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Student-Centered Instruction and Academic Achievement: Linking Mechanisms of Educational Inequality to Schools’ Instructional Strategy

Ida Gran Andersen^{a,b} and Simon Calmar Andersen^c

^aSfi – The Danish National Centre for Social Research, Copenhagen K, Denmark; ^bDepartment of Sociology, University of Copenhagen, Denmark; ^cDepartment of Political Science, Aarhus University, Aarhus C, Denmark

Abstract

Research in the sociology of education argues that the educational system provides different learning opportunities for students with different socioeconomic backgrounds and that this circumstance makes the educational process an important institutional context for the reproduction of educational inequality. Using combined survey and register data of more than 56,000 students in 825 schools, this paper conducts the first empirical test of the argument that instructional strategies that emphasize student responsibility and activity, also referred to as student-centered instruction, increases educational inequality. We analyze whether the impact of student-centered instructional strategies on academic achievement differs for students with different socioeconomic backgrounds. Results suggest that a student-centered instructional strategy has a negative impact on academic achievement in general and for students with low parental education in particular. Our findings support the argument that the instructional strategy of schools is an important mechanism in generating educational inequality through the stratification of learning opportunities.

Word count: 7,885

Keywords: educational success, inequality of educational opportunity, instructional strategies, student-centered instruction

Introduction

Sociologists have theorized that the educational system plays a key role in the transmission of social inequality because it represents the institutional mechanism through which social and cultural resources are converted into educational success (Bourdieu 1977, 1984; Bourdieu and Passeron 1990; Bernstein 1975; Frykman 1998; Lareau 2000). The central argument is that schools’ pedagogical

communication is 'inefficient' because it presupposes knowledge of social and cultural codes (see Bourdieu and Passeron 1990; Bernstein 1975). As a result, learning opportunities are stratified according to students' socioeconomic background. This theoretical position has inspired a large empirical literature, most of which confirms a strong link between social and cultural resources and different measures of educational outcomes (Aschaffenburg and Maas 1997; Bukodi and Goldthorpe 2012; Cheadle 2008; De Graaf, de Graaf, and Kraaykamp 2000; DiMaggio 1982; Dumais 2002; Jæger 2009; Schindler and Lörz 2012; Sullivan 2001; van de Werfhorst and Hofstede 2007).

Although previous research has identified positive correlations between students' social background and educational success, it has not investigated the particular features of the educational processes in schools that produce these correlations. But why are differences in students' socioeconomic background systematically related to differences in academic achievement? Prior research suggests four potential sources of these disparities in educational outcomes among students from different socioeconomic groups: (1) differences in students' access to material, social and cultural resources outside the school (Andersen and Hansen 2011; Buchman and DiPrete 2006; Georg 2004; Schindler and Lörz 2012; Sewell and Hauser 1975; Teachman 1987); (2) differences in access to resources and quality across schools (Bodovski and Farkas 2007; Clotfelter, Ladd and Vigdor 2005; Kahlenberg 2003; Lee and Burkam 2002; Rumberger and Palardy 2005); (3) differences in the students' skills and strategies to actively create their own advantages in the classroom (Calarco 2011; Lareau 2000; Lareau and Weininger 2003); and (4) differences in the way in which the institutional context, such as educational policies and strategies, affect educational inequality (Pfeffer 2008; Stadelmann-Steffen 2012).

In line with the fourth strand of research, recent empirical literature has investigated the effect of different instructional strategies on student achievement (Aslam and Kingdon 2011; Bodovski and Farkas 2007; Lavy 2011; Schwerdt and Wuppermann 2011; van Klaveren 2011) and suggest that

classroom teaching that emphasizes lecture style teaching and the instilment of knowledge, also referred to as *teacher-centered* or *traditional* instruction, has a positive impact on student achievement (Lavy 2011; Schwerdt and Wuppermann 2011). However, ‘constructivist’ learning theories highlight the importance of using classroom techniques that emphasize student responsibility and activity, which has been labeled *student-centered instruction* (Baeten et al. 2010; Newmann, Marks and Gamoran 1996). This student-centered instruction is often characterized as substantially contrary to the teacher-centered, traditional instruction (Frykman 1998; Newmann, Marks and Gamoran 1996; Prince 2004).

The aim of this paper is to test whether a student-centered instructional strategy in schools reinforces educational inequality. The motivation for analyzing heterogeneous effects of a student-centered instructional strategy stems from the sociological theories that argue that the educational process enhances social inequality and from the lack of empirical studies investigating this hypothesis. While previous studies assume, by estimating mean effects, that instructional processes influence all students equally (Aslam and Kingdon 2011; Lavy 2011; Schwerdt and Wuppermann 2011; van Klaveren 2011), this paper examines whether the impact of a student-centered instructional strategy on academic achievement varies with parental socioeconomic background.

