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Chapter 13. Early Skills as Predictors for Later Educational Outcome in Mathematics and Science in Finland and Sweden - A Further Analysis on TIMSS 2015 Data

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Abstract

Family-related factors, like parent's educational level, expectations and socio-economic variables have a significant impact on students' educational outcomes. In this study our aim is to examine how parental attitudes and the socioeconomic status of student's family are related to student's early literacy and numeracy skills and, further, to student's performance in mathematics and science in the TIMSS assessment. As data we use the latest TIMSS 2015 data collected from parents and students in Finland and Sweden and further as method we use path analysis. According to the results, all considered variables have a highly significant and positive direct effect on the 4th grade student performance. However, some differences between the countries emerged. The results of this study highlight the importance of high-quality early childhood environments on students later educational outcome.

Introduction

A child's learning happens in an ecology with home and different learning environments. The educational outcome of a child is a complex construct of many factors affecting each other's (Garvis, Harju-Luukkainen, Sheridan, Williams, 2019). It is important to note, that the impact of these factors are individual. According to Considine & Zappala (2002) the effect of parental SES on children's educational outcomes may be neutralised, strengthened or mediated by a range of other contextual, family and individual characteristics. Therefore, what families have as material resources can mediate what family members do (ibid.) and these have further consequence on the child's educational outcome. The age of the child is also of importance. The younger the child is, the stronger the influence of the family is (Caro, James and Douglas, 2009).

As stated, family related factors affect children's educational outcomes and they include among others family's socio-economic and cultural status (Harju-Luukkainen & Vettenranta, 2014; Yamamoto & Holloway, 2010). A rich body of research point out, that socio-economic hardship put children in an underprivileged position. Here, contextual indicators are among the most important ones and they predict attainment, learning trajectories and later also career outcomes (Banerjee 2016). According to OECD (2016) learning should not be hindered or restricted in any way even if a child comes from a poor family, has an immigrant background, is raised by a single parent or has limited resources at home. This is something that most of today's successful educational systems have understood, and the different systems have found various ways to allocate resources so as to level the playfield (OECD, 2016). Further, family's material resources like socioeconomic status and educational background can influence what family members do. This can be seen in parental attitudes, expectations (Siraj-Blatchford, 2010) and how they support their child (Christenson, 2004; Fantuzzo, Tighe & Childs, 2000). However, not all parents are equipped with equal possibilities to support their child, and here expert skills are needed from the educators (see for instance Uusimäki, Yngvesson, Garvis & Harju-Luukkainen, 2019).

As mentioned above, child's learning happens in an ecology with home and different learning environments. One important environment is early childhood educational context. Through a collaboration between family and ECEC, parents will get a broader perspective on their child's overall growth, development and learning as well as in this collaboration their attitudes are formed. In Finland the co-operation (also called the partnership, parental involvement or parental collaboration) with the parents is highlighted in the Finnish ECEC steering documents. An entire chapter in the national core curriculums for ECEC (Finnish National Agency for Education 2016; 2018) is devoted to this parental participation and its implementation. The National Core Curriculum for ECEC (Finnish National Agency for Education, 2018, p. 14) defines its mission as following "*The mission for ECEC is to advance children's overall growth, development and learning in collaboration with the guardians of the child. ECEC is a service that promotes equality and equity and prevent social exclusion. The skills and knowledges children learn during ECEC strengthens children's active engagement in the society. Furthermore, ECEC supports guardians in their parenting and makes it possible for them to work or to study.*" According to the National Core Curriculum for ECEC (Finnish National Agency for Education, 2018, 32-33), the aim for the partnership is meeting the needs of the child to ensure their growth-, development and learning. The partnership between ECEC and parents is defined by such terms as, "trust, respect, and equality... and parental knowledge is underlined" (Alasuutari, 2010, 150). The initiation of a collaborative partnership is the role of the ECEC and requires expert collaboration skills as well as in meeting families with understanding and respect. In this partnership the family's diversity and children's individual needs are take into consideration. The importance of open and positive dialogue between the guardians and the personnel is emphasized during two occasions. Firstly, when an ECEC educational plan is designed for each child and secondly, when a support plan for child's development and learning is designed.

In Sweden this collaboration is not as defined as clearly as in the Finnish policy documents. However, in Sweden the ECE must follow, like in Finland the national curriculum and are duty-bound to actively promote understanding and communication between the parents and the teachers. The purpose of this is to build trust between the child's main learning contexts and to ensure a safe environment in which each child is met and treated as an individual. The task of the preschool is to also to help families by supporting them in their role of bringing up and helping their children to grow and develop. The task of the preschool means "*working in cooperation with parents so that each child receives the opportunity of developing in accordance with their potential*" (Curriculum for preschool Lpfö 98, p. 4).

