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Explaining achievement inequality in primary schools using social contagion theory

A quantitative study on Dutch primary education

Key words: inequality, primary education, spatial autocorrelation, social contagion

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ABSTRACT

Unequal opportunities in education disadvantage certain individuals, but also prevent people to make their maximum contribution to society as a whole. The objective of this research is to better understand the dynamics of educational achievement, so governments can better pursue their goal of letting children reach the maximum potential out of themselves and their education. Using Anselin Local Moran's I and multiple linear regression, it was found that achievement differences in Dutch primary education are present. The effect of social contagion between children on their educational achievement is highly dependent on the specific composition of factors like parental education, neighborhood income and neighborhood ethnicity. Raised awareness about the critical role that social contagion might have in classroom dynamics can help in moving towards a more equal education system.

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List of Abbreviations

BRIN	<i>Basisregister Instellingen</i> , a unique identification number for institutions in the Netherlands
CBS	Statistics Netherlands
CET	<i>Centrale Eindtoets</i> , a type of final test for primary schools in the Netherlands
DUO	The Education Executive Agency of the Dutch Ministry of Education, Culture and Science
GPA	<i>Grade Point Average</i> , the weighted average for all course grades in secondary school in the United States
IEP	<i>ICE Eindevaluatie Primair Onderwijs</i> , a type of final test for primary schools in the Netherlands
SAT	A standardized test widely used for college admissions in the United States
SES	Socio-economic status
VIF	Variance inflation factor, factor to check if no multicollinearity between the explaining variables exists

1. INTRODUCTION

Education is considered to be one of the strongest influencers to the development of societies. It can be used to steer societies in a positive direction or to prevent undesirable social developments (Dronkers, 2011). Unequal opportunities in education therefore not only disadvantage certain individuals, but also prevent people to make their maximum contribution to society as a whole. For this reason, it is a challenge for governments to let all children get the maximum potential out of themselves and their education.

Previous research pointed out several factors that play a role in the educational development of a child, like cognitive ability (IQ), self-beliefs and socio-economic status (SES) (Greven et al., 2009). Beyond these individual factors, geographical aspects like school and neighborhood factors affect educational achievement as well. In studies about these geographical aspects, the emphasis is often laid on the effect of the school's and neighborhood's SES, ethnicity and/or the degree of urbanity that children are situated in. For example, evidence has been found that SES on both the school and neighborhood level positively affects educational achievement, while a higher prevalence of immigrants in an area lowers educational achievement (Sykes & Musterd, 2010; Pong & Hao, 2007; Kauppinen, 2008). Despite the rather broad range of research that has gone into school and neighborhood effects on educational achievement of an individual, it is yet undiscovered whether, and to what extent, pupils with different backgrounds affect each other's educational achievement.

Drawing on the aforementioned research, it seems obvious that schools with children that all live in high-SES neighborhoods with a low prevalence of immigrants, show better results. Likewise it is presumable that schools with children that exclusively live in less advantaged areas, show lower results. It would be easy to conclude that schools serving children from both more *and* less advantaged areas would score average. However, it might be a bit more complicated than that. When children go to the same school, they are in each other's physical proximity and while they interact with each other, they are susceptible to be influenced by their peers. These influences may lead to the spreading of certain behaviors, beliefs and attitudes in a school, a process known as *social contagion*. Through social contagion, behaviors, beliefs and attitudes become more similar (Burgess et al. 2018). As a result a child from a less advantaged area might benefit from being in a "better" peer group if it goes to school with children that live in more advantaged areas. A child from a more advantaged area might experience negative effects likewise (Van Ewijk & Slegers,

2010). Therefore, alongside the effect of the *average pupil background* on the average results of a school, the composition of children within a school might play a role as well.

The objective of this research is to better understand the dynamics of educational achievement. A better understanding of this could open the door to new tools for governments to pursue their goal of letting children get the maximum potential out of themselves and their education. This leads the way to the research question of this study:

❖ **To what extent does social contagion between children from different ethnic and socio-economic living environments affect educational achievement?**

To build towards an answer to this question, several sub questions will be studied:

- ❖ How big are the *current* achievement differences between Dutch regular primary schools?
- ❖ To what extent can the average achievement in a school be explained by its pupils' *average* ethnic and socio-economic living environment characteristics?
- ❖ To what extent can the average achievement in a school be explained by its pupils' *variation* in ethnic and socio-economic living environment characteristics?

This research is delimited to primary education. Of course, the social benefits that can be achieved from education, result from education at all ages - not only from primary education. However, because primary school children are still very young and their educational opportunities largely depend on their primary school achievement, this stage of their educational career is very – perhaps most – vital to their further development. To determine educational achievement, results of the final test that children take at the end of their primary education will be considered.

To measure the impact of social contagion between pupils on their educational achievement, quantitative methods will be used. Quantitative methods are most suitable for recognizing general patterns as opposed to qualitative methods, as quantitative methods allow to include each single regular primary school within the Dutch education system. Once general mechanisms have been discovered, qualitative studies can be useful to advance theories.

To answer the research question, the study is structured into different chapters. In the second chapter, different theories on the topic will be discussed and literature that already exists will be reviewed. Specific attention will be given to social contagion theory. Based on that, possible outcomes of this study are drawn. This will be summarized in a conceptual framework. After that,

in the third chapter, the methodology will be explained. This includes not only the way in which the variables are analyzed, but also the way the data will be collected and edited. It critically reflects on data quality and the implications that this will have on the final outcomes. Then, in the fourth chapter, the results of the data analysis will be revealed and the chapter will serve as a guide through the interpretation of these results. The fifth chapter discusses strengths and weaknesses of the research and ends in a conclusion, where the results are put back into the wider context.

2. THEORETICAL FRAMEWORK

In order to discover to what extent social contagion between pupils influences their educational achievement, this chapter elaborates on existing theories and literature that can help to explore the subject. Section 2.1 shortly highlights a set of cultural and socio-economic factors that (dis)advantage children's educational opportunities. Section 2.2 illustrates the existence of homogeneous schools, which predominantly accommodate pupils with either advantaged or less-advantaged positions. Section 2.3 illustrates the existence of heterogeneous schools, which accommodate a mixed ethnic and socio-economic group of pupils. The differences between homogeneous and heterogeneous schools are important, as they determine the exposure of pupils to peers that are in different positions. Section 2.4 and 2.5 elaborate on the social contagion model, and explain how larger differences within classes create more space for social contagion to occur. It also argues how this could impact school results. In section 2.6 the compositional effect is discussed. It must be emphasized that it is *not* the compositional effect that is being measured in this study. Instead of measuring the compositional effect (that is: measuring the impact of the average classroom SES on individual school achievement), this study measures the impact of diversity of SES in a school on the average school achievement. However, the compositional effect shows strong similarities to this study as both are trying to measure the effect of peers on each other's educational results. Section 2.7 and 2.8 present the possible outcomes and the conceptual framework of this study.

2.1 Neighborhood level determinants of educational achievement

Next to personal factors like cognitive ability (IQ) and self-beliefs, socio-economic status plays a significant role in educational achievement (Greven et al., 2009). Children that are born in low socio-economic families generally tend to achieve lower in school than children growing up under more beneficial circumstances. For example, Halle et al. examined the effect of the parental educational level on achievement-related behavior and beliefs by parents in low-income, African American families. They found that mothers with a higher educational background had higher expectations for their children's academic achievement and that these expectations were related to the children's actual achievement in math and reading (Halle et al., 1997).

Especially when it comes to measuring *children's* SES, it is not always clear what is meant by the term SES. Generally, the most commonly used indicators for SES are income and education level. Although these two indicators often correlate with each other, they are also very different.

Educational level rather determines the cognitive and cultural aspects of SES, while income emphasizes material aspects. Besides, education level is often stable throughout the life cycle, while income is more sensitive to fluctuation (Kunst, 2010). Next to viewing these indicators under the common denominator of SES, it is therefore important to continue regarding them as individual indicators as well. However, for children it is harder to determine SES using these indicators, as they normally do not have an own income and they have yet to reach their educational level. Because of their dependency in terms of socio-economic resources, the situation of their direct environment is often considered. This entails the family situation, but also the neighborhood children grow up in.

The neighborhood that children grow up in matters for their educational achievement (Pong & Hao, 2007). In a literature study that was performed by Leventhal & Brooks-Gunn (2000), the authors found consistent findings that having high-SES neighbors had a positive effect on school readiness and achievement outcomes, after accounting for individual and family characteristics (Leventhal & Brooks, 2000). One of the reasons for this is that children that are exposed to the effects of higher education or higher income are incited to reach the same goals by doing their best in school (Pong & Hao, 2007).

In addition to neighborhood SES, neighborhood ethnicity (which is sometimes considered as an SES indicator as well) is also relevant to the schooling of children, as children develop their language skills through communicating with peers (Pong & Hao, 2007). Not only does neighborhood ethnicity matter in terms of language development, but also the more general gap between school climate and cultural living environment disadvantages children living in non-native neighborhoods when it comes to school performance (Mulder et al., 2014).

Interestingly, it is often seen that children who live in comparable socio-economic and ethnic environments, end up in the same schools. The next section pays attention to this phenomenon and explains the drivers behind it.