Within the past decades, there has been a shift in the educational process from traditional, teacher-centered teaching processes towards student-centered teaching processes (see Frykman 1998). This shift might partly explain why educational systems have failed in creating equal opportunities despite massive investments in social and educational policies and programs. Whereas the traditional school of the 1960s and 1970s was ritualized and formalized with its visible discipline and exercise of power, contemporary schooling is characterized by student-centered instruction, which is often implicit and informal in its structure (Frykman 1998). Accordingly, participation in

student-centered instruction presumes knowledge about expectations and demands, which are less explicit than those of traditional teaching methods.

The sociology of Basil Bernstein further links pedagogical communication to social class differences in learning opportunities (Bernstein 1975). He argues that student-centered instruction—or what he terms progressive pedagogy – favors students from advantaged social classes because this pedagogical context corresponds well to the socialization in these families. The educational process may thus reinforce the social stratification of educational outcomes because learning opportunities are dependent on ascribed characteristics such as students’ socioeconomic background (Hallinan 1988). While some instructional processes are presumed to improve the chances of students of lower socioeconomic background to participate in the educational process, others are expected to hinder equal educational opportunities (Bernstein 1975; Esping-Andersen 2008; Frykman 1998). Sociological theory therefore suggests that we pay explicit attention to the educational process in which social background promotes educational success and what schools can do to modify social disadvantage (Hallinan 1988).

This paper makes two important contributions to the literature. First, to the authors’ knowledge, our study is the first quantitative analysis of the classical sociological hypothesis that the instructional process generates educational inequality because it supposes knowledge of cultural codes. Second, we analyze a set of unique measures of school principals’ student-centered instructional strategy. Applying these measures allows us to investigate specific attributes of the educational process: the instructional strategies in schools and how they relate to academic achievement. Ultimately, this analysis contributes to research on how social and cultural resources are converted into educational success within a particular institutional setting of student-centered instruction. Moreover, we have a large and detailed sample of more than 56,000 students, which includes information on students’ achievement and parental background. Since this data is provided by Statistics Denmark, they are

official and reliable measures. Furthermore, we have information on academic achievement and parental background for all students at a school.

We analyze data from Denmark, which we argue constitutes a suitable context for investigating student-centered instruction due to a double purpose of compulsory education emphasizing not only subject proficiency, but also social and personal development. We combine administrative data on students' academic achievement at the end of compulsory education when the students are 16 years old with detailed administrative data on parental background and a survey of 825 school principals. Based on four indicators, we construct an index of school principals' student-centered instructional strategy. Our results suggest that this strategy has a significantly negative impact on academic achievement in general and on academic achievement of students with low parental education in particular. Consequently, our findings suggest that even when measured at the school principal level a student-centered instructional strategy affects educational equality negatively. The results should be interpreted cautiously, but they do support sociological theories that predict that educational inequality is reproduced in the process of education, and stress the importance of studying the processes of instruction taking place in schools, in order to understand the link from micro to macro processes of social inequality.

Changes in the instructional process

According to Jonas Frykman (1998), the structures of the educational system have changed significantly within the past decades. With the purpose of investigating why the Swedish educational system has failed in creating equal opportunities, he analyzes how schooling today diverges from schooling in the 1960s and 1970s. He argues that over the past 50 years there has been a shift from a traditional, teacher-centered pedagogy towards a more individualized and student-centered pedagogy in schools. In the traditional school, transmission of skills and subject proficiency was the central

purpose and the role of the teacher was to transmit facts to students who were seen as passive recipients. The teacher would typically use a lecture style format and instruct the whole class as a unit (Smerdon, Burkam and Lee 1999). Accordingly, in traditional classrooms it is the teacher, who is active. In comparison, contemporary schools perform a much broader task of developing not only students' academic skills, but also their social and personal competences. The role of the teacher is to function as a guide or coach who supports students in their individual learning process (Smerdon, Burkam and Lee 1999). Whereas the main objective of the traditional school was to turn the students into *something*, the objective of contemporary schooling is to turn the students into *somebody* (Frykman 1998), i.e., shape and support their identity work. The aim of contemporary education is therefore much more comprehensive than (just) equipping students with academic skills to pursue further education and work (become something). Rather, education takes the holistic approach of developing complete human beings (become somebody).

The concept of student-centered instruction

Within the past decades, constructivist learning theory has inspired a wide range of new teaching methods (Baeten et al. 2010; Newmann, Marks and Gamoran 1996; Smerdon, Burkam and Lee 1999). These new teaching methods typically emphasize student-centered instruction, which is characterized by 'ways of thinking about teaching and learning that emphasize student responsibility and activity in learning rather than content or what teachers are doing' (Cannon and Newble 2000: 16-17). Student-centered instruction is similar to what has also been referred to as learner-centered (as opposed to subject- or content-centered) teaching styles (Fischer and Fisher 1979; Opdenakker and Van Damme 2006), authentic teaching (Smerdon, Burkam and Lee 1999) and informal (as opposed to formal) teaching style (Bennett 1976). Despite differences in terminology, common for instructional strategies inspired by a constructivist theory of learning is a set of assumptions about

the nature of knowledge and learning: 1) some of our notion of what constitutes knowledge may be culturally constructed, rather than truth or fact, 2) knowledge is distributed among group members and the knowledge of the group is greater than the sum of the knowledge of individuals, and, 3) learning is an active, rather than passive, process of knowledge construction (Smerdon, Burkam and Lee 1999).