In this study, the focus will be on parental attitudes, home educational resources and students' early skills before school start and on later educational outcomes. Therefore, also the theoretical frame of this study will be constructed of these different, but intertwined research areas. From these premises we have formulated two research questions. We firstly explore how 1) parents' educational level, home resources and parental attitudes towards mathematics and science are connected to students' early competencies and to their competencies on the fourth grade. Further we explore 2) how largely early competencies predict educational outcome on the fourth grade in both Finland and Sweden. Here a comparison between the Finnish and Swedish data is presented. The results are presented with the help of a path analysis.

Theoretical frame

The theoretical frame of this paper constructs of three sections. These sections have been developed from our research questions. Firstly, we take a closer look on the effect of

socioeconomic status on children's educational outcome. Secondly, we look at early skills and its connection with later educational outcome and thirdly we focus on parent's attitudinal influence on student's educational outcome.

Socioeconomic factors affecting educational outcomes

One of the mostly studied factors affecting child's educational outcome is the socioeconomic status (SES) and therefore there is a rich body of research evidence and an understanding of the effect of family's SES on children's educational outcome. It has typically been studied in sociological and educational research on educational inequality to address or control for socioeconomic differences. SES is generally regarded as one of the major variables in explaining student performance, together with institutional variables and other social status indicators such as ethnic background, gender, and other family-related factors (e.g. Yang, 2003). For instance, The Trends in International Mathematics and Science Study (TIMSS) provides information on SES indicators related to student achievement including the parental education level, the number of books at home, and home educational resources. TIMSS data has consistently shown positive effects between student achievement and SES indicators (see Baker, Goesling & LeTendre, 2002; Bouhlila, 2015; Byun & Kim, 2010; Chudgar and Luschei, 2009; Hanushek & Luque, 2003; Harris, 2007; Liu, Wu, & Zumbo, 2006; Takashiro, 2016; Yang, 2003). Recently, Takashiro (2016) found that the number of books, the possession of computers, and parental education as student SES indicators had a positive effect on student mathematics achievement by using TIMSS 2013 Japan data. The largest predictor was the number of books, which accounted for 10.7% of variance in student achievement. Overall, student SES appears as a strong contributor to student achievement in TIMSS. In Korea, Byun & Kim (2010) reported a strong relationship between student SES and achievement in TIMSS data from 1999, 2003, and 2007.

Sirin (2005) conducted a meta-analytic review (comprising 58 articles from 1990 to 2000) of the relationship between SES and student achievement at both individual and school level. According to Sirin (ibid.), family's socio-economic status is a strong correlate of academic performance at the individual level (average correlation of 0.299). Students with higher family SES are found to have much higher educational achievement than those having poorer family resources, and vice versa (e.g. Okpala et al., 2010; Engin-Demir, 2009; Yang, 2004; Battle and Lewis, 2002; Tomul and Savasci, 2012).

However, it is important to note that the explanatory power of SES-related factors for student achievement varies in different countries. Baker et al. (2002) reported that the student SES explained from 1.5% to 20% of math and science test score variation, depending on the country. In Finland socio-economic background explains very little of the between-student variance in mathematical literacy. According to Harju-Luukkainen, Nissinen, Sulkunen & Suni (2014) student's socio-economic and cultural status index (ESCS) could only explain approximately 9 percent of the between-student variance in PISA 2012 mathematics test results. This was among the lowest percentages within the OECD countries (OECD average 15 percent). Also among students with an immigrant background in Finland the ESCS index explained only 10 percent of the variance between students. This has led also to an assumption that the ESCS explanatory power would be as low throughout Finland and through the education span. The latest research has however been proven this assumption wrong. For instance, the effect of ESCS index in Finland vary somewhat between the different parts of the country (Harju-Luukkainen & Vettenranta, 2013).

The influence of SES-related factors is not constant throughout the span of schooling. The younger the child is, the stronger the influence of the family is. Caro, James and Douglas (2009) found out that the achievement gap caused by SES varies by student age groups from childhood to adolescence. According to their findings, the gap remains stable from the age of 7 to 11 years and widens increasingly from 11 to 15 years. This bears no clear implications for interventions, however – these are most likely needed and benefit disadvantaged children at any age from early childhood to adolescence. As such, SES-related differences in learning outcomes seem to remain more modest during elementary school but tend to grow significantly wider at the upper grades and stages.