2.2 How homogeneous schools arise

Children living in comparable socio-economic and ethnic environments, often end up in the same schools. This *filtering* of children into the same schools is caused by different processes. First of all, residential segregation in neighborhoods causes families with similar characteristics to be unevenly distributed over space (Karsten et al. 2006). Because the neighborhood population informs the local school population, this segregation of demographic groups is also visible in

particular schools (Sykes & Musterd, 2010). This reflection of neighborhood demographics in schools specifically occurs in countries where children get assigned a primary school based on the school catchment area they live in, like in the United States. In these countries, parents are prevented from sending their children to a school with demographics that are different from the neighborhood they live in. However, even in countries where parents *do* have the freedom of choice for a primary school, the composition of neighborhood demographics still affects school demographics. Taking the Netherlands as an example, Dutch families report the distance from their home to school as one of the most influential factors in their school choice decision (Karsten et al., 2006; Ten Broeke et al., 2003).

Different from the previous, the second incentive for the filtering of children into particular schools is parental choice of primary schools. In the Netherlands, where parents can freely choose a primary school for their children, it has been detected that not all school populations represent the district that the school is located in. In Amsterdam for example, 25% of the schools are either *too White* or *too non-White*, given the demographics of the neighborhoods these schools are located in (Karsten et al., 2006). Nationwide, 6.2% of all elementary schools in the Netherlands have pupil compositions that significantly differ from the neighborhood population composition (Karsten et al., 2006). The main reason for this lies within freedom of school choice: data from Amsterdam about home and school locations show that native Dutch families who live in relatively black neighborhoods, often dodge to whiter, more distant schools in other neighborhoods (Herweijer, 2008).

The last incentive for sorting children into particular schools that will be mentioned here is the existence of denominated schools. In the Dutch education system, all schools are funded on an equal footing, regardless of their religious nature (Karsten et al., 2006; Sykes & Musterd, 2010). Next to Christian and public schools, the introduction of migrant groups has resulted in schools that are denominated as Islamic or Hindu. These schools are almost by definition non-White (Karsten et al., 2006). The existence of these schools leads to an increase in the number of non-White schools.

All three aforementioned processes lead to what is referred to in literature as *black* schools and *white* schools. Intertwined with, yet different from black and white schools, the same processes also lead to respectively low-SES and high-SES schools (Herweijer, 2008). In the Netherlands, these groups of schools show great overlap. Like in many other societies, ethnic minorities in the

Netherlands are often worse off when it comes to their socio-economic position. As a result, achievement in black schools falls far short of the achievement of average primary schools (Herweijer, 2008). The relatively poorer socio-economic position of ethnic minorities is not the only explanation for their shortfall of school achievement. Other drivers behind poorer school achievement of ethnic minorities are language- and dialect use; a large gap between school climate and family culture; less educational stimulation from the family; and insufficient expectations of the teachers (Mulder et al., 2014).

One of the consequences for children attending either black or white schools and/or low-SES or high-SES schools, is that they are mainly exposed to children from similar backgrounds. Therefore, these children are less exposed to the potential benefits (or obstructions) of being around children of different backgrounds. Examples of such benefits are: being surrounded by children who have a good command of the Dutch language or having access to a higher *effective teaching time*. Effective teaching time may decrease in classes with many disadvantaged pupils, as more time may be lost to repetitions of the learning material or on disruptions due to the problems that pupils bring over from home or from the street (Herweijer, 2008). Due to the unequal exposure to these benefits between homogeneous schools, the gap between black/low-SES and white/high-SES schools remains preserved and may even widen (Van Ewijk & Slegers, 2010).

The filtering processes that have been described in this section should logically lead to particular schools that score disproportionately high or low compared to its surrounding schools. Identifying this would be interesting for answering the first sub question about current achievement differences in Dutch primary education. The methodology section (chapter 3) will elaborate on how this will be done.

2.3 Heterogeneous schools

Up until now, only the schools that are at the extremes of the advantaged-to-disadvantaged spectrum have been discussed. Although the aforementioned mechanisms do actually lead to schools that are primarily black/low-SES or white/high-SES, in practice there are many schools that are heterogeneous for this matter. In contrast to homogeneous schools, children at these mixed schools are exposed to peers from diverse backgrounds. Due to their physical proximity to one another, they are susceptible to influences from each other.

The presence of pupils from diverse backgrounds can affect learning behavior and learning outcomes of pupils. Examples of both positive and negative effects can be found in literature. An

example of a way in which negative effects could manifest themselves, is given in a Dutch report about ethnic minorities. In this report it is suggested that in schools with many non-native pupils, teachers adjust their way of teaching to the average weaker pupil. This leads to ‘downward leveling’: the most gifted children perform poorer than they potentially could, because their educational needs are not met (Tesser et al. 1995; Herweijer, 2008). Likewise, the concept of ‘upward leveling’ occurs in literature. Here, weaker pupils benefit from the higher demands that the teacher sets. Upward leveling is a common goal of education policy, but measures to achieve upward leveling (i.e. creating mixed groups) can also unwillingly lead to downward leveling (Franck & Nicaise, 2018).

Apart from the impact of teaching methods that teachers maintain, Driessen (2007) gives an overview of the potential positive and negative effects of the *cognitive class composition* and the central differences between cognitive-homogeneous and cognitive-heterogeneous groups. In a heterogeneous class, a pupil is exposed to peers of different cognitive levels. According to proponents of heterogeneous grouping, weaker pupils can pull themselves up to the better pupils. However, opponents of heterogeneous grouping find that both gifted and less gifted pupils suffer from this type of composition. Gifted pupils would miss the incentive of other gifted pupils and therefore perform below their level. The less gifted pupil would be demotivated by the fact that he always performs poorer than most peers (Driessen, 2007).

Without claiming that cognitive-homogeneous schools are equal to either black/low-SES or white/high-SES schools and cognitive-heterogeneous schools are equal to mixed schools, it has been detected that ethnic minorities generally perform lower in school (Herweijer, 2008). For that reason it is assumed that black/low-SES and white/high-SES schools tend to be *more* cognitive-homogeneous than mixed schools. Therefore, the notions of proponents of both homogeneous and heterogeneous grouping, can partly be applied this study as well.

The debate about class composition can be positioned within a central theory about group dynamics: social contagion theory. The next section will explain the concept and use of social contagion in further detail and will discuss how it can exert an effect on educational achievement.

2.4 Introducing social contagion

Contagion theory found its origins more than a century ago. Reason to hypothesize the existence of this effect was a wave of suicides across Europe. These suicides were committed by people that had come into contact with a book in which the hero commits suicide himself. This led to the idea

that certain behaviors and beliefs can multiply themselves through populations, as if they were somehow epidemic (Marsden, 1998). It is for this reason that contagion theory is often referred to as *epidemic theory*.

The word contagion literally means *from touch* and thus refers to a process of transmission by (physical) contact. Originally the term was solely used for the spread of biological phenomena, but later became popular as an explanatory instrument for social phenomena as well. Serious empirical research only started in the 1950s. It was then when strong evidence was found that under certain circumstances, just simple exposure to a culture is enough for social transmission to occur (Marsden, 1998).

There has been, and still is, much debate about the exact interpretation of the concept of social contagion. This has led to a large set of definitions. For example, the Oxford Dictionary of Psychology defines social contagion as *the spread of ideas, attitudes, or behavior patterns in a group through imitation and conformity*. In addition to the general idea that behavior spreads, this definition claims that this phenomenon occurs in groups, without specifying any conditional group size and how the behavior spreads between persons within the group. Furthermore, the spreading of behavior happens through imitation and conformity. Although this might sound somewhat vague, it seems to indicate that taking over the behavior of the group does not happen entirely unconsciously. Levy and Nail (1993) define social contagion as *spread of affect, attitude or behavior from person A (“the initiator”) to person B (“the recipient”) where the recipient does not perceive an intentional influence attempt on the part of the initiator*. In this definition, the recipient is rather portrayed as a passive entity that participates in the behavior, whether he likes it or not. Apart from that, this definition is more specific about how the behavior spreads between persons: it goes from one person to another. Remarkably, this definition does not explicitly claim that this process occurs in a group context.

Neither one of these two, nor any other definition, will be picked as the most accurate or correct definition of social contagion. However, to make sure that everybody interprets social contagion in the same way, this study uses the definition from *The Handbook of Social Psychology* (Lindzey & Aronson, 1985), which states that social contagion is *the spread of affect or behavior from one crowd participant to another; one person serves as the stimulus for the imitative actions of another*. This definition refrains from the presence of internal states, like (un)intentionality, while being specific about the nature of the spreading process at the same time.

2.5 Application of social contagion theory

Now that a wider picture of social contagion is acquired, its use in scientific research and literature will be considered. Social contagion theory is used in many different disciplines, among which marketing economics, sociology, psychology and the study of non-infectious diseases (Howard & Gengler, 2001; Christakis & Fowler, 2007). Also in the field of educational development the contagion model has been used before, though to a limited extent. In their article on how neighborhood and school factors influence school performance of immigrants' children, Pong and Hao (2007) discuss several mechanisms through which people in someone's environment exert an effect on the individual. In their argument, they predominantly focus on the negative influence that contagion can exert. One important peer influence to educational achievement they mention, is caused by peers who are foreign-born and do not speak Dutch as their mother tongue. Children that are exposed to peers whose Dutch proficiency is underdeveloped or incorrectly spoken are likely to adopt similar language use themselves, especially if Dutch is not their own primary language either (Pong & Hao, 2007). In turn, underdeveloped language proficiency could limit children to fully participate in the Dutch education system (Mulder et al., 2014).