Pedagogical communication and invisible pedagogies

The changes in the instructional process from traditional, teacher-centered instruction towards a more student-centered pedagogy, as described by Frykman, essentially constitutes a change in the mode of transmission of curriculum in schools, rather than necessarily a change in what is transmitted. Basil Bernstein's theory of social and educational codes elaborates in further detail this mode of transmission, i.e. the rules and structures of the pedagogical communication. .

Bernstein uses the concept of *classification* to describe the organization of knowledge into curriculum. Strong classification refers to a curriculum that is highly differentiated and separated into traditional subjects; weak classification refers to a curriculum that is integrated and in which the boundaries between subjects and curriculum are fragile (Sadovnik, 2001: 3). *Framing* concerns transmission of knowledge through pedagogical communication. It is the degree of control teacher and pupil possess over the selection, organization, pacing and timing of the knowledge transmitted and received in the pedagogical relationship (Bernstein, 1973b: 88). Strong framing refers to a limited degree of options between teacher and students; weak framing implies more freedom.

Bernstein applied his theory to what he termed 'traditional/conservative' and 'progressive/child-centered' pedagogical practices (Sadovnik 2006:201). The progressive pedagogy – or student-centered instruction – is characterized by *invisible pedagogy*. Invisible pedagogy stands in contrast to the visible pedagogy of the traditional school context and is characterized by other forms

of differentiation. Where visible pedagogy is characterized by explicit regulative and instructional rules, invisible pedagogy is implicit in its manner of transmission. Invisible pedagogy has the following characteristics: 1) The teacher's control over the child is implicit rather than explicit, 2) Ideally, the teacher arranges the context which the child is expected to re-arrange and explore, 3) Within this arranged context, the child apparently has wide powers over what he selects, over how he structures, and over the time scale of his activities, 4) The child apparently regulates his own movements and social relationships, 5) There is a reduced emphasis upon the transmission and acquisition of specific skills and 6) The criteria for evaluating the pedagogy are multiple and diffuse and so not easily measured (Bernstein 1975: 23). Under invisible pedagogical practices, student and teacher roles are flexible and there is a mixing of categories: elements of the curriculum mingle and teachers and students participate in heterogeneous groupings (Atkinson 1985: 28). Moreover, it emphasizes achieved characteristics; 'ability', for instance, is not thought of as a fixed and generic attribute, but is portrayed as a process that is realized in the context of learning, and in interaction with teacher and peers (Baeten et al. 2010). These invisible pedagogies thus emphasize group and project-oriented problem solving.

Whereas invisible pedagogies are realized through weak classification and weak frames, visible pedagogies are realized through strong classification and strong frames. Accordingly, the basic difference between visible and invisible pedagogies is in the manner in which criteria are transmitted and in the degree of specificity of the criteria. The strength of Bernstein's conception of invisible pedagogies is that it highlights that student-centered or 'progressive' pedagogies are not characterized by an absence of expectations, demands and evaluation criteria. Rather, they are implicit and, consequently, favor students who are capable of decoding the possibilities and rules on which learning is based.

Student-centered instruction and academic achievement

In sum, Frykman (1998) argues that school systems that prioritize student-centered instruction tend to increase inequality. Bernstein's theory provides some of the micro-level theoretical explanations of *why* a focus on student-centered instruction may be detrimental to low-socioeconomic status (SES) students: They are less capable of decoding an invisible pedagogy.

To our knowledge, only few empirical studies have examined how student-centered instruction in schools affect students' academic achievement, and we have not been able to find any studies of the impact of school principals' student-centered instructional strategies, nor any studies that examine any heterogeneous effects of student-centered instructional strategies. Some studies do relate to our analysis by investigating for instance differences in access to didactic and constructivist teaching (Smerdon, Burkam and Lee 1999), however in these studies the teaching strategy is the dependent variable since the authors do not analyze its relationship with academic achievement. Furthermore, Bodovski & Farkas (2007) analyze the effect of traditional and interactive teaching activities and find that both have a significant positive association with mathematics achievement growth in kindergarten.