Early skills as predictors for educational outcome

Early childhood has become a priority in policy in many countries (Garvis, Philippon & Harju-Luukkainen, 2018). There is a wide notion that high quality early childhood education (or learning environments) will provide many benefits for children and families both in short as well as in long term. However, according to Taguma, Litjens & Makowiechki (2012) these positive benefits are related to the ‘quality’ of early childhood education. The challenge in this lies in the fact, that the definition of quality differs across countries or across different interest groups. There are to be found research on the quality of early childhood environments from different perspectives, but lesser focus has been paid towards family’s influence, thus parents are child’s first educators.

Parents provide their child, alongside with other learning environments, a broad mathematical and early literacy input. What type of an input this is, is of importance, since early years mathematical knowledge is strongly correlated with later mathematical and reading skills (Watts, Duncan, Siegel & Davis-Kean, 2014). Similarly, according to Hannover Research (2016) early academic skills related to literacy and math are the most significant predictors of future academic achievement. Also, children’s early non-academic skills, such as social competence and self-regulation, also contribute to school success.

However, not all kind of support have an impact on the child’s skills. Zippert & Rittle-Johnson (2018) found barely any links between parent support and children’s broad mathematical skills. Further, according to a recent longitudinal study of 554 three-year-old children, conducted by Lehr, Ebert, Blaurock, Rossbach and Weinert (2019), show that book exposure and the quality of verbal interaction regarding mathematics both predicted mathematical outcomes in secondary school and those effects were mediated through early language and arithmetic skills. Reading outcomes in secondary school were not directly predicted by early home learning environments but indirectly via early language and literacy skills. Path models revealed that the different dimensions of the early home learning environments were differentially associated with pre-schoolers’ early competencies. All effects remained significant when including the concurrent home learning environments during secondary school which predicted reading outcomes directly. Therefore, the quality of early learning environments seems to have an impact on later outcomes, which in turn have an impact on student future prospects. The impact of early academic skills on student’s educational outcome can in turn vary dependent on gender, socioeconomic status and English proficiency (Hannover Research, 2016).

Parental influence

Parents’ can influence their child in multiple ways. However, parental attitudes and parental expectations are two different things. Their attitudes on mathematics and science are important, but not necessarily highly correlate with their child’s attitude. Mohr-Schroeder et al. (2017) investigated parents’ attitudes towards mathematics and parents’ influence on students’ attitude.

According to their results parents' and students' attitudes towards mathematics were correlated, but only 5.6% of the variation in students' attitude could be explained by the variation in parents' attitudes. Expectations towards academic achievement seems to be a more important factor, however the research results in this matter are still very controversial. According to a study conducted by Loughlin-Presnal & Bierman (2017) in the USA, bidirectional longitudinal associations emerged between parents' academic expectations and child academic outcomes. Child's perceived academic competence mediated this association from second to fifth grade. In a study conducted by Froiland & Davison parental expectations were positively related (standardized path coefficient=.44) to positive school outcomes and had a stronger effect than SES (standardized path coefficient=.24). The findings suggest that educators should be aware of the potential for parents to play a significant role through expectations and developing supportive relationships with educators. Further, Yan and Lin (2005) studied parent involvement and mathematics achievement. The findings indicate that parent expectations had a strong positive effect on 12th graders' mathematics achievement. According to Vukovic, Roberts, & Wright (2013) parental home support and expectations influenced children's performance in mathematics. However, not all results point out to a clear correlation between parental involvement and positive changes in achievement. El Nokali, Bachman & Votruba-Drzal (2010) investigated children's trajectories of academic and social development across 1st, 3rd, and 5th grades. Hierarchical linear modelling was used to examine within- and between-child associations among maternal and teacher reports of parent involvement and children's standardised achievement scores, social skills, and problem behaviours. Findings suggest that within-child improvements in parent involvement predict declines in problem behaviours and improvements in social skills but do not predict changes in achievement.

Data

TIMSS is an international assessment of mathematics and science at the fourth and eighth grades. The first TIMSS assessment took place in 1995 and the program has continued with subsequent rounds every four years since then. Approximately 70 countries were involved in TIMSS 2015, which makes it one of the largest international assessments in the world. TIMSS is conducted by the International Association for the Evaluation of Educational Achievement (IEA), which is an independent international cooperative of national research institutions and government agencies doing cross-national achievement studies. The assessment yields information not only about students' overall achievement, backgrounds and attitudes toward mathematics and science but also about their teachers' education and training, classroom characteristics and activities, and school contexts for learning and instruction in mathematics and science. Therefore, TIMSS 2015 assessment employed questionnaires for students' as well as for parents, schools and teachers, respectively.