Hornstra (2013) concludes that children with a lower socio-economic status more often deal with lower learning motivations and problematic behavior. If these attitudes or behaviors spread within classes or schools, this could lead to additional adverse consequences for schools' performances. An example of this can be found in Zimmerman (2003), who examined the effect of social contagion on SAT scores (standardized test used for college admissions in the United States) between two groups of roommates. Using random room assignment, he found that negative effects were present, but that they were more strongly linked to verbal SAT scores than to math SAT scores. The study suggested that scores of students who had average GPA (weighted average for all course grades in secondary school) were likely to drop when they had a roommate in the bottom 15% of the verbal SAT distribution (Zimmerman, 2003).

Although the contagion model is often used to explain how negative behaviors multiply within groups or communities, it does not necessarily limit itself to the spread of negative behaviors. Instead, it can help in understanding how positive behavior spreads as well (Burgess et al., 2018). As already mentioned in the previous section, some claim that weaker pupils can pull themselves up to the better pupils (Driessen, 2007). Various explanations can be designated for this. Just like pupils can be limited in their language development through the presence of peers

with limited Dutch proficiency, a class with a generally higher developed Dutch proficiency can help the weaker pupils to expand their vocabulary (Mulder et al., 2014; Pong & Hao, 2007). Pong and Hao mention that children living in affluent neighborhoods with successful neighbors, such as adults having had higher education and high status occupation, receive a message that hard work and good education pays off. This enhances their intrinsic motivation to do their best in school (Pong & Hao, 2007). When these children carry out their ambition to perform well in school, they might motivate their peers to behave the same way through the social contagion effect.

2.6 Compositional effect

Much of what has been discussed so far is closely related to the composition of schools or classes. If the composition of a class were to consist of identical children, there would be no space for social contagion to occur. However, the greater the differences within a school or classroom are, the more children are exposed to different backgrounds. This leads to a larger probability for social contagion to occur.

The study to compositions of classrooms is not something entirely new. In fact, the study into *compositional effects* is an existing field of study where the effects of peers on the school results of a pupil are researched. In most studies into compositional effects (also referred to as “peer effects” or “peer group effect”) individual factors like SES-background are considered, as well as the average school SES. In this way the effect of peer SES on educational achievement is measured alongside the effect of the individual SES. However, this field of study has not reached consensus about the effect of peers yet, as some researchers find small effects, others find large effects, and others find no effects at all (Van Ewijk & Slegers, 2010). In a meta-study into different analyses of peer effects performed by Van Ewijk & Slegers (2010), they suggest that peer SES may indeed be an important determinant of educational achievement.

Although this type of research is insightful and highly relevant, this approach to class composition can also be criticized. Indeed, the way of measuring composition effects is not entirely true to the real meaning of composition, as composition comprises *the way in which the parts of something are arranged*. Thus, although the term “composition” is used while measuring the composition effect, it is not the actual composition of the classroom that is being measured. Instead, it is solely the average classroom SES relative to the individual SES.

In order to get a more detailed notion of the composition of a class or a school, it would be interesting to consider the difference between the least advantaged pupils and the most advantaged

pupils within a school in addition to the average status of pupils. In that way, variety between pupils is taken into account, which is likely to matter for transferring contagion effects.

2.7 Hypothesis

The previous section discussed the social contagion effect and its potential implications for educational results. These implications could be either positive or negative; they could be cancelling each other out; or they could be not present at all. Because literature does not consistently point at one of these possible outcomes, this study will not phrase one hypothesis that is most probable. Instead, several possible outcomes are considered.

In case children tend to adopt attitudes of less advantaged children, this could cause a disadvantageous effect on the schools' results. This could mean that - apart from the negative influence on a school's results that disadvantaged pupils already exert - social contagion might even worsen this effect by transferring discouraging behaviors and attitudes to the rest of the group.

In case children tend to adopt attitudes of more advantaged children, this can cause a beneficial effect on the average school final test score. This could mean that - apart from the positive influence on a school's results that advantaged pupils already exert - social contagion might even strengthen this effect by transferring encouraging behaviors and attitudes to the rest of the group.

In case children tend to adopt attitudes of more advantaged children *and* less advantaged children equally, the beneficial and worsening effects of social contagion might cancel each other out. If this is true, no effect of social contagion will be detectable by the analysis in this study. However, no detection of the social contagion effect might also mean that the effect simply does not exist at all.

2.8 Conceptual model

The conceptual model in figure 1 gives an overview of the possible effects of social contagion that are being researched in this study. Note that the grey colored parts of the model are effects that have already been looked into in previous studies. The green colored blocks form the part that is being added to existing literature by this study. The model starts with living locations of pupils that together form the school service area (1). The word catchment area is avoided to prevent confusion with formal catchment areas like in the US.

The class composition can be specified by the average ethnic (2) and the average socio-economic (3) living environment of all pupils *and* by variation in ethnic (5) and variation in socio-economic (6) living environments of children who are part of the class. The average ethnic and socio-economic living environments (2/3) lead to a general attitude (4) within the class. For example, in a class where the average ethnic and socio-economic living environments (2/3) are very advantaged, the general attitude (4) might be a motivated attitude. Children from disadvantaged living environments might have a less motivated attitude. The general attitude (4) is considered to impact the school's average result (9).

The variation in ethnic and socio-economic living environments of children (5/6) leads to differences in attitudes (7) between children. This creates space for social contagion (8) to occur. The social contagion might either positively, negatively or neutrally influence the school's average achievement (9).

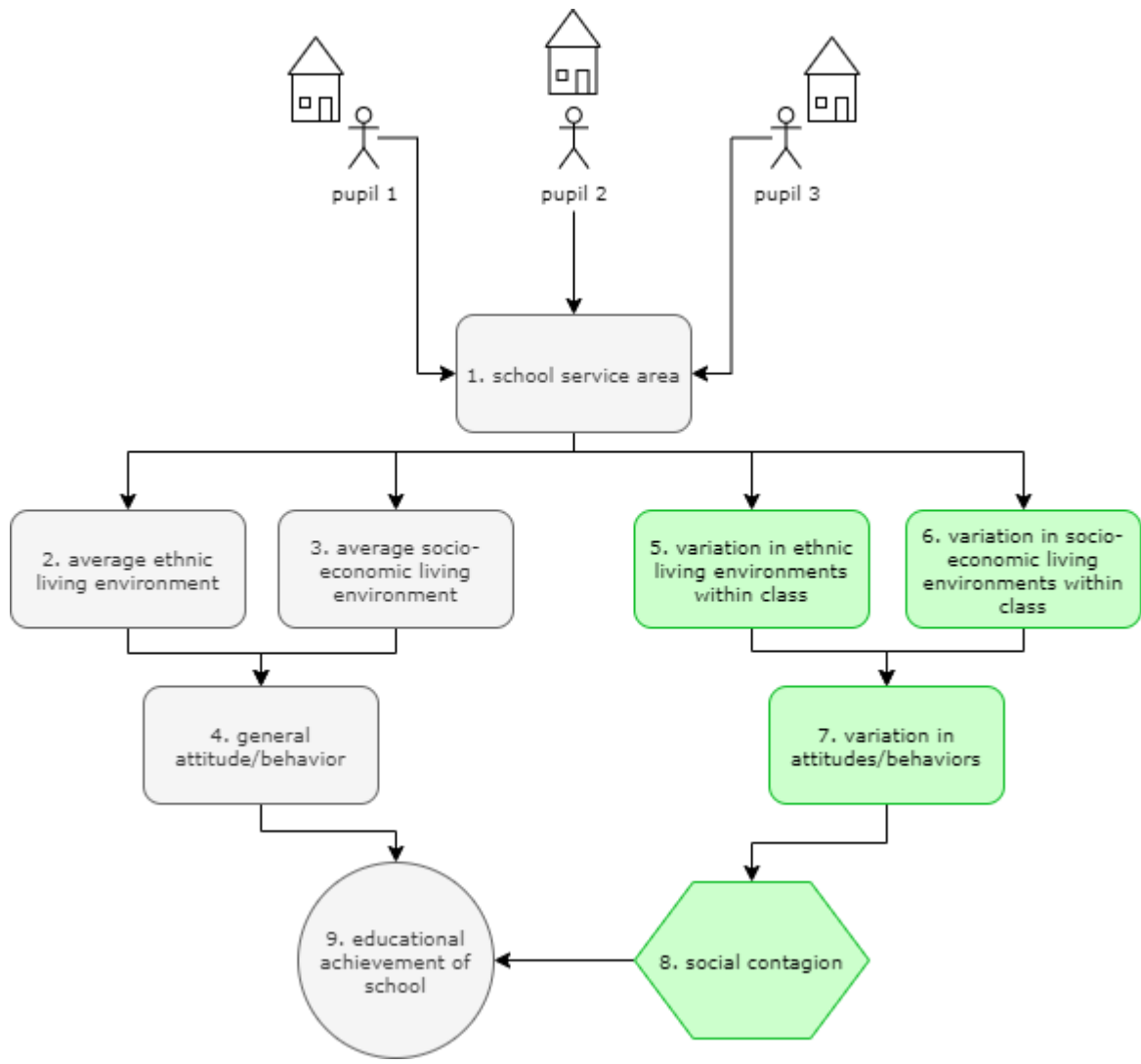


Figure 1 Conceptual model

3. METHODOLOGY

In order to reveal the extent to which social contagion between children from different ethnic and socio-economic living environments affects educational achievement, linear regression analysis will be used. The data that is used to analyze the topic, comes from two data sources: DUO (Education Executive Agency of the Dutch Ministry of Education, Culture and Science) and Statistics Netherlands.

The main reason for the selection of quantitative methods is because it allows for inclusion of almost all regular primary schools within the Dutch education system. Considering a large sample of schools has great potential of pointing out the general patterns. That being said, qualitative analysis could be of great value by adding depth to the study in a more advanced stage. Once general mechanisms have been discovered, theories can be expanded by conducting in-depth interviews or focus groups.