Recent empirical studies in the Economics of Education have, however, investigated the effect of traditional instruction on academic achievement. With a focus on the subject, the curriculum and the instilment of knowledge, rather than a focus on the student activity and involvement, traditional instruction is often regarded as contrary to student-centered instruction (Frykman 1998; Prince 2004). Therefore, the results from this literature are relevant for our expectations of how student-centered instruction may influence academic achievement since we would expect results with the opposite sign if the two forms of instruction are opposites. Schwerdt and Wupperman (2011) examine whether the

time teachers spend on lecture style teaching affects student test scores and find that, in general, students benefit when their teachers spend more time on lecture style teaching. Similarly, Lavy (2011) finds a positive effect of instruction that emphasizes the instilment of knowledge and comprehension on student test scores. In contrast, investigating the impact of the proportion of time teachers spend lecturing in front of this class on student test scores, Van Klaveren (2011) does not identify an effect. Consequently, previous research suggests mixed results on the average effect of traditional instruction on student achievement.

Educational inequality in the educational process

The results from some of the empirical literature that suggest that traditional instruction benefits student achievement imply that student-centered instruction might in contrast reduce student achievement. While previous research estimates mean effects, sociological theory suggests that the impact of student-centered instruction is heterogeneous, thus contributing to educational inequality.

By focusing on social and personal development and identity work, the student-centered pedagogy draws social and cultural resources into the educational process. Moreover, the implicit and diffuse mode of transmission inherent in student-centered instruction may be a disadvantage for students with few social and cultural resources, because this form of pedagogical communication presupposes knowledge of cultural codes. On the other hand, proponents of student-centered instruction have argued that by building on what students already know, student-centered instruction may place greater value on the knowledge derived from the home and thereby reduce the dissonance between home and school for disadvantaged students in particular. Also, low-SES students may be less encouraged and motivated to pursue academic learning. Giving them extensive influence on how instruction is carried out may enhance their motivation. Finally, opportunities to explore ideas based

on own observations and experiences outside school may be more limited for economically disadvantaged students (Smerdon, Burkam and Lee 1999, Hermann 2007).

Empirical research is therefore needed to examine how student-centered approaches to instruction affect achievement of students with different socioeconomic backgrounds and the consequences for educational inequality. Following Stadelmann-Steffen (2012), we operationalize educational inequality¹ as the dependence of academic achievement on individual student background conditional on student-centered instruction. We thus investigate how students' social and cultural resources come into play in an educational process characterized by student-centered instruction and how this affects academic achievement.

Hypotheses

In this study, we focus on student-centered instructional strategies at the school level, i.e. how school principals prioritize a focus on students' social competencies rather than academic skills, prioritize the teaching process rather than the result, etc. School principals' strategy is not necessarily equivalent to the instruction taking place in the classroom. We would expect a more direct and greater impact of teachers' actual instruction in the classroom than of the school level strategy. But by focusing on the school level, we examine if a student-centered instructional strategy at a more aggregate level does indeed impact individual students' academic achievements in a way that reinforce inequality in learning opportunities.

The theoretical and empirical work presented in this section can be summed up in two hypotheses. First, we hypothesize that school strategies for prioritizing student-centered instruction have a negative impact on student achievement. This hypothesis corresponds to Lavy's (2011) and

¹ Jacobs (1996) identifies three types of educational inequality; inequality in educational access, inequality in educational outcome and inequality in the education process; i.e. the particular features of the school context such as school policies and instructional strategies. This article examines inequality in the educational process.

Schwerdt and Wuppermann's (2011) results, although this study tests the impact of student-centered instruction rather than traditional, teacher-centered instruction. If traditional instruction and student-centered instruction are opposites, as argued by Prince (2004), we expect that student-centered instruction negatively affects student achievement. However, if they are not, as argued by Lavy (2011), we might find that student-centered instruction does not significantly affect student achievement or that it – along with traditional instruction – benefits student achievement.

Second, following Frykman's and Bernstein's theoretical arguments our main hypothesis is that the impact of student-centered instruction is heterogeneously distributed according to students' socioeconomic background. If student-centered instruction requires cultural knowledge and skills – typically possessed by advantaged students – in order for students to decode the pedagogical communication, learning opportunities are potentially contingent on family socialization. We therefore expect student-centered instruction to reinforce inequality of educational opportunity.

Design of the study: Data, variables and empirical strategy

The Danish context

In Denmark, compulsory education consists of nine years at a private school, public school or home schooling. The objects clause on compulsory education contains explicit elements of both traditional acquisitions of knowledge and student-centered instruction with the aim of promoting the students' '*all-round and personal development*'. Compulsory education serves the double aim not only of providing students with academic skills, but also of turning them into 'whole human beings' (Frykman 1998), i.e. help them develop social and personal competences. In a historical account of the Danish school system, Hermann (2007) describes a development that in many corresponds to Frykman's analysis of the Swedish system. In particular, student-centered and individualized teaching processes, such as curriculum differentiation, have been proposed as an advantage for low

achieving students. Furthermore, within the public debate, there is an ongoing discussion on the priority between focus on *subject proficiency* on the one hand, and *social and personal development* on the other (Rasmussen 2007). In sum, the diverging attitudes towards student-centered instruction in the Danish context provide variation in the adoption of student-centered instruction across schools.

