Abstract Title Page

Title:
Is transition to a special education school an effective answer to mathematics difficulties?

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Abstract Body

Background / Context:
Special education schools aim at giving appropriate education to students with special educational needs (SEN), but remain highly debated everywhere (Graham & Jahnukainen, 2011). First of all, special needs education is costly to provide (Greene & Forster, 2002). Consequently, most governments want to know whether the benefits in terms of student outcomes outweigh the extra costs, especially at a time where more and more students are diagnosed with a label making them a candidate for special education (Graham & Jahnukainen, 2011; Lebeer et al., 2010). Second, there are ethical objections towards the segregated special education schools (Slee, 2001): grouping special needs students in segregated schools results in isolation and overprotection. That way, students with and without special needs do not get the chance to come in contact with each other and learn from each other (Daniels & Garner, 1999). Referral to special education might therefore limit social and career opportunities in further live (Avramidis, 2010). Consequently, the idea of inclusive education is becoming more attractive. However, research has not yet provided convincing evidence that either inclusive or separate school placement is more effective to reach certain goals. The third reason why special education is controversial, is the lack of convincing evidence that supports or rejects the effectiveness of special or mainstream school placement for students with special needs (Sullivan & Field, 2013). The complexity of special education as a field as well as the fact that most studies so far show methodological shortcomings, e.g., not accounting for selection bias and dependence among observations, partly explain the inconsistent findings that have been reported (Carlberg & Kavale, 1980; Odom et al., 2005). Indeed, the investigation of special education effectiveness is complicated by the very nature of the services. Students are identified for special education based on need, although who actually receives special education is likely due to a number of student, family, school, and context level characteristics that may also be related to academic outcomes (Sullivan & Field, 2013). In the current study, the problem of selection bias was addressed by implementing a quasi-experimental design.

In this paper, we will look at the effectiveness of special education schools for mathematics learning. Mathematics education is a key to increasing the later professional and citizenship opportunities of students; mathematical understanding influences decision making in all areas of life (Anthony & Walshaw, 2009). Math failure correlates highly with referral to special education, grade retention, and school dropout (Jordan & Levine, 2009). Moreover, mathematics difficulties are cumulative and worsen with time, therefore, early identification and intervention is important (Dowker, 2005; Jordan, 2010).

Research Question:
'Do students, who make the transition to a special education school, acquire greater or smaller math skills during the following two years, than students with similar characteristics who promote to the next grade in mainstream education?'

Setting:
We use empirical data from Flanders, the Dutch-speaking part of Belgium, which makes an interesting case study as it has a strong tradition of separate special education (Ghesquière, Moors, Maes, & Vandenberghe, 2002); Flanders has the highest proportion (7%) of elementary school students in separate special schools in Europe (European Commission, 2012). Moreover, rich and longitudinal data are available.

During the last decades, more and more practitioners and policymakers became aware of the fact that placing students in segregated settings labels them and might hinder integration in society (Kroesbergen, Sontag, van Steensel, Leseman, & van der Ven, 2010). As a result, some students with SEN now stay in mainstream schools where they receive some extra support from special education (EACEA, 2010). However, in Flanders, this extra support is limited. These students follow all classes in the same way as their peers do, except for a maximum of two hours a week, when they get to see a tutor who provides some extra learning guidance. Most teachers in mainstream schools continue to teach as they did without students with SEN in their class (Ghesquière et al., 2002).

The final decision on whether or not a student makes the transition to a special elementary school, lies with the parents of the student. If the teacher, or any other stakeholder, judges that a student encounters difficulties, the student can, after the parents' consent, undergo neurological and psychological tests in a Center for Student Counseling (CLB), where a multidisciplinary team of professionals works. If the student is diagnosed with some disorder, the stakeholders might decide that a transition to a special school is advisable. Such an advice is necessary for the transition, but it is not imperative (De Ro, 2008).