In order to analyze how social contagion affects educational achievement, the variety of pupils' ethnic and socio-economic living environments will be calculated for each school. These will be used to explain average school final test scores. The variables that will be used to define pupils' ethnic and socio-economic living environments, are:

- ❖ the prevalence of non-western migrants in the areas pupils live in (in %);
- ❖ the average income per capita in the areas pupils live in (in € x1000);
- ❖ parental education of the pupils from the school in question (dummy: parents are low-educated or not low-educated).

This chapter covers several aspects that relate to the execution of the statistical data analyses. Section 3.1 starts with working out the conceptual model that was built up in the previous chapter. That entails: transforming the concepts into measurable features. This requires a data-driven approach that ultimately leads to a collection of secondary data. While the selected data is being discussed, the required transformation and preparation of the data will be described. Once a clear overview of the dataset composition is insured, the exact structure of the linear regression will be uncovered in section 3.2. The chapter ends with section 3.3, discussing ethical issues.

3.1 Data

The data that is used in this study comes from two data sources: DUO and Statistics Netherlands. Data on educational issues in the Netherlands is shared by the Education Executive Agency of the Dutch Ministry of Education, Culture and Science, an organization that is often abbreviated to DUO (*Dienst Uitvoering Onderwijs*). Statistics Netherlands, often abbreviated as CBS (*Centraal Bureau voor de Statistiek*) is the Dutch national statistical office. This section will provide greater detail in three issues: (1) how data from DUO and CBS are collected, (2) how the sample is selected and (3) how the concepts from the conceptual framework (figure 1) are operationalized. Before continuing this section, it explicitly needs to be pointed out that *none* of the data used in this research are about individuals. All of the data is gathered on - or recalculated to - the school level.

3.1.1 Data collection

DUO shares data about primary, secondary and higher education institutions and about students. Data is retrieved about average school final test scores, school characteristics (like denomination) and pupil characteristics (like residential area and parental education). In addition to the data itself, DUO also provides extensive explanations for each dataset. This is helpful in handling the data and interpreting results. DUO assigns an identification number (BRIN) to each school, which enables to link all required datasets together.

CBS has developed a comprehensive data portal (Statline) that includes statistics on topics like labor and social security, income and spending, health and wellbeing and population. Besides national statistics, CBS also provides regional statistics that are nationwide. Regional statistics are available on the municipality, district and neighborhood level. Because regional statistics are more sensitive to anonymity issues, data on some topics are only made public after a few years. For example, it is not possible to find data on average income per neighborhood from last year. Although data on educational achievement is already available for more recent years, there is no access to all required neighborhood data of these years. It is for this reason that this study examines educational achievement of schools of the year 2015-2016. From Statline, data on the prevalence of non-western migrants and average income per capita are downloaded for each neighborhood in the Netherlands. Combined with the data from DUO, these data are used to define the ethnic and socio-economic living environment of pupils for each school.

3.1.2 Sample selection

This study aims to include all *regular* primary schools in the Netherlands. That means that primary schools for children with special needs (special primary education) are excluded from the analysis. The reason for this is that children for whom special education is intended, often have extra difficulty learning, are dealing with behavioral issues or face parenting difficulties (Rijksoverheid, 2019). The drivers underlying their educational achievement are much different from children that attend regular schools and therefore go beyond the scope of this study.

The original dataset with average school final test scores, provided by DUO, contains 6751 primary schools. From this dataset, 413 schools were immediately omitted because no average school final test scores were available. Another 74 schools were left out of the dataset because they were not specified as regular primary education. Furthermore, for some schools in the dataset no school name, street address or sufficient neighborhood data was available. This led to the removal of 9 other schools. The final dataset of schools includes 6255 schools.

3.1.3 Operationalization of concepts and data preparation

In order to test the conceptual model that was built in the previous chapter (see figure 1), all concepts that are part of it need to be measured. For each concept, this will be done by using secondary data from either DUO or CBS. For each measured concept, this part explains the data that is used. The numbers behind the concept headings correspond with the numbers in the conceptual model.

School service area (1)

To define the school service area, it would be ideal to possess data about individual pupils. However, for privacy reasons DUO does not publish data about individual pupils. Instead, for every primary school DUO publishes in which four-digit zip code areas (PC4) pupils live. A distinction is made between different ages. Using these data, the living environments of children can be determined for each particular school. In this study, only the zip codes of children aged 11-14 are used. This is because pupils are around this age when they take the final test. Merging zip code areas of pupils from separate schools results in a service area for each school. Figure 2 shows an example of what a school service area may look like. Knowing the service area for each school, it is possible to determine ethnic and socio-economic living environments of its pupils.



Figure 2 Service area of school x, showing the number of pupils that live in each zip code area (source: DUO, Esri)

Average ethnic and socio-economic living environment (2 and 3)

As mentioned in the previous chapter, there are numerous indicators for children’s ethnic and socio-economic living environments that matter for educational outcomes. This study examines three indicators that underlie the ethnic and socio-economic living environment of a child: the concentration of ethnic minorities in the area pupils live in, the average income per capita in the area pupils live in, and parental education level of the pupils.

To calculate the average concentration of ethnic minorities in the areas pupils live in, CBS neighborhood data on the prevalence of non-western migrants is used. This poses a challenge, because DUO serves no direct data on the neighborhoods pupils live in, but instead DUO shares in which zip code area pupils live. Geometrical differences between neighborhoods and zip code areas make it impossible to link neighborhood data directly to the school service areas. Therefore, recalculations must be made to match them. Figure 3 gives an example of the geometrical differences between neighborhoods and zip code areas. Nationwide, there are on average three neighborhoods for every one zip code area, which means that neighborhoods are generally smaller in size than zip code areas. For those interested, the exact method of recalculation can be found in the appendix (1). Using CBS neighborhood data on the prevalence of non-western migrants, the

zip code averages are calculated. From here, the prevalence of non-western migrants in school service areas can be determined. As mentioned earlier, it needs to be underlined that this variable indicate the profile of *neighborhoods* that pupils live in, but not necessarily profiles of the pupils themselves. If the latter were to be assumed, ecological fallacy would occur, since the nature of individuals would be deduced from the nature of the neighborhood. Although the neighborhood variables are recalculated to the school level, they still indicate the average neighborhood characteristics from children of a specific school, but not individual characteristics of children themselves.

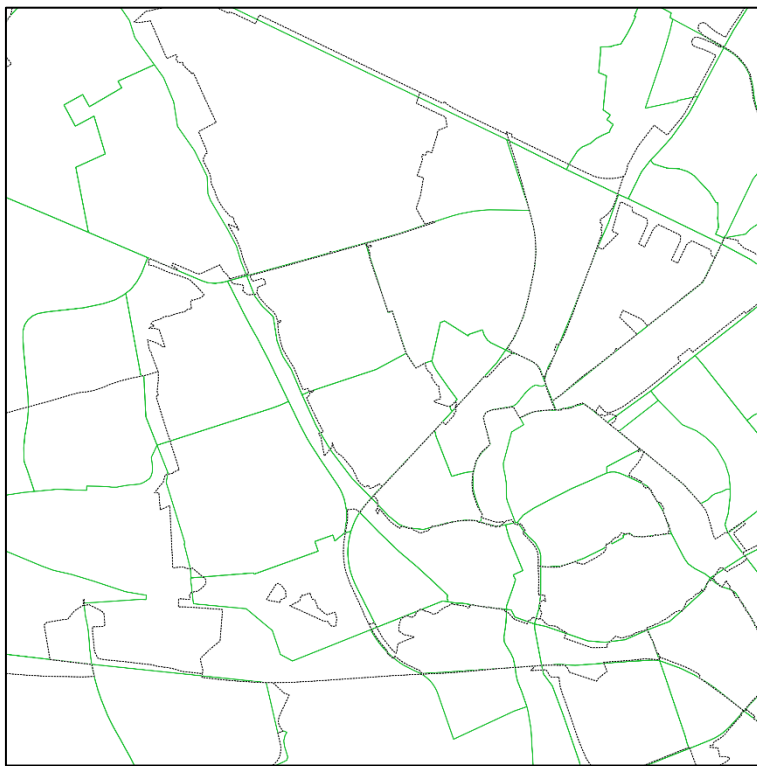


Figure 3 A cutout of neighborhoods (green) and zip code areas (black) (source: Esri, CBS)

To calculate the average income per capita in school service areas, the same situation with geometries occurs. For each neighborhood CBS publishes the average annual income per capita. Recalculating this to zip code averages, the average income in school service areas are defined. Again, this leads to a variable that indicates the economic neighborhood profile pupils live in, but it does not say anything about the economic profile of pupils individually.

A different situation applies to defining parental education. The variable used to measure parental education is not a neighborhood variable, but it is measured on the school level. DUO

assigns weights to pupils based on the educational level of their parents. Data on these weights are published for each school. Weights determine whether - and how much - extra government funding schools get. Based on the type of education completed by the pupil's parents, a pupil gets assigned a weight of either 0 (no weight), 0.30 or 1.20 (low parental education level). Table 1 indicates the exact meaning of each weight. For each school it is specified how many children are assigned which weight. As the quantitative nature of these weights may be questioned, a dummy variable is created that indicates whether the majority of a class has low-educated parents or not.

Weight	Meaning
1.20	Pupil of whom one parent only has completed primary education and whose other parent only has completed practical education or pre-vocational education of the (basic) pre-vocational learning pathway.
0.30	Pupil of whom both parents only have completed practical education or pre-vocational education level of the (basic) vocational learning pathway.
0	Pupil of whom at least one parent has completed higher than preparatory vocational education level of the vocational learning pathway.

Table 1 Explanation of pupil weights

Some consider the weights construction to be short-sighted, as other characteristics influence school performance as well (Posthumus et al., 2016). However, this problem does not apply to this study, since this study uses this unit of measurement to assess parental education level itself, instead of using it as a proxy for school performance. As the weights are directly based on parental education, they serve as a legitimate proxy for parental education. Yet it must be said that a more detailed categorization of parental education would promote more concrete statements about the influence of parental education on educational achievement of children. The available data on pupil weights primarily indicate prevalence of *low* parental education in the class. It would have been interesting to possess more information about higher education levels as well.

Variation in ethnic and socio-economic living environments within class (5 and 6)

To discover the effect of social contagion on educational achievement, merely analyzing average class characteristics is not sufficient. This is true because the extent to which social contagion can take place largely depends on the variety in characteristics of pupils. To illustrate this: in a class with little variety, little differences are expected in attitudes and behaviors. Social contagion then can have little effect: the attitudes and behaviors in the group were already similar to each other in the first place. However, if there is a large variety in characteristics of pupils, large differences are expected in their attitudes and behaviors. The spread of behavior from one pupil to another can then have a large effect on educational achievement of the group. For the different indicators of the ethnic and socio-economic living environment, variety between pupils is measured in different ways.

To calculate the variety in concentration of ethnic minorities between the neighborhoods pupils live in, CBS neighborhood data on the prevalence of non-western migrants is used. To define variety between neighborhoods within the school service area, the lowest occurring neighborhood percentage within the service area is subtracted from the highest occurring neighborhood percentage within the service area (see figure 4).

The service area of school x has an average non-western migrants prevalence of 21.8% (weighted for area size). As it appears, the highest occurring neighborhood percentage for school x is 25% and the lowest occurring neighborhood percentage for school x is 11%. The variety in neighborhood prevalence of non-western migrants thus equals the value of 14.

A point of haziness might be the situation of a school service area with two neighborhoods that each have a non-western migrants prevalence of 50%. In this case the resulting value for this variable would be 0. This can be confusing because, after all, a fifty-fifty distribution would logically lead to maximum potential for social contagion to occur. This is indeed true within the neighborhoods. However, the extent to which pupils from both neighborhoods are affected by this distribution is equal for the entire school. A value of 0 thus indicates no difference between neighborhoods that pupils come from. To make this clearer, a fictional example can be found in box 1.

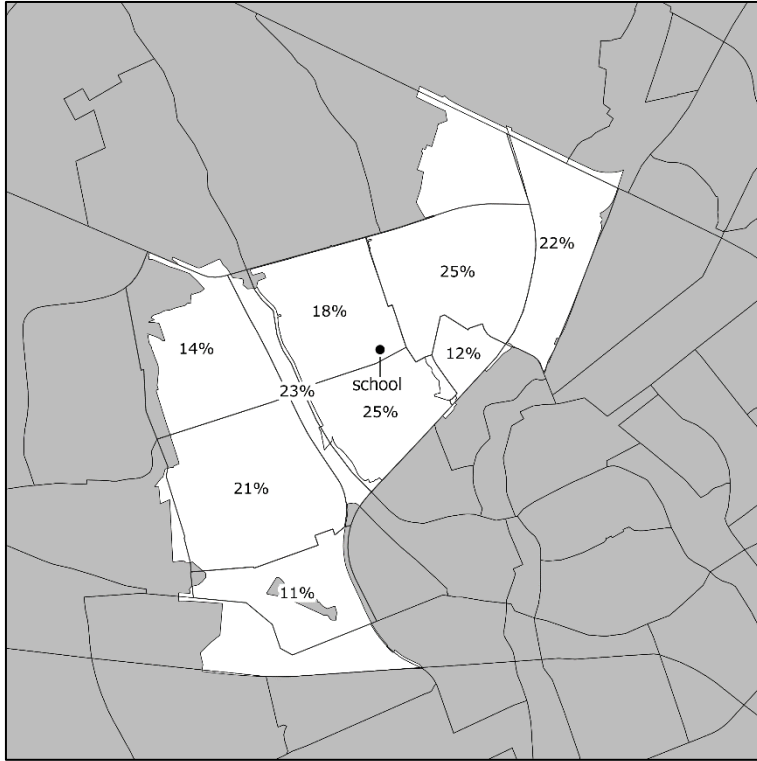


Figure 4 The variety in prevalence of non-western migrants for school x (source: CBS)

Susan and Tom are both pupils of primary school *The Rainbow*, although they live in different neighborhoods. Susan's neighborhood has a non-western migrant prevalence of 30%. Tom's neighborhood has a non-western migrant prevalence of 30% as well. The average prevalence of non-western migrants for their school service area is 30%.

Every day after school, Susan goes to a baby-sitter who does not speak Dutch very well. Because Susan communicates with her a lot, Susan's own language development goes a bit slower than that of average Dutch peers, but that is ok. She has friends in the neighborhood where she can pull herself up to.

Tom has a neighboring friend who does not speak Dutch very well. Because Tom plays with his friend a lot, Tom's own language development goes a bit slower than that of average Dutch peers, but that is ok. He has other friends in the neighborhood as well where he can pull himself up to.

Whenever Susan and Tom go to school, they work on their exercises together. Since Tom and Susan are both subject to the same level of effects from non-western migrants in their neighborhoods, they are not much different from each other. Thus, their variety in neighborhood prevalence of non-western migrants is set to 0. This leaves little space for social contagion between Susan and Tom.

Box 1 Fictional example

Again it needs to be pointed out that this variable does not indicate individual ethnic differences between students, but merely differences between ethnic profiles of neighborhoods they live in. Although in an ideal situation individual differences would be taken into account as well, due to data constraints this study cannot say anything about social contagion as a result of individual ethnic differences between pupils.

To calculate the variety in income per capita in the area pupils live in, the same method is applied. CBS data about income per capita for neighborhoods is used. In the service area of school x, the annual average income is €21,800. Subtracting the lowest occurring neighborhood value from the highest occurring neighborhood value, a value of 2,480 results as the variety in income per capita in the school service area of school x.

To define the variety in parental education, a different method is required. In contrast to measuring neighborhood income and neighborhood ethnicity, the data that is used to measure parental education is measured on the school level. As mentioned before, a dummy variable was created that indicates whether the majority of a class has low-educated parents or not. To determine variety in parental education, it is calculated how large that majority is. In case a class has no low-educated parents at all, the size of the majority is 100% compared to the entire class. In case all parents are low-educated, the size of the majority is 100% as well. In both these situations there is no variety. In case there are 6 pupils with low-educated parents in a class of 10, the majority is 60% compared to the entire class. In this case the variety is large. For better interpretation, the variable that emerges will be inverted, so that high values relate to high variety, and low values to low variety. This results in a variable that ranges from 0 (no variety) to 10 (high variety). In mathematical notation this looks like:

$$var\ p = \left(1 - \frac{\max(a, b)}{a + b}\right) * 20$$

where

a = number of weighted children in a class

b = number of unweighted children in a class.

It needs to be pointed out that from the group of schools with little variety in parental education, a vast majority owes that to the fact that *no or few* children have low-educated parents. Only few schools have no or little variety in parental education due to the fact that *all* parents are low-

educated. Therefore schools that show a large variety in parental education, are mostly schools that show a substandard average parental education level. It is important to be aware of this, as it could possibly bias results.

Educational achievement of schools (9)

Defining educational achievement is a sensitive topic and has recently reached the Dutch news repeatedly. Especially in the final phase of primary school, pupils' future education possibilities are largely determined through tests. Next to the advice that results from final tests, teacher advice is taken into account as well when determining secondary school advices. With effect from 2014-2015, the central final test will only be taken if the teacher's advice is already known. This policy was introduced because the final test is sensitive to circumstances like illness and fear of failure (De Bruin, 2019). However, recently this approach has received critique because teachers are possibly biased against children from lower social environments (De Bruin, 2019). This has caused a movement of people who believe that the final test should again be leading in determining secondary schools advice, because this is a more objective measure.

Every year, DUO publishes the average test score of each primary school. These average test scores will be the measurement of educational achievement in this study. School boards get to choose between final tests from different certified providers. In the educational year 2015-2016, schools could choose between three different tests: CET, IEP and Route8. All three result in numerical scores. In order to make results of CET, IEP and Route8 intercomparable, test scores of all schools need to be converted to one and the same scale. To realize this, a conversion table has been requested from DUO.

3.2 Method of data analysis

To identify the current achievement differences between Dutch primary schools, both descriptive statistics and *Anselin Local Moran's I* are used. Anselin Local Moran's I identifies spatial clusters of high or low values, as well as spatial outliers (Esri, 2020). Identifying clusters and outliers could indicate that a filtering process of specific children into certain schools is going on. For example, in a specific region where all schools achieve relatively low (cluster) and one school achieves relatively high (outlier), children from more advantaged backgrounds might actually have been sorted into the higher achieving school. The spatial relationship that is being considered is *inverse distance squared*. This means that nearby neighboring schools have an exponentially larger influence on the computations for a target school than schools that are farther away. Using this

method, only a target school's closest neighbors will exert substantial influence on computations for that school. Because distance from home to school is one of the most important determinants in school choice decision of Dutch families, it is reasonable to weigh heavily on distance (Karsten et al., 2006; Ten Broeke et al., 2003).