To measure the degree of student-centered instructional strategies at the school level we use data from a mail questionnaire to school principals in all public and private schools in the spring 2004 (response rate 71 per cent, see Andersen 2008). School principals were asked to what extent they agreed with the following statements on a five-point Likert scale (1 = ‘Strongly agree,’ 2 = ‘Agree,’ 3 = ‘Neutral,’ 4 = ‘Disagree,’ 5 = ‘Strongly disagree,’ and 6 = ‘Don’t know’): At my school (1) ‘it is more important to develop students’ social competences than to improve their academic skills’, (2) ‘the teaching process is more important than the result’, (3) ‘alternative teaching styles are more important than traditional class instruction’, and (4) ‘teaching processes directed by the students are more important than teaching processes directed by the teacher’. Each question taps into different aspects of a student-centered instructional strategy, e.g. a reduced emphasis on the transmission and acquisition of specific skills (Bernstein 1975: 23); ways of thinking about teaching and learning that emphasize student responsibility and activity in learning rather than content or what teachers are doing (Cannon and Newble 2000: 16-17); and student and teacher roles are flexible (Atkinson 1985: 28).

We recode answers so that higher scores indicate priority of social competences, the teaching process, alternative teaching practices, and student-directed teaching processes. ‘Don’t know’ answers are excluded. We use principal component analysis² and together the four items load on a single factor (only one factor has Eigenvalue >1) with all factor loadings >0.6. This result confirms that the four items measure a one-dimensional construct. We use factor scores to form an index with

² Results are similar for a factor analysis.

a Cronbach's alpha reliability coefficient of 0.6. Appendix Table A.1 shows the factor loadings of the four items, and Figure A.1 shows that the index is approximately normally distributed, indicating that this combined measure is able to tab both ends of the empirical variation.

Measuring student achievement

The Danish Ministry of Children and Education formulates the written examinations at the end of 9th grade, the final year of compulsory education in Denmark. To ensure standardization in grading across schools, the written examinations are graded both by the student's own teacher and by an external officer appointed by the Ministry of Children and Education. These standardizations of the written examinations ensure comparability between schools regarding not only the specific test, but also the objectivity of the grade.

Our measure of academic achievement is students' examination grade in written Math in 9th grade. We use the grade from Math examinations because this measure is more objective than other subjects since answers are either right or wrong, and we use written exams because oral examination grades are more likely to be more influenced by students' social background (Andersen and Hansen 2011). For the written examinations, all schools are required to use the same examination questions issued by the Ministry of Children and Education and with general standards for the use of each grade. Consequently, written tests can be graded relatively objectively and are comparable across schools. Grades are given on a 10-point scale from insufficient to excellent performance. Data on written examination grades is available through the administrative registers and our total sample includes 98.7 per cent of all students in 9th grade in 2004 and 2005, in total 56,300 students in 825 schools.

Students' socioeconomic background

Via unique person identification numbers, Danish administrative registers provide comprehensive population data that enable us to link the survey data with information on students' achievement and socioeconomic background. To examine the heterogeneous effects of student-centered instruction we use two measures of socioeconomic background: parental education measured as the average length of their parents' education in years and parental income measured as the parents' average yearly disposable income.³ Using data from administrative registers provides highly valid and reliable measures of education and income compared to self-reported data.

At the student-level, we control for 1) gender, 2) immigrants (first or second generation compared to non-immigrants), and 3) family type (student living with both parents or not). At the school level, we control for 1) number of students in 9th grade as a measure of school size, 2) the average parental education of the peers, and 3) whether the school is public or private. Table 1 shows descriptive statistics for all variables used in the analysis.

TABLE 1 HERE

Empirical strategy

The purpose of this study is to examine the impact of a student-centered instructional strategy on academic achievement for students with different socioeconomic backgrounds. Our combined survey and register data has a two-level structure consisting of students nested in schools. To account for the hierarchical structure of our data (Rabe-Hesketh and Skrondal 2008: 51), we apply a multilevel model

³ More specifically we use the logarithm to the income to obtain linearity in the regression

in which the random intercept of a linear regression of academic achievement on student-centered instruction is allowed to vary across schools. We write

$$y_{ij} = \beta_0 + \beta_1 x_{ij} + \beta_2 z_j + \beta_3 c_{ij} + \beta_4 (x_{ij} * z_j) + \mu_{0j} + e_{ij} \quad (1)$$

where y_{ij} is academic achievement for individual i in school j , x_{ij} is socioeconomic background, z_j is our index of student-centered instruction, c is a vector of control variables at the individual and school level and, finally, the error term is decomposed into two parts partitioned into the school level (μ_{0j}) and the individual level (e_{ij}). We introduce an interaction term between student-centered instruction and student socioeconomic background (measured as parental education and parental income) to test whether the impact of student-centered instruction varies across different socioeconomic groups of students. Significantly positive interaction terms will support the hypothesis that student-centered instruction increases the influence of students' socioeconomic background on academic achievement and, consequently, contributes to educational inequality. To examine the effect of student-centered instruction for different groups of students, we also estimate marginal effects based on the regression analysis (Brambor et al. 2006).

