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The contribution of intersectionality to quantitative research into educational inequalities

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Educational inequalities are one of the most critical issues facing contemporary societies. While there is a substantial body of quantitative literature tracking inequalities in education based on students' characteristics, an emerging literature is applying the concept of intersectionality to acknowledge the multiple, overlapping impact of these characteristics. We discuss the contributions of intersectionality to quantitative research on (vertical and horizontal) educational inequalities (attainment and subject choice). We then discuss the limitations inherent in this work, along with methodological innovations aimed at addressing these limitations. Finally, we make recommendations for researchers, to encourage greater use of intersectionality in quantitative educational research and thereby to deepen our knowledge of inequalities.

Introduction

Inequalities in education are one of the most enduring social problems in contemporary societies and have been examined extensively in social science research. People from the most privileged backgrounds dominate educational opportunities, and this is related to the inter-generational transmission of socio-economic position (Ishida et al., 1995; Breen & Jonsson, 2005; Breen et al., 2009, Breen 2010). Inequalities in educational outcomes contribute to differences in civic participation (Marien et al., 2010), wellbeing (Melhuish, 2014), earnings (Checchi & Van de Werfhorst, 2017) and health (Conti et al., 2010). These inequalities also have implications for countries' economic prosperity (Hanushek & Woessmann, 2008). A myriad of policy proposals and social programmes have been initiated aiming to tackle educational inequality, yet there appear to be no straightforward solutions, and research on its patterns, trends and mechanisms is ongoing.

An obvious first step to tackling educational inequality is defining the problem adequately. In political and public discourse, 'educational inequality' is often framed in simplistic, vague terms, referring to individuals who are more or less privileged with respect to education. However, this description obscures a highly complex reality. Multiple aspects of advantage and disadvantage, both separately and in combination, influence educational outcomes. This can include socio-economic

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background, gender, and ethnic background, among other influences. In this article, we argue that the concept of 'intersectionality', derived from feminist theory, is a useful lens through which to view these interlocking disparities in education, and with which to better define and understand the problem of educational inequality. Noting that the concept has been used extensively and effectively in qualitative research into educational inequality, we discuss the possible contributions of the intersectionality approach to quantitative research on (vertical and horizontal) educational inequalities (attainment and subject choice). Applying an intersectional approach has already expanded thinking about educational inequalities, yet there are challenges to overcome if it is to be fully embraced by quantitative educational researchers. In particular, quantitative researchers need to acknowledge that intersectional inequalities have evolved over time as a result of specific historical and contextual conditions.

'Educational inequalities' are systematic variations between individuals based on their social group membership (gender, ethnicity, social class), including access to education, experiences, outcomes and returns to education (Jacobs, 1996; Gross et al., 2016b). Our article focuses on educational inequalities across two important educational outcomes: attainment and subject choices. We thereby distinguish between 'vertical' inequalities, which separate individuals in a hierarchical fashion according to the amount or level of education completed, and 'horizontal' inequalities, which relate to differences within a given level of education (for example, degree subjects) (Gerber & Cheung, 2008). The reason for considering both vertical and horizontal inequalities is that both are associated with life chances. Across the world, grades and qualifications strongly influence individuals' opportunities in the labour market, leading to higher earnings, higher chances of entering more prestigious occupations and higher employment rates (Barone & Van de Werfhorst, 2011; Sullivan et al., 2017), as well as structuring individuals' lives in a range of other important ways (see Pallas, 2000). However, it is becoming clear that subject choices also shape these outcomes. For example, choosing the 'right' subject can determine income returns to a given level of education (Van de Werfhorst et al., 2003; Britton et al., 2016).

The present article focuses on quantitative educational research. The concept of intersectionality has historically been much more widely used in qualitative educational research, where it has been a pivotal concept for theorising the experience of inequality and discrimination (for example, see Gillborn et al., 2012; Gillborn, 2015). However, owing to a perception that feminist-informed theory and quantitative methods are incompatible (Scott, 2010), the concept of intersectionality has been less commonly deployed in quantitative educational research. Therefore, to our knowledge there is no review covering intersectional inequalities in education from a quantitative perspective [although see Gross et al. (2016a) for an overview of qualitative, quantitative and mixed methods approaches]. The aim of this article is to show that there is in fact a close fit between the concept of intersectionality and certain quantitative research techniques and to advocate for a wider, more explicit use of this concept in quantitative educational research.

The questions addressed in this article are:

- How can an intersectional perspective be applied to the quantitative study of inequalities in educational outcomes?
- What are the main findings of research considering the intersections between socio-economic background, gender and ethnicity? How can these results contribute to an intersectional understanding of educational inequality?
- What are the methodological challenges associated with using the concept of intersectionality in quantitative educational research?

The first part of the article outlines the concept of intersectionality and why it is relevant for studying inequalities in education. We then describe the methodological techniques typically used by quantitative researchers when assessing complex inequalities in education. The third section reviews quantitative educational research that has employed the concept of intersectionality, either explicitly or implicitly, to studying these complex inequalities. We highlight the contributions of these studies to knowledge on educational inequalities, while engaging with critiques that this type of research is not fully 'intersectional'. We further describe the methodological challenges involved in applying intersectionality to quantitative research on educational inequalities and suggest methodological innovations that would facilitate its use to greater effect. Finally, the article summarises the points raised and concludes with several recommendations for future research.

Origins of intersectionality

'Intersectionality' refers to the idea that social categories, principally those that involve inequality or power, such as gender, race or ethnicity, and social background, are almost always permeated by one another. One's specific location, at the interface between these categories, determines one's experience of the world. The term is often attributed to the American legal scholar Kimberlé Crenshaw, who, in two influential articles (Crenshaw, 1989, 1991), drew attention to the unique disadvantages faced by African American women. Crenshaw's observations became, for researchers and activists, a way to frame complex forms of discrimination and to draw attention to 'interlocking systems' of inequality (Hill Collins, 2002). The theoretical advances of Crenshaw and others built upon an existing critique of the second-wave feminist movement as being dominated by the concerns of relatively advantaged white, middle class women, overlooking the experiences of women facing additional disadvantages related to ethnicity or social status. While intersectionality is most closely associated with gender studies (Lutz et al., 2016), it is now gaining attention across the social sciences. This has led to in-depth reviews of how the concept can be applied in health research (Hankivsky, 2011), sociology (Choo & Ferree, 2010), family studies (Few-Demo, 2014), and psychology (Else-Quest & Hyde, 2016).

Intersectionality and educational inequalities

Notwithstanding its increasing popularity as a conceptual tool for social science research, the definitive meaning of the term 'intersectionality' is somewhat elusive, and it has been used in various ways (Davis, 2008). It is sometimes used more broadly

to describe a perspective on inequality, which emphasises its multi-dimensionality and contextuality, and sometimes refers to more specific research techniques. McCall (2005) summarises the different uses of intersectionality in social science: to deconstruct social categories such as gender, ethnicity and class (termed 'anti-categorical complexity'); to analyse differences and similarities within social categories ('intra-categorical complexity') or to focus on multiple, intersecting inequalities between social categories ('inter-categorical complexity'). All three variants have been deployed to address the issue of educational inequality (Gross et al., 2016a). Studies discussed in the present article mainly use the 'inter-categorical complexity' approach, since this is the most obviously applicable to quantitative methods (Gross et al., 2016a). However, we will go on to argue that 'intra-categorical complexity' can also be addressed to some extent using quantitative methods.

We concentrate on social background, gender and ethnic disparities, as these are the best-researched and most pervasive forms of inequality in education (see Shavit & Blossfeld, 1993; Marks, 2005a,b; Buchmann et al., 2008; Heath et al., 2008; Gross et al., 2016b). Social background inequalities (also referred to as socio-economic status (SES) inequalities) are defined as differences in educational outcomes between those with more financial, cultural and/or family resources, and those with fewer such resources. Gender inequalities are differences in educational outcomes between males and females.[1] This is a complex issue, since both males and females can be disadvantaged in different areas and stages of education (Buchmann et al., 2008). Research on ethnic inequalities in education often focuses on the disadvantages faced by ethnic minorities (Heath et al., 2008). However, as we will describe, some studies have identified majority groups as being more vulnerable to certain disadvantages.

An intersectional, 'inter-categorical' perspective on inequality recognises that it is not sufficient to focus on ethnic, gender or social background disparities alone; instead, these multiple identities combine to produce 'complex inequality' (McCall, 2001). A focus on 'complex inequality' seeks to correct the idea that different types of (dis)advantages stand alone or are the same for every individual who experiences them (Ferree & Hall, 1996). Ethnic, gender or social background inequalities in educational outcomes may even stem from similar sources. For example, social norms around gender and education, which may inform gender differences in subject choice, can be linked both to gender ideology and to patriarchal control of economic and political resources, which is inherently linked to class inequality (Browne & Misra, 2003) and the exclusionary practices of powerful, privileged groups (Weber, 2001; Hill Collins, 2002). Thinking 'intersectionally' about inequality in education therefore requires a fundamental shift to thinking about a person's whole set of characteristics and circumstances, and how this relates to systems of power and discrimination within and beyond education.

How can an intersectional perspective on educational inequality be used in quantitative research?

As mentioned in the introduction, the concept of intersectionality has historically been much more widely used in qualitative than quantitative educational research. Gross et al. (2016a) suggest that this is because qualitative research is better suited to

analysing complexity and the everyday experience of inequalities. Other authors have suggested that, because of its focus on assigning individuals to pre-defined categories, quantitative research is incompatible with an intersectional perspective (Spierings, 2012). From quantitative researchers, there has been concern about the use of small samples (lacking external validity) in research aiming to capture wider social processes surrounding inequalities (Scott, 2010). However, despite these tensions, we suggest that the most important aspects of an intersectional perspective on inequality —multi-dimensionality and contextuality—are amenable to a quantitative research approach (Scott, 2010). Moreover, with innovations in data collection and moves towards inter-disciplinarity and multi-method research, quantitative research on inequality should increasingly be embracing intersectional theory.

Quantitative research into intersectional inequalities mainly relies on secondary data analysis, using large-scale survey or administrative data. For example, in the UK, researchers have used longitudinal data sources such as the Millennium Cohort Study (MCS), which contains detailed information on family background, early development and educational attainment for a representative sample of 19,000 individuals born in the UK in 2000–2001. Another key source is the Longitudinal Survey of Young People in England (LSYPE, now known as 'Next Steps'), which has been linked with administrative data on educational attainment routinely collected by the UK government. Administrative datasets, such as the National Pupil Database (NPD), and the Higher Education Statistics Agency (HESA) data on university students, are also rich sources in their own right. Many other European countries have detailed administrative records linking education and outcomes, and there are several widely available survey datasets in the USA, including the National Longitudinal Survey of Youth (NLSY), and the National Education Longitudinal Study (NELS).

The main analytical techniques used to study 'inter-categorical' intersectional inequalities in education are interaction effects and sub-group differences. While these are not complex methods, they have the potential to deepen and contextualise more conventional analysis of inequality. First, one must identify raw differences between groups, such as differences in mean scores, or proportions of people selecting particular subjects. Researchers can use regression modelling to identify unique associations between, for example, gender and the likelihood of selecting a Science, Technology, Engineering and Maths (STEM) subject, while controlling for other factors that might affect the outcome. Research that stops here assumes that associations between characteristics and outcomes are purely additive. Using the previous example, an additive interpretation would be that the lower likelihood of women studying STEM is independent from the lower likelihood of socially disadvantaged students studying STEM.

In contrast, an intersectional approach to analysing inequalities acknowledges that characteristics like gender and social background interact statistically. For example, the impact of growing up in a low-income family on STEM choice may differ by depending on a young person's gender. To identify these interactions, researchers can run regression analyses for young men and women separately, to see whether social (dis)advantage influences subject choice in similar or different ways for each gender (Harnois, 2013). This can be done by comparing the sign or size of coefficients and is known as a sub-group approach or split-sample regression. An

alternative is to add an interaction term to the regression model. A statistical interaction is present when the effect of an independent variable (such as social background) on a dependent variable (such as STEM choice) differs depending on the value of a third variable (such as gender) (Jaccard, 2001). Interactions are usually set up in terms of a 'focal' and a 'moderator' variable. In our example, the focal variable is social background, and we want to see whether its association with STEM choice is moderated by gender.

Prior research applying intersectionality to the quantitative study of educational inequality

In this section we give an overview of the main applications of an 'inter-categorical', intersectional approