregon State University. Written informed consent to participate in this study was provided by the participants' legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

RL: conceptualization, investigation, writing, methodology, formal analysis, original draft preparation, and preparing data sets. CG: conceptualization, investigation, writing, methodology, formal analysis, preparing data sets, and supervision. IS and MM: conceptualization, investigation, writing, funding acquisition, and supervision. All authors contributed to the article and approved the submitted version.

FUNDING

The research here was supported by (1) the Norwegian Research Council grant number 203326 and 237973 and (2) the United States Department of Education Institute of Education Sciences grant number R305R305A100566 to MM, Oregon State University. The Publication fee was supported by the Norwegian Research Council grant number 270703.

ACKNOWLEDGMENTS

We are thankful to all children, parents, and teachers who participated in this study.

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Conflict of Interest: The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.