We link the survey data from spring 2004 to register data on student achievement and socioeconomic background from 2004 and 2005. The detailed information on student characteristics provides a comprehensive list of control variables, which limits the possibility of omitted variable bias. This allows us to control for a substantial amount of factors, which we suspect affect both the adoption of student-centered instruction and academic achievement. For instance, by controlling for parental education and income, any significant correlations, we may find, are unlikely to be a result of schools of principals in socially disadvantaged areas (or areas characterized by other social factors that are highly correlated to education and income) places a higher value on process rather than

product. However, to the extent that unobserved factors that are not captured by our control variables affect both the use of student-centered instruction and subsequent student achievements, our model does not account for that. We discuss our results in the light of these limitations of our model.

Results

This section presents the results from the empirical analysis. We run regressions of academic achievement as measured by students' examination scores in math in 9th grade, on school principals' student-centered instructional strategy and controls. Our analytical strategy is, first, to estimate the mean effect of a student-centered instructional strategy on academic achievement. Second, we investigate whether the effect of a student-centered instructional strategy differs by parental socioeconomic background. We estimate these models to assess heterogeneity in the effect of a student-centered instructional strategy on academic achievement and to analyze whether this strategy contributes to educational inequality. We incorporate separate measures of students' socioeconomic background and introduce the interaction terms in the model one at a time in order to analyze what aspects are most important for the stratification of learning opportunities.

Table 2 summarizes results from five models. Column 1 shows results from a multilevel model of academic achievement without explanatory variables. Column 2 shows the correlation between a student-centered instructional strategy and academic achievement. Column 3 shows results from a model in which we introduce an interaction term between a student-centered instructional strategy and parental education. Column 4 shows results from a model in which we introduce an interaction term between the measure of a student-centered instructional strategy and parental income. Column 5 shows the results from the full model.

TABLE 2 HERE

The results in Table 2 suggest that a student-centered instructional strategy has a significantly negative impact on student achievement in math. In other words, at schools that prioritize student-centered instruction, students perform worse on average in math.⁴ This finding confirms our first hypothesis and is substantially in line with Schwerdt and Wuppermann's (2011) finding that traditional instruction has a significantly positive effect on student achievement.

Table 2 also shows results from the interaction model with parental education and income, respectively. These models assess whether the marginal effect of a student-centered instructional strategy on academic achievement is stratified according to student's socioeconomic background. Column 3 and 4 show significantly positive interaction terms between a student-centered instructional strategy and both measures of socioeconomic background. Accordingly, an increase in parental education and income reduces the negative correlation between a student-centered instructional strategy and achievement. However, when we include both interaction terms in the same model (column 5), the interaction term between student-centered instruction and parental income becomes insignificant. Consequently, while parental income modifies the impact of student-centered instruction strategy on academic achievement, the modifying effect disappears when we include the interaction term between student-centered instruction and parental education in the model. This finding suggests that parental income does not add further information about the students' home resources than can be explained by parental education. Parental education is thus more important than parental income in terms of explaining how educational inequality is produced in the educational process. We interpret this result in line with previous literature, which suggests that 'soft' resources are more important than 'hard' resources in predicting educational success in a Scandinavian mobility

⁴ We have tested the results for non-linearity by means of a Kernel regression. We find no indications of a non-linear effect.

regime (Jæger and Holm 2007). We will now study heterogeneous relationships between student-centered instructional strategy and academic achievement in further detail.

FIGURE 1 HERE

Figure 1 plots the interaction between a student-centered instructional strategy and (average) parental education to illustrate how student-centered instruction may affect educational inequality. The figure shows the predicted math grade as a function of parental education at different levels of a student-centered instructional strategy. Figure 1 shows that for all levels of parental education, there is a negative correlation with student-centered instruction, however, the negative correlation decreases with parental education.

FIGURE 2 HERE

Figure 2 further illustrates the estimated marginal effect of a student-centered instructional strategy for students with different levels of parental education. The marginal effect is the change in academic achievement for a one standard deviation increase in student-centered instruction conditional on parental education. Figure 2 shows that a student-centered instructional strategy has a significantly negative correlation with academic achievement of students whose parents on average have less than approximately 16 years of education. This level of education corresponds to a few years more than secondary education, and about one standard deviation above the mean for this sample.

Furthermore, Figure 2 suggests that any negative impact of a student-centered instructional strategy diminishes as parental education increases. For students with highly educated parents there is no significant correlation with student-centered instruction. For students with medium and low

parental education, however, the correlation with student-centered instructional strategy is negative. This finding is substantially in line with the theoretical arguments put forward by Frykman and Bernstein and indicates that a student-centered instructional strategy contributes to educational inequality.