To analyze the extent to which social contagion between pupils affects educational achievement, multiple linear regression will be performed. Multiple linear regression uses two or more independent variables and one dependent variable as its input. The model tests whether the independent variables influence the dependent variable. In doing so, the independent variables take each other into account and it is also examined whether these variables influence each other (Moore & McCabe, 2005). The regressions are performed by using the Huber-White Robust Sandwich Estimator. This estimator was selected instead of the commonly used Ordinary Least Squares, because heteroscedasticity was detected when using Ordinary Least Squares. The Huber-White Robust Sandwich Estimator obtains unbiased standard errors of OLS coefficients (Freedman, 2006).

Other assumptions of linear regression were not violated. These assumptions will be listed here, including how they were accounted for.

- ❖ No or little multicollinearity. Multicollinearity exists when independent variables correlate. Multicollinearity could lead to untrustworthy betas and to difficulties in distinguishing the true relationship between each of the variables and the outcome variable (Moore & McCabe, 2005). To check if no multicollinearity between the explaining variables exists, the variance inflation factor (VIF) is considered. When this factor is higher than 5 for a certain variable, it means that that variable shows coherence with the other variables. STATA is used to measure VIF. After performing the linear regressions in STATA, it was concluded that multicollinearity does not occur.
- ❖ Independent residuals. To make sure that there is no spatial effect that has not been included in the analysis, the residuals of the regression were tested for spatial autocorrelation. Using Global Moran's I (inverse distance squared), it has been determined that this effect does not exist ($p = 0.292$) which means that it is legitimate to use linear regression instead of spatial regression models.
- ❖ Normally distributed residuals. Since the number of observations in this study is high, this assumption can be relaxed.

In order to create a better model fit, control variables are added to the model (see table 2). Although these are beyond the scope of the research question, their possible effects will be shortly explained. First of all, school denominations are added to the model as dummy variables. As discussed in the theoretical framework, the existence of denominating schools could stimulate sorting children into particular schools. According to the theory, this could matter for educational outcomes. Because this variable does not necessarily indicate pupil characteristics or the variety between children, it is added as a control variable. Secondly, the different test providers are included as dummies. To make test scores intercomparable, a conversion table from DUO was used to recalculate the test scores. To cancel out any irregularities regarding this conversion, the type of test will be added as a control variable. Thirdly, for all schools the number of pupils that took the final test are added to the model. This variable could be related to educational achievement in all kinds of ways. For example, in small schools pupils might get more attention from teachers, which might positively impact their achievement. Or maybe a large number of pupils is a result from a good reputation of the school. To cover the possible effect of the number of pupils, it is added as a control variable.

Because these variables are not relevant to answering the research question, their effects will not be explained in the results section. However, the effects will be shown in the resulting tables.

Dependent variable	Interval: Average school final test score
Independent variables	Ratio: Average school service area annual income per capita Ratio: Differences in neighborhood annual income per capita Ratio: Average school service area % non-western migrants Ratio: Differences in neighborhood % non-western migrants Dummy: Majority parents lower educated, yes = 1 (ref: no) Interval: Variety of parental education
Control variables	Dummy: School denomination = Christian (ref: Public) Dummy: School denomination = Other (ref: Public) Dummy: Test = IEP (ref: CET) Dummy: Test = Route8 (ref: CET) Ratio: Number of pupils that participated in the final test

Table 2 Overview of all variables included in regression

3.3 Ethics

Scientific research that looks into the ethnic and socio-economic situation and ethnic origin of people can be considered as a sensitive matter for people who fall within the research population. In this thesis, economic and ethnic data at the neighborhood level are used. Especially because the data has been converted to the school level, the anonymity of the residents of the relevant neighborhoods is guaranteed. The sensitivity of the concept of economic status and ethnic origins makes the use of secondary data an appropriate choice, as it is not necessary to ask about the financial situation or ethnic origins of individual participants. The used data about parental education is more specific, but is still not traceable to individuals. In the interest of the reputation of schools, no names of schools are mentioned in this study.

4. RESULTS

This chapter reveals the results of the data analysis. In order to find out to what extent social contagion between children from different ethnic and socio-economic living environments affects educational achievement, multiple linear regression are executed. To build towards an answer to the research question, this chapter will answer the following sub questions:

- ❖ How big are the *current* achievement differences between Dutch regular primary schools?
- ❖ To what extent can the average achievement in a school be explained by its pupils' *average* ethnic and socio-economic living environment characteristics?
- ❖ To what extent can the average achievement in a school be explained by its pupils' *variation* in ethnic and socio-economic living environment characteristics?

Section 4.1 considers some descriptive statistics as well as the results of Local Moran's I. These results are used to identify current achievement differences in Dutch regular primary education. Section 4.2 looks at the first regression model. This model aims to discover the effect of average ethnic and socio-economic living environment characteristics on achievement differences between schools. In this study, it will be called the *first model*. Section 4.3 introduces the variables that indicate variety within classes to the first model. By doing this, it aims to identify the effect of social contagion between children from different ethnic and socio-economic living environments. This model will be called the *second model*.

4.1 Differences between Dutch primary schools

Table 3 summarizes the final dataset that is being worked with in this study. Looking at the minimum and maximum occurring values for *average school final test score*, it needs to be noted that the theoretical minimum and maximum average school final test score are respectively 10 and 60. The lowest occurring value **18.111** leads in most cases to an advice for *basic pre-vocational secondary education* (vmbo BB), while the highest value **56.750** mostly leads to an advice for *higher general secondary education* (HAVO) or *pre-university education* (VWO). In Dutch regular secondary education, these levels represent respectively the lowest and highest possible forms of secondary education. It thus appears that differences between Dutch primary schools are big. The mean value is **41.686**, which equals an advice for the *mixed and theoretical learning path*. Looking

at the histogram in figure 5, average school final test scores show a distribution that is a bit skewed to the left but otherwise is close to a normal distribution. This means that the largest outliers are the lowest values in the dataset. There is no reason to expect that this will be a problem during the analysis.

Variable	Number of observations	Mean	SD	Min	Max
Educational achievement					
Average school final test score	6,255	41.686	6.243	18.111	56.750
Parental education					
Majority parents lower educated, yes = 1	6,255	0.033	0.178	0	1
Variety in parental education	6,255	2.406	2.565	0	10
Ethnic minorities					
Average school service area % non-western migrants	6,255	10.541	12.034	0	81.128
Difference neighborhood % non-western migrants	6,255	0.120	0.142	0	0.794
Income					
Average school service area annual income per capita	6,255	25.423	4.030	13.553	62.652
Difference neighborhood annual income per capita	6,255	6.384	6.671	0	68.589
Denomination					
Public	6,255	0.369	0.483	0	1
Christian	6,255	0.611	0.488	0	1
Other	6,255	0.020	0.139	0	1
Test					
CET	6,255	0.650	0.477	0	1
IEP	6,255	0.256	0.436	0	1
Route8	6,255	0.094	0.292	0	1
School size					
Number of pupils that participated in final test	6,255	27.590	16.998	5	163

Table 3 Descriptive summary statistics

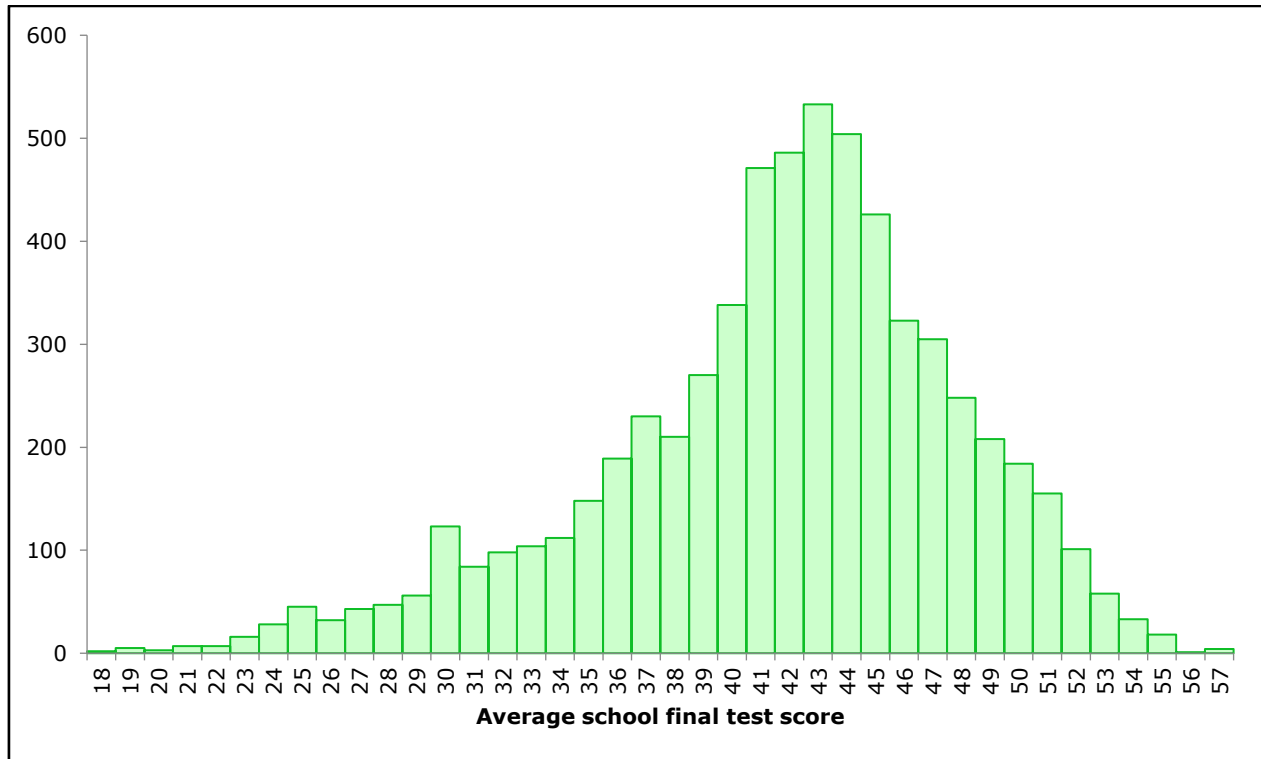


Figure 5 Histogram of average school final test score (source: CBS)