In this study we used TIMSS 2015 data, conducted for fourth graders. We used data collected from two countries, from Finland and Sweden. Here we looked closer at the Early Learning Survey, directed to parents, as well as for data collected from the students. The Finnish data comprised in total of 158 schools and 5251 students and the Swedish data comprised of 144 schools and 4142 students.

Methods

In this study our aim was to examine how parental attitudes and the socioeconomic status of student's family are related to student's early literacy and numeracy skills and, further, to student's performance in mathematics and science in the TIMSS assessment. This was done by fitting a path model to the Finnish and Swedish TIMSS data sets. The parental attitudes towards mathematics and science is measured in TIMSS through a quantitative index (TIMSS variable

ASBHAMS) derived from eight statements in the Early Learning Survey, directed to parents. In the fourth-graders' TIMSS data the family SES is measured with a composite index (TIMSS variable ASBGHRL, 'home educational resources') constituting of variables concerning parents' educational level, occupational status, number of books and children's books at home as well as student having an Internet connection or own room available (Martin, Mullis & Hooper 2016). In measuring students' early competencies, we employed two quantitative indices (TIMSS variables ASBHELT and ASBHENT, 'early literacy tasks' and 'early numeracy tasks') formed from 13 items in the parent questionnaire. These items deal with what literacy (six items) and numeracy (seven items) skills the child possessed before he/she started school, assessed by his/her parent. Due to the high inter-correlation between these indices we combined them into a principal component to be used in our analyses. Finally, we created a variable measuring student's competency at Grade 4 by forming a single principal component from the student's mathematics and science scores (i.e. we performed a principal component analysis of five plausible values of mathematics and five plausible values of science). The chosen approach was path analysis. The target was to analyse, whether the home resources and parental attitudes affect directly the student performance in the 4th grade, and do the early skills possess an intermediary role. The model contains five path parameters: two effects of parental attitudes, two of home resources and one of early skills. In addition, the model contains variances of all variables and the correlation between parental attitudes and home resources.

Results

The Finnish data, the saturated model showed only sufficient fit to the data. That is, all effects were highly significant, and no parameter could be removed from the model without sacrificing the model fit. In the Swedish data, the parental attitudes have no significant direct effect. These held equally for girls and boys. In addition, the parameter estimates of girls and boys were very similar, suggesting that the pooled model would be valid for the both genders and in Finnish and Swedish data as well. The estimation results of the pooled models are shown in Figure 13.1.

All considered variables have a highly significant and positive direct effect on the 4th grade student performance. Of them, the strongest association is observed with student's early skills (0.38 and 0.25) and the relation between home resources and student performance (0.29, 0.45), while the association of parental attitudes with Grade 4 performance is relatively weak (Finnish data) or insignificant (Swedish data). It is however worth noting that parental attitudes and home resources are correlated (0.24, 0.23).

The home resources and parental attitudes have positive effects on the early skills also. It is interesting that home educational resources seem to be associated more strongly with the Grade 4 performance than the skills child possessed before starting school.