To interpret this as effect sizes, we note that the (standardized) index of student-centered instruction ranges from -2.7 to 3.2, which is a range of (almost) six standard deviations (see Table 1). For students with parents at the lowest educational level, the marginal effect is approximately -0.1 math grades (see Figure 2). Accordingly, for disadvantaged students, the difference between attending a school that fully prioritizes student-centered instruction and a school that does not at all prioritize student-centered instruction is about 0.6 math grades. This is almost the same as the achievement difference between immigrants and native Danes or about three times the difference between boys and girls. If this change is measured as standard deviations on the grading scale (which has a standard deviation of 1.53, see Table 1), 0.6 math grades correspond to 0.4 standard deviations. Lipsey et al. (2012) find that 9th grade students (the grade level in our study) gain 0.25 of a standard deviation in math test scores within one year. Compared to this, the 0.4 standard deviation in our study corresponds to more than 1.5 years of learning.

From the perspective of a school principal aiming at changing the degree of student-centered instruction, a change of six standard deviations is hardly realistic, though. But changing the instructional strategy by about two standard deviations would make students with lowest parental education gain about half a year in math achievement.

If we investigate the effect of prioritizing student-centered instruction in terms of predicted math grades, students with low levels of parental education (7 years) experience a reduction in predicted math grade of twice as much as students with higher levels of parental education (16 years) with a change in student-centered instructional strategy from 1 (lowest level) to 5 (highest level). For

students with the lowest level of parental education, the predicted math grade is reduced with 1.14 grades (on the 10-point scale). Even if we calculate the differences in grades when changing a school's student-centered instructional strategy from 2 to 4 (which might be more realistic), the difference in predicted math grade is 0.57 math grades for students with 7 years of parental education and 0.42 math grades for students with 16 years of parental education. Consequently, students with low parental education experience a decrease in math grades of more than one third more than students with high parental education in absolute terms. Although there are uncertainties attached to these estimates and the effect sizes cannot be interpreted as exact measures, the findings do suggest that the impact of student-centered instruction on educational inequality is by no means trivial.

Conclusion

This paper analyzes if the impact of prioritizing student-centered instruction at the school level on student achievement in math differs across socioeconomic groups of students. The main conclusion from our analysis is that a student-centered instructional strategy in Danish schools correlates negatively with student achievement in general and with achievement for disadvantaged students in particular. The motivation for this analysis is that no previous quantitative study has tested the sociological argument that the educational process poses students with different learning opportunities which are related to socioeconomic background. Though previous research has tested the effect of traditional, teacher-centered instruction (which can be regarded as the opposite as student-centered instruction, see Prince 2004) on student performance, these studies have not taken into account the heterogeneous effects related to student socioeconomic background.

The results of the study should be interpreted cautiously. First, while school principals are asked about their priority of student-centered instruction, we do not know the extent to which the individual teachers share this priority. We would expect that data on each teacher's use of student-centered

instruction correlates more closely with student achievements than the school principals' general priorities. Our results may therefore be smaller than the immediate effects of student-centered instruction.

Second, while our combined survey and register data set is very comprehensive with respect to the range of available control variables, including students' demographic characteristics, it has important limitations. We measure student-centered instruction at a single point in time, so we cannot control for prior achievement. That could be a problem if schools in areas with low achieving students on entry are more likely to adopt more student-centered approaches. However, when these data were collected, school principals had no systematic, standardized test used across all schools to evaluate the achievement of their students. So if principals made decisions about teaching strategies based on student composition, they may have used students' family background (which is known to be highly correlated to achievement) as an indicator. Since we control for family background in the analyses this may be less of a problem. Still, we cannot rule out that unobserved factors influence both schools' instructional strategy and student achievement.

Third, in this study we use grades from written math exams since they are arguably more objective and less influenced by teachers' perceptions of students than oral exams within the humanities. However, this implies that we cannot conclude anything about the impact of student-centered instructional strategies on achievement in other domains. One purpose of student-centered teaching is to facilitate deep-learning, which has been argued to be more dominant within the humanities (Baeten et al. 2010). Future research should examine the heterogeneous effects of student-centered instruction in other domains such as language.

Fourth, we examine student-centered teaching strategies as opposed to traditional, teacher-oriented approaches. Our factor analysis of four different characteristics of teaching strategies shows that they load on a single factor indicating that they measure one dimension. However, other teaching

strategies (that we do not measure in this study) may also be relevant. Bearing these caveats in mind, the results support the hypothesis that school principals' prioritization of a student-centered instructional strategy negatively affects achievement for students with lower parental educational and, consequently, has a negative impact on equality.