In only 3.3% of the schools the majority of the parents of pupils are lower educated (table 3). That is, in these schools the majority of pupils have such low-educated parents that the school receives government funding for them. In total these are 206 schools. In all other schools, pupils that get such funding are the minority of the group. To define variety in parental education, schools were scored a value that ranges from 0 to 10 based on the proportion of pupils that is weighted. A value of 0 means that all pupils are either weighted or non-weighted (and thus there is little variety) and a value of 10 means that the division between weighted and non-weighted pupils is fifty-fifty (i.e. maximum measurable variety). On average, schools score **2.406** on variety in parental education. That equals either a class with 1 weighted pupil for every 7 unweighted pupils or a class with 1 unweighted pupil for every 7 weighted pupils.

The average school service area percentage of non-western migrants is **10.5%**. It has some large outliers that go upwards. It is worth mentioning that 7 schools have a value of 0, which means that no non-western migrants at all are living within their service areas. The number of schools that have less than 1% of non-western migrants within their service area, is 245. Spatial residential segregation and filtering could be the drivers behind these white school service areas. The

difference between the minimum and maximum occurring neighborhood percentage of non-western migrants within school service areas is on average **0.120**, or 12 percent point.

There seem to be large differences between annual average incomes in school service areas. The lowest occurring value is €13.553 and the highest occurring value is €62.652. However, this variable shows some large extremes that go upwards. In total, only 51 school service areas have an average income of more than €40.000 per year.

Of all regular primary schools in the Netherlands, **61.1%** is denominated as being some form of *Christian*. Schools that are denominated as a *public* school account for **36.9%** of all schools. Schools that are categorized under ‘other’ were denominations that were too small to put into the dataset as separate groups, and include denominations *Hindu*, *Islamic*, *Jewish* and *Anthroposophical* (i.e. Waldorf education). Together they form **2.0%** of all schools in the dataset.

Of the three available options in the school year 2015-2016, the majority of the schools in the dataset selected the CET final test. Historically, this has been the only option. From 2015 onwards other providers of tests have entered the market as well.

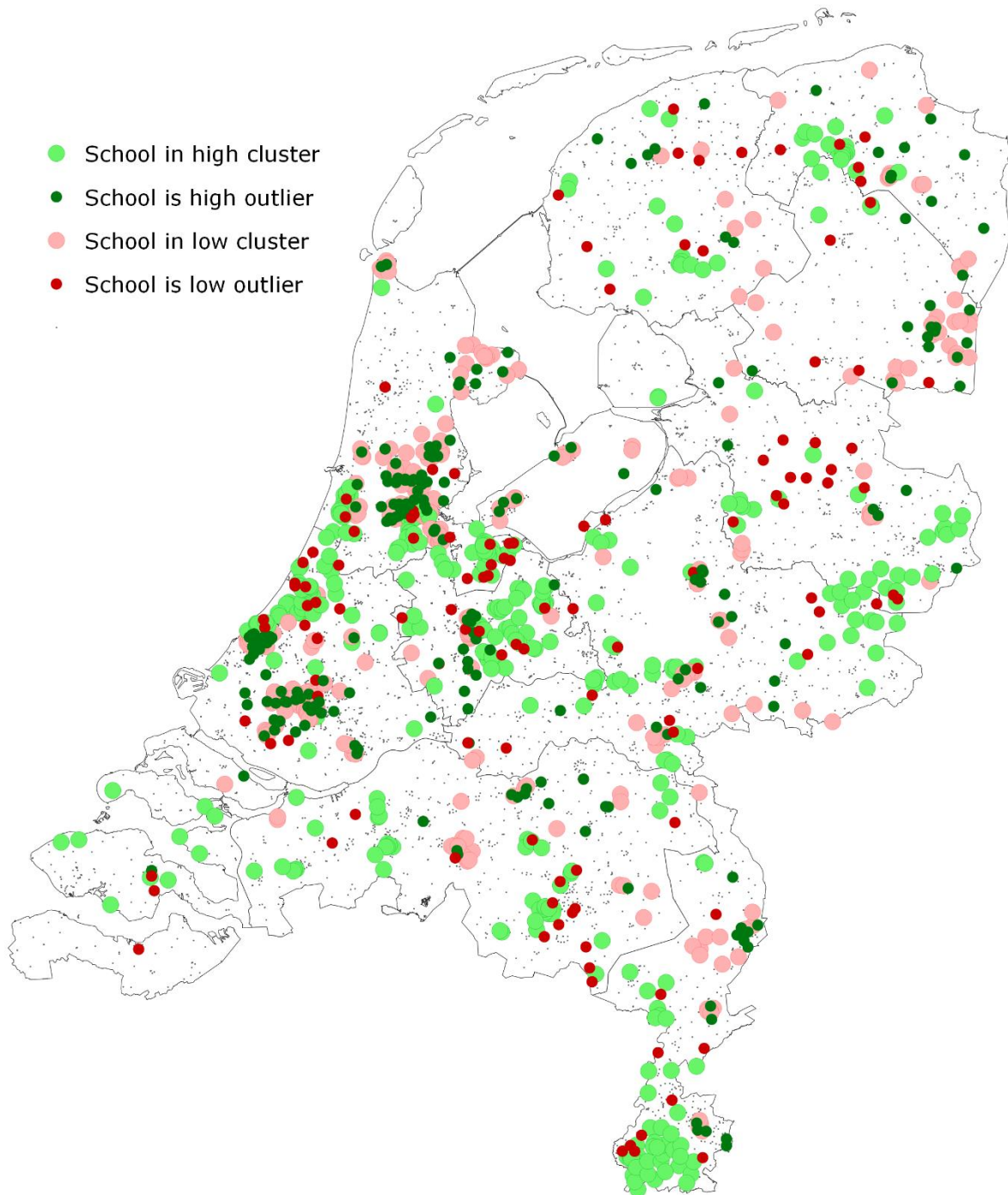


Figure 6 Anselin Local Moran's I cluster and outlier analysis for average school final test scores

Figure 6 shows the spatial clusters and outliers of high and low average school final test scores. It is remarkable that clusters and outliers seem to be located in and around cities (see figure 7). This is not surprising, since a certain density of schools is a precondition for the existence of clusters. After all, one isolated school cannot form a cluster. What is important here is that in areas of higher

school density, parents have more opportunities to select a school that suits their own demographic profile. This possibly leads to disproportional black/low-SES or white/high-SES schools in certain areas.

To test whether outliers of educational achievement indeed tend to be located in and around cities, a one-sided proportion test was performed. The groups that were compared to each other were (1) schools that are located within 5 kilometers of a city with at least 30,000 inhabitants and (2) schools that do not meet this requirement. The null hypothesis ($\text{diff} = 0$) was rejected ($p = 0.001$) and the alternative hypothesis ($\text{diff} < 0$) was accepted. This suggests that outliers indeed tend to be located in and around cities.

In total, 213 schools (3.4%) in the dataset score significantly high relative to their environments. The number of schools in the dataset that score significantly low relative to their environments, is 124 (2.0%).



Figure 7 Dutch cities > 30,000 inhabitants (Source: PDOK, 2019)

Summarizing this section, differences in Dutch primary education are present in various ways. Average school final test scores of primary schools are diverse. Differences in parental education, concentrations of ethnic minorities and differences in welfare of pupils' living environments can also be identified and are possibly drivers behind educational achievement. Positive as well as

negative spatial outliers in average school final test scores could be identified, and they mostly occur in urban areas.

4.2 Effect of average ethnic and socio-economic living environment

In order to detect the effect of ethnic and socio-economic living environments on educational achievement, the first regression model was developed. The results of the first model are shown under *coefficient* in table 4. The coefficient is the extent to which the dependent variable changes when the independent variable increases by 1. By means of the coefficients, the expected value for the dependent variable can be calculated together with the constant. The coefficient therefore shows whether the independent variable positively or negatively influences the dependent variable. The model explains 22.8% of the variance in the dataset (R-Squared = **0.228**). All added variables are significant at the 0.1% confidence interval level.

As expected, a lower parental education leads to lower educational achievement of pupils. Compared to a class where the majority of the parents is *not* low educated, a class where the majority of the parents *is* low educated scores on average **3.805** lower on the final test.

The concentration of ethnic minorities within living environments of pupils, expressed as the *average service area % of non-western migrants*, has a negative effect on the average school final test score as well. If the average percentage of non-western migrants within the service area of a school rises with 1 percent point, the average school final test score decreases with **0.116**.

Average income per capita within living environments of pupils has a positive effect on educational achievement. When the average annual income per capita rises with €1000, the average school final test score increases with **0.328**.

The results from the first model are consistent with what has been discussed in the theoretical framework. Educational achievement of children is positively influenced by the average income in their living environments, while it is negatively influenced by low parental education and the prevalence of ethnic minorities in their living environments. However, the first model cannot indicate the effect of social contagion between pupils on their educational achievement. The next section will elaborate on the results of the second model that aims to measure the effects of social contagion.

Variable	Coefficient
Constant	33.618***
Parental education	
Majority parents lower educated: yes (ref: no)	-3.805***
Ethnic minorities	
Average service area % non-western migrants	-0.116***
Average income per capita	
Average school service area annual income per capita (x €1000)	0.328***
Control variables	
Test: IEP (ref: CET)	-0.704***
Test: Route8 (ref: CET)	-5.165***
Denomination: Christian (ref: public)	0.944***
Denomination: Other (ref: public)	2.250***
Number of children that participated in final test	0.040***

* p < 0.05, ** p < 0.01, and *** p < 0.001

Table 4 Multiple linear regression of average school final test scores (first model)

4.3 Effect of social contagion

The results of the second model are shown in table 5. Besides measuring the effects of average ethnic and socio-economic living environments of pupils, it also aims to measure the effects of social contagion between pupils on educational achievement. It does this by adding variables to the model that indicate variety between pupils' living environments. The R-Squared of the model is **0.266**. That means that 26.6% of the variance in the dataset can be explained by the model. Compared to the first model this is an increase, meaning that the second model is better explaining educational achievement than the first model. As opposed to the first model, not all variables are significant in the second model. The variables that were already part of the first model, have not changed in significance nor direction.

A larger variety in parental education within a class seems to have a negative effect on educational achievement. The model suggests that for every 1 unit the variety increases, the average school final test score decreases with **0.567**. Schools that accommodate a rather homogeneous group regarding parental education – whether that means *mostly* low-educated parents or *no* low-educated parents at all – thus score better than schools that are more heterogeneous for this matter.

It thus seems that social contagion between children with lower educated parents and children with higher educated parents, leads to a lower joint educational achievement.

Variation in the presence of ethnic minorities in living environments of pupils seems not to make a difference in educational achievement. In other words, in a class with both children from ethnically diverse neighborhoods and from ethnically monotonous neighborhoods, social contagion does not affect educational achievement in any direction.

Differences in income per capita in living environments of pupils have a positive influence on educational achievement. If the difference between the lowest and highest occurring annual neighborhood income within a school service area increases with €1000,-, this causes an increase in the average school final test score of **0.060**. Schools that accommodate a rather heterogeneous group regarding neighborhood income thus score better than schools that are more homogeneous group for this matter. It thus seems that social contagion between children that live in wealthier areas and children that live in poorer areas has a positive effect on educational achievement.

It is interesting to find out that social contagion manifests itself in multiple ways. The next chapter will discuss this in further detail.

Variable	Coefficient
Constant	37.831***
Parental education	
Majority parents low educated: yes (ref: no)	-2.102***
Variety in parental education	-0.567***
Ethnic minorities	
Average service area % non-western migrants	-0.077***
Difference neighborhood % non-western migrants within service area	-1.254
Average income per capita	
Average school service area annual income per capita (x €1000)	0.211***
Difference neighborhood annual income per capita within service area	0.060***
Control variables	
Test: IEP (ref: CET)	-0.722***
Test: Route8 (ref: CET)	-5.041***
Denomination: Christian (ref: public)	0.798***
Denomination: Other (ref: public)	1.595***
Number of children that participated in final test	0.025***

* p < 0.05, ** p < 0.01, and *** p < 0.001

5. DISCUSSION

This study examined the effects of social contagion between children from different ethnic and socio-economic living environments on educational achievement. Current achievement differences in Dutch primary education are visible through divergent average final test results between schools. Spatial outliers of educational achievement were detected by using Anselin Global Moran's I. This means that some schools score either significantly high or low compared to envioning schools. This could confirm the notion that children get filtered into schools: in areas that are denser populated, a larger selection of schools is available. Parents in these urban areas have more opportunities to select a school that fits their own demographic profile. Often, different demographic profiles go along with differences in socio-economic status (Herweijer, 2008; Karsten, 2006). In areas with few inhabitants and few schools, parents are more likely to just select whatever school is available.

Achievement differences between schools can partly be attributed to the average living environment characteristics of pupils in a class. Using linear regression, this study found that when the majority of pupils in a class have low educated parents, the average results of that class decrease as well. Also the prevalence of ethnic minorities in living environments of children exerts a negative effect on the average results of the class. Average income in the living environments of pupils has a positive influence on their achievement. These results imply that educational achievement of children is subject to children's living environment. This finding is in line with what other studies have suggested as well.

Besides average ethnic and socio-economic school characteristics, social contagion seems to exert an effect on educational achievement as well. If living environments of pupils in a class diverge in terms of parental education, this seems to have a negative effect on the average final test scores of the class. This means that children with lower educated parents negatively influence the educational achievement of children with higher educated parents. This could possibly be caused by a lower effective teaching time as a result of the extra attention that children with lower educated parents may need (Herweijer, 2008). Although this finding does not at all contradict social contagion theory, it needs to be pointed out that the variable that was used to indicate variation in parental education within classes is of a limited quality. Therefore it could possibly cause distorted

results. A more detailed categorization of parental education would promote more concrete statements about the influence of parental education on educational achievement of children. The use of a more detailed variable to indicate parental education and variety in parental education is recommended for further research.

Variation in the prevalence of ethnic minorities in living environments of pupils seems not to make a difference in educational achievement. Previous work suggests that children that are exposed to peers whose Dutch proficiency is underdeveloped or incorrectly spoken are likely to adopt similar language use themselves, especially if Dutch is not their own primary language either (Pong & Hao, 2007). Underdeveloped language proficiency possibly limits children to fully participate in the Dutch education system, which could lead to lower results. Although this study finds that the average prevalence of ethnic minorities in pupil's living environments does matter for educational outcomes, it turns out that variety in the prevalence of ethnic minorities in pupils' living environments does not affect educational achievement. A possible explanation for this could be that the differences that arise from living in neighborhoods with varying concentrations of ethnic minorities are so small, that it leaves no space for social contagion to occur. Another explanation could be that it *does* cause social contagion, but that this social contagion does not affect educational outcomes.

Differences in income per capita between living environments of pupils have a positive influence on their educational achievement. It thus seems that social contagion between children that live in wealthier areas and children that live in poorer areas has a positive effect on educational achievement. Pong and Hao (2007) mention that children living in affluent neighborhoods with successful neighbors, such as adults having had higher education and high status occupation, receive a message that hard work and a good education pay off. This enhances their intrinsic motivation to do their best in school (Pong & Hao, 2007). When these children carry out their ambition to perform well in school, they might motivate their peers to behave the same way through the social contagion effect.

There is not one simple answer to the question to what extent social contagion between children from different ethnic and socio-economic living environments affects educational achievement. Different factors, like ethnic composition of the environment, the financial environment and education level of parents exert different effects on the way social contagion takes

place. The specific composition of these factors will eventually determine whether the resulting effect of social contagion is a positive or a negative one.

6. CONCLUSION

Education can be used to steer societies in a positive direction or to prevent undesirable social developments (Dronkers, 2011). For this reason, it is a challenge for governments to let all children reach the maximum potential out of themselves and their education. The research question that was composed, is: to what extent does social contagion between children from different ethnic and socio-economic living environments affect educational achievement?

Previous research identified that some groups are worse off when it comes to educational opportunities. When different children go to the same school, they are in each other's physical proximity and while they interact with each other, they are susceptible to social contagion. This can affect the joint educational achievement of a class positively as well as negatively (Burgess et al., 2018). However, social contagion in the educational context has received limited attention in scientific literature at present.

This study used spatial autocorrelation and multiple linear regression to clarify the relation between social contagion and educational achievement. The major findings are as follows: (1) a larger variety in parental education of classmates negatively influences educational achievement, (2) a larger variety in concentrations of ethnic minorities in neighborhoods classmates live in does not matter for educational achievement and (3) a larger variety in income in neighborhoods classmates live in positively influences educational achievement. There is this not one simple answer to the question to what extent social contagion between children from different ethnic and socio-economic living environments affects educational achievement. Instead, whether the eventual effect of social contagion is positive or negative, highly depends on the specific composition of different relevant factors.

Future researchers that will study the effects of students' characteristics within the educational context are encouraged to consider the effects of social contagion between students as well. In addition, it is suggested to look deeper into the effect of differences in parental education with more accurate data.

A recommendation to policy makers is to reconsider the current weights system that is used in primary education to determine whether - and how much - extra government funding schools

get. This study has shown that just predicating upon parental education level to determine how (dis)advantaged a pupil is, is too short-sighted. Instead, multiple personal as well as living environmental factors increase the risk of underperforming in school.

It is worrying that some children seem to find themselves in a disadvantaged position when it comes to educational opportunities. Primary school is a fundamental phase of people's lives and differences that emerge in this phase are likely to affect somebody's opportunities in further life. This study has shown that social contagion does matter for educational achievement. Raised awareness about the critical role that social contagion might have in classroom dynamics can help in moving towards a more equal education system.

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Appendix 1: recalculation from neighborhood level variables to zip code level variables

Software used: QGIS

Step 1. Intersect zip code geometries with neighborhood geometries, so that all unique combinations of overlapping zip codes and neighborhoods become separate parts.

Step 2. Calculate for each separate neighborhood part what percentage of the associated zip code area it covers.

Step 3. Using the percentage of the zip code area as weights, the neighborhood average incomes and non-western migrant prevalence are used to calculate the zip code average income and non-western migrant prevalence.