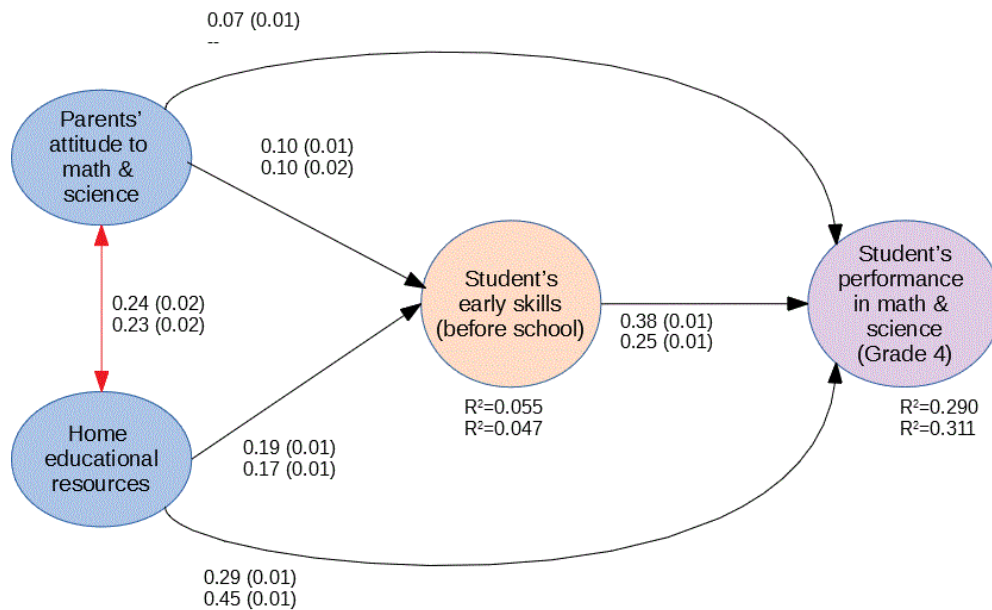


Figure 13.1 The estimated path model of the Finnish (upper numbers) and Swedish data (lower numbers). Standard errors of the parameter estimates are given in parentheses.

The path model explained 29 percent of the variance in Grade 4 performance in the Finnish data 31 percent in the Swedish data. The proportion of variance in the early competencies, which parents' attitudes and family SES explained was not more than 5 percent. The estimated effects of parental attitudes and home resources on early competencies are quite similar in Finland and Sweden. Instead, the effects on 4th grade performance are somewhat different. The direct effect of home resources is significantly stronger in Sweden than in Finland, while the opposite holds for the effect of early competencies.

Conclusions and recommendations

In this paper our aim was, with the help of path analysis, to explore how parents' educational level, home resources and parental attitudes towards mathematics and science are connected to students' early competencies and to their competencies on the fourth grade. Further we explored how largely early competencies predict educational outcome on the fourth grade in both Finland and Sweden. As data we use the latest TIMSS 2015 data collected from parents and 4th grade students in Finland and Sweden.

According to figure 13.1, Somewhat surprisingly in the Swedish data, parental attitudes towards science and math had no significant direct effect on student's educational outcome in math and science on the fourth grade. The effect was a bit larger (.10), however still weak, when it comes to parents' attitudes effect on students' early skills in both of the countries. Therefore, according to the results of this study, parental attitudes seems to play a minor role in students' educational outcome, however these are positively connected. This finding is in line with previous research (Mohr-Schroeder et al., 2017). Unfortunately, parental expectations were not studied in TIMSS, which might have given another type of results on parental influence on educational outcome (Loughlin-Presnal & Bierman, 2017; Yan & Lin, 2005).

There is a clear positive effects between student achievement and SES indicators in international studies as well in the results of this study (Baker, Goesling & LeTendre, 2002; Bouhlila, 2015; Byun & Kim, 2010; Chudgar and Luschei, 2009; Hanushek & Luque, 2003; Harris, 2007; Liu, Wu, & Zumbo, 2006; Takashiro, 2016; Yang, 2003). According to the results of this study, the direct effect of home resources was significantly stronger in Sweden than in

Finland. The fact that the Swedish students home resources were more influential when it comes to the educational outcome, is somewhat concerning. The less home resources effect on student's educational outcome, the better the education system is in 'levelling the playing field' (see further OECD 2016) and giving students equal opportunities. On contrary, the direct effect of early skills was significantly stronger in Finland, compared to Sweden. This poses a challenge, in making sure that all children are exposed to high quality early learning environments. We know from previous findings that for instance the attendance to early childhood education is much higher in Sweden, compared to Finland (see for instance Garvis, Harju-Luukkainen, Sheridan, Williams, 2019).

The path model described in this study was able to explain 29 percent of the total variance in fourth grader's performance in the Finnish data and 31 percent in the Swedish data. This is a large proportion, but still only few studies have been conducted on the connections between the different areas described in this study. Therefore, the results underline a need for additional research in order to understand the mechanism between family related factors, early learning skills and later educational outcome in different student groups.

The results of this study point out the importance for all children to have a possibility to take part in high quality early childhood environments, since early skills in math and science have a direct effect on the child's later educational outcome in science and math (see also Taguma, Litjens & Makowiechki, 2012). Both the Finnish and Swedish ECEC, is based on an integrated approach supporting children's wellbeing through care, education and teaching, the so-called "educare" model, where learning through play has an important role. Also, in both environments the parental collaboration is highlighted in order to support child's overall growth, development and learning. Therefore, one aspect of high-quality learning environment is well organised as well as conducted collaboration with the parents. However, how this parental collaboration is put into practice varies. Through good collaboration parents can receive tools to support their child and to develop their own attitudes towards, for instance, education. The ECEC is one important early learning environment and it therefore also has one of the key roles in leveling the later playing fields for individual children. This important work includes parental collaboration as well.

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