This study is the first empirical test of a central theoretical argument within sociology. The study is conducted using data from Denmark, but the results may be of broader relevance. In his historical account of the development of the Swedish school system, Frykman (1998) argues that there has been a shift in the educational process from a traditional approach towards a more individualized and student-centered approach which has important implications for social mobility. Ironically, the motivation for this change at least in Denmark has been to assist students from less educated families (see Herman 2007), but the effects may have been counterproductive. Whether the results can be replicated with more robust empirical designs in other school systems outside Scandinavia remains to be seen. In this paper, we have established a common theoretical ground for further research that links processes of social inequality to features of the institutional context. Specifically, we have developed empirical indicators of Bernstein's theoretical concept of invisible pedagogy and applied them to what we term a student-centered instructional strategy. We would expect the results to generalize to other countries, since Bernstein's theory was developed in the context of another school system than the Scandinavian. But future research should focus on testing the theory in other countries and on developing better empirical models with better data on student-centered teaching at the teacher level to examine in further detail how different instructional contexts facilitate social class dynamics and inequality in the process of education.

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Table 1. Descriptive statistics

Variable	Mean	Std. Dev.	Min	Max	N
<i>Student level</i>					
Written math	7.94	1.53	0	13	56,300
Girls	.500	.500	0	1	56,300
Immigrants	.0580	.233	0	1	56,300
Parents' average education (years)	12.7	2.11	0	20	56,300
Parents' average disposable income (log)	12.1	.411	0	16.0	56,300
Living with both parents	.748	.434	0	1	56,300
<i>School level</i>					
Student-centered teaching	-.008	.996	-2.73	3.20	825
School size (number of students in 9 th grade)	38.4	19.0	1.67	134	825
Sum of parental education (school average)	25.1	1.64	18.4	30.2	825
Private school	0.211	.408	0	1	825

Table 2. Results from multilevel models of the impact of student-centered teaching on academic achievement.

Model	(1)	(2)	(3)	(4)	(5)
Student-centered teaching (SCT)		-0.055*** (0.0120)	-0.173*** (0.0392)	-0.412** (0.183)	-0.345* (0.185)
Parents' average education (years)		0.197*** (0.00315)	0.197*** (0.00315)	0.197*** (0.00315)	0.197*** (0.00315)
Parents' average income (log)		0.260*** (0.0159)	0.260*** (0.0159)	0.266*** (0.0163)	0.264*** (0.0163)
SCT*Parental education			0.00941*** (0.00297)		0.00841*** (0.00315)
SCT*Parental income				0.0294* (0.0151)	0.0152 (0.0160)
<i>Controls at student level</i>					
Girl		-0.194*** (0.0116)	-0.194*** (0.0116)	-0.194*** (0.0116)	-0.194*** (0.0116)
Immigrant		-0.651*** (0.0266)	-0.650*** (0.0266)	-0.649*** (0.0266)	-0.650*** (0.0266)
Living with both parents		0.229*** (0.0138)	0.229*** (0.0138)	0.229*** (0.0138)	0.229*** (0.0138)
<i>Controls at school level</i>					
School size (number of students in 9 th grade)		-0.000312 (0.000530)	-0.000301 (0.000530)	-0.000315 (0.000530)	-0.000304 (0.000530)
Parental education (school average)		0.0603*** (0.00730)	0.0599*** (0.00730)	0.0601*** (0.00731)	0.0599*** (0.00731)
Private school		0.0880*** (0.0315)	0.0908*** (0.0315)	0.0893*** (0.0315)	0.0911*** (0.0315)
Constant	7.866*** (0.022)	7.210*** (0.245)	7.170*** (0.245)	6.490*** (0.248)	6.800*** (0.248)
<i>Random effects parameters</i>					
School level	0.423*** (0.015)	.256*** (0.019)	.256*** (0.012)	.256*** (0.012)	.256*** (0.012)
Student level	1.459*** (0.004)	1.370*** (0.004)	1.370*** (0.004)	1.370*** (0.004)	1.370*** (0.004)
ICC	0.225	0.157	0.157	0.157	0.157
N students	56,300	56,300	56,300	56,300	56,300
N schools	825	825	825	825	825

Notes: *** $p \leq 0.01$, ** $p \leq 0.05$, * $p \leq 0.1$. Standard errors in parentheses.

Figure 1. The impact of student-centered teaching on academic achievement at different levels of parental education

Calculations based on model 5 in Table 2.

Figure 2. The impact of student-centered teaching on academic achievement for students with different length of parental education

Note: 95 % confidence intervals marked by vertical lines. Calculations based on model 5 in Table 2.

Table A1. Principal component analysis of student-centered teaching survey items

Survey items	Factor 1
<i>To what extent do you agree or disagree with the following statements? At my school...</i>	
... it is more important to develop students' social competences than to increase their academic skills	0.65
... the teaching process is more important than the result	0.67
... alternative teaching styles are more important than traditional class instruction	0.72
... teaching processes directed by the students are more important than teaching processes directed by the teacher'	0.61
Eigenvalue	1.75

Note: Principal component analysis. Cronbachs' alpha: 0.6

Response categories: (Strongly agree, Agree, Neutral, Disagree, Strongly disagree, Don't know). 'Don't know' answers are excluded from the analysis.

Figure A1. Histogram of index on student-centered teaching.