Population / Participants / Subjects:
The data used are derived from the large-scale longitudinal SiBO-database. SiBO is the Dutch acronym for pathways through elementary education. In this project, a cohort of approximately 6,000 Flemish students was followed from kindergarten, in school year 2002-2003, until the end of grade 8, in school year 2010-2011 (Gadeyne, Onghena, & Ghesquiere, 2008). For this study, we selected for each school year, the students that got the advice to make the transition to a special school.

Practice:
Transition to a special elementary school is the treatment in our design. Special education schools in Flanders provide a very intensive care, with several paramedics among their personnel, e.g., logopedics, nurses, physiotherapists. Special education teachers followed an extra year at college and are thus trained to guide students with SEN. There are maximum 7 students in one class, whereas the average number of students in mainstream classes is 18. In other words, comparing Flemish SEN students who go to a special school, with SEN students who go to mainstream education, is particularly interesting because we are comparing two opposite 'interventions', i.e., either an extensive care in a special school, or a minimum of care in a mainstream school.

Research Design:
At the end of every school year, some students get the advice to make the transition to a special education school in the next year. We matched the students in the treatment group to students in the control group based on **the advice** given to them **at the end of the school year**. Not all students who get the advice to transfer to a special education school follow this advice. However, this advice is given by professionals who followed the student, and who observed the student in the daily school context. Therefore, we assume that all students who get this advice, have a similar probability of making the transition to special education.

For each school year, we first selected all students from our sample, who got the advice to go to a special education school. From this group, the students who actually made the transition to a special education school in the next school year, are considered as the treatment

group. The students who did not follow the advice but went instead to the next grade in a mainstream school, are considered as the control group.

Data Collection and Analysis:
Data: The SiBO-database contains: student background characteristics, tests for math and language skills, teacher questionnaires, an extensive parent questionnaire, etc. The advice given at the end of the school year, was obtained via the questionnaire that each teacher filled in about each of their students. The mathematics tests administered at the end of the two school years following the treatment, are the outcomes in our study. All math achievement scores were calibrated using Item Response Theory, to be comparable across the years (Cronbach's α > .86). All math tests were administered in school, curriculum-related, and gauged to the student's visual-spatial skills, knowledge of math language, algebra, and number sense and competencies (Verachtert, De Fraine, Onghena, & Ghesquière, 2010).

Analysis: We applied a many-to-one matching-design: each student in the control group, was matched with the four students that resembled them the most and made the transition to a special school. Although the control and treatment groups were based on the advice given by a multidisciplinary team of professionals who have taken into account many characteristics of the student, we also matched the variables that are in the literature considered as important indicators for early school and mathematics difficulties, to optimize our matching procedure (e.g., Beratan, 2008; Dowker, 2005; Gabel, Curcic, Powell, Khader, & Albee, 2009; Gadeyne et al., 2008; Goos, Van Damme, Onghena, & Petry, 2012; Jordan, 2010; Jordan, Kaplan, Oláh, & Locuniak, 2006; Jordan & Levine, 2009; Van de gaer, 2006; Van de gaer, Pustjens, Van Damme, & De Munter, 2008; Verachtert et al., 2010). We did this under the assumption that the math growth in the years following the treatment, can be influenced by the aforementioned variables. By comparing students who have similar values on these variables, we assume that possible treatment effects cannot be attributed to these characteristics. In the next step, to test the robustness and sensitivity of our results, we matched on additional relevant variables. Since the same results were obtained with different matching variables, we can conclude that our results are robust. We corrected for the distance between treated students and their matches in the control group, using the bias-adjusted matching estimator developed by Abadie and Imbens (2002). Also, we matched with replacement, which has the advantage that one student in the control group can be matched with more treated students, minimizing the distance between the matched students (Dehejia & Wahba, 2002). Finally, we **_estimated the average effect of special schools on mathematics_** achievement at the end of the two school years following the treatment. With the *nnmatch* command in Stata, we estimated the average treatment effect, the average treatment effect for the treated, and the average treatment effect for the controlled (Abadie, Herr, Imbens, & Drukker, 2004).

Findings / Results:
Due to space limitations, we only present the results of our first matching based on advice given at the end of kindergarten. We created our control and treatment group as presented in Figure 1. From the 5,295 kindergarteners in our sample, 248 students got the advice to go to a special education school after kindergarten, and thus were somehow diagnosed by a paramedical practitioner. Out of these 248 students, 180 followed the advice, and 68 students went to grade 1 in a mainstream school despite the advice. A limitation of the study is that the proportion of missing math scores within the group of students that got a special education advice, was high (see Figure 1). Then, we matched each of the students in the control group, with his four nearest

neighbors in the treatment group. The results of the first matching are shown in Table 1. No matter which model, for all of the different matching procedures, the results were highly similar: mathematics achievement in special education was significantly lower than in mainstream education.

Conclusions:
Our results indicate that students with SEN are better off in mainstream education than in a special education school, at least as far as mathematics goes. Some caution is needed when interpreting these results. (1) This study considered only one outcome: mathematics achievement. More research is needed to investigate whether the students with SEN would have reached other educational goals easier within mainstream education than within special education. (2) Our analyses relied on a set of available variables. This approach only approximates randomization and rests on an untestable assumption that there were no unobserved confounding variables omitted. It might be argued that the lack of potential predictors for certain childhood conditions typically associated with transition to special education (e.g., ADHD) invalidates the analytical approach adopted here. Anticipating this line of criticism, we argue that possible disorders are taken into account in our matching approach given that they play a role in the advice given at the end of kindergarten. Furthermore, in an earlier study, we matched based on propensity scores taking into account a broad but comprehensive list of variables, and we obtained the same results. (3) We had a limited number of treated students in the SiBO-database, and even less students of whom we had the mathematics scores in the following school years at our disposal. Further research is needed with larger samples of treated students to get more certainty about the results, and to receive results about long term effects of referral to special education. (4) Because of this limited number of treated students in our study, we were not able to make a distinction between students with different types of SEN. We did control for their different characteristics by matching similar students with each other, but we cannot give separate results for each type of SEN. It would be very interesting to differentiate between students with learning disabilities, behavioral or emotional disorders, and social disabilities for instance. There might be a differential effect of special education transition for these different groups of students, and further research needs to clear this out.

Other issues, often addressed in literature and by practitioners, is that placing students with SEN in mainstream education, might have negative effects on the other students in the class (Ruijs, Peetsma, & van der Veen, 2010; Ruijs, van der Veen, & Peetsma, 2010) or may cause too much workload to their teachers (Avramidis & Norwich, 2002; Evans & Lunt, 2002). Also, teachers in mainstream schools do not always have the competencies needed to deal with a growing number of students with SEN (Buell, Hallam, Gamel-Mccormick, & Scheer, 1999).

Although our initial findings should be considered with caution, the contribution of our study to the field of education is important because so little research has been conducted on the effectiveness of special education and the existing literature is out-of-date. By using a quasi-experimental design, we meet methodological problems that were faced in previous international research. Our results have practical implications: they suggest that transferring students to special schools is, on average, not beneficial. This finding can feed the debate on providing the best educational environment for students with SEN. They might suggest that special schools are not enough academically oriented, or not enough focused on preparing their students to return to mainstream education after the achievement gap with their peers is narrowed. In any case, more and methodologically sound research is needed on these issues.

Appendices

Appendix A. References

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Appendix B. Tables and Figures

2002-2003	K3: 5,295 SpEd advice: 248

	Treatment group	Control group

2003-2004	Special ed.: 180 (94 scores)	Grade 1: 68 (48 scores)

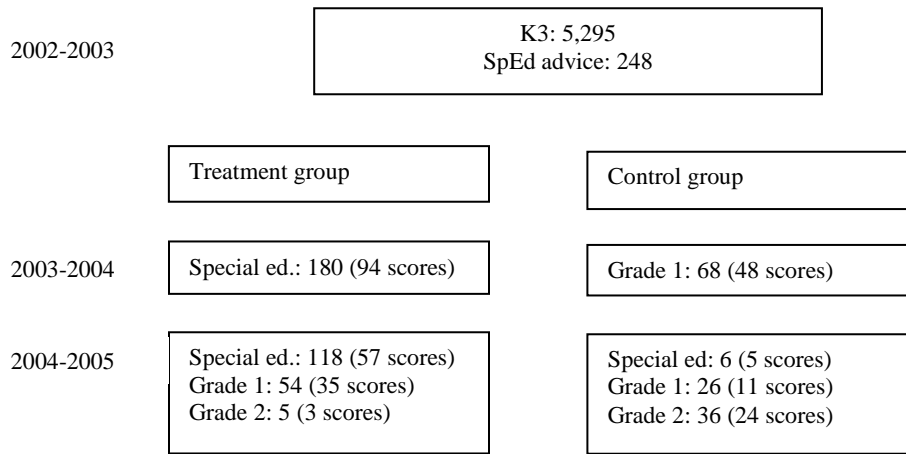| 2004-2005	Special ed.: 118 (57 scores) Grade 1: 54 (35 scores) Grade 2: 5 (3 scores)	Special ed: 6 (5 scores) Grade 1: 26 (11 scores) Grade 2: 36 (24 scores)

Figure 1: Creation of control and treatment group, based on the advice given at the end of kindergarten. The number of available math scores are given between brackets for each group.

Table 1: Results of matching based on advice at end of kindergarten

	Coef.	S.E.	z	P>|z|	[95% Conf. Interval]		ES
Basic matching							
Math04 (n= 142)							
ATE	-8.16	1.22	6.69	.000	-10.55	-5.77	0.96
ATT	-8.43	1.30	6.47	.000	-10.98	-5.87	0.99
ATC	-7.64	1.23	6.22	.000	-10.05	-5.24	0.89
Math05 (n= 135)							
ATE	-5.64	1.45	3.91	.000	-8.48	-2.81	0.59
ATT	-5.79	1.50	3.87	.000	-8.73	-2.85	0.60
ATC	-5.29	1.54	3.43	.001	-8.32	-2.26	0.55
Extended matching							
Math04(n= 142)							
ATE	-8.28	1.51	5.49	.000	-11.24	-5.32	0.97
ATT	-7.81	1.80	4.34	.000	-11.34	-4.29	0.91
ATC	-9.20	1.31	7.05	.000	-11.76	-6.64	1.08
Math05 (n= 135)							
ATE	-7.39	1.85	4.00	.000	-11.02	-3.76	0.77
ATT	-8.27	2.10	3.93	.000	-12.39	-4.15	0.86
ATC	-5.31	1.68	3.15	.004	-8.61	-2.01	0.55

Notes:
- Matching variables Basic model: gender, age, socio-economic status, immigrant status, and prior language and math skills, all measured before the treatment
- Matching variables Extended model: basic matching variables + hyperactivity, teacher expectations, supporting home environment, pro-social behavior, anxious behavior, linguistic capital of the family, work attitude, and to which extent the student needed extra support
- ATE= $Y(1) - Y(0)$: average treatment effect
- $Y(0)$: potential math score of a student when going to mainstream education
- $Y(1)$: potential math score of a student when going to a special education school
- ATT = $Y(1) - Y(0)$ when SpEd = 1: average treatment effect for the treated
- ATC = $Y(1) - Y(0)$ when SpEd = 0: average treatment effect for the controlled
- ES: effect size based on the SD of the math scores, calculated based upon all the students who participated in the SiBO project (SD_{math04}= 8.54, n=4,333; SD_{math05}= 9.59, n=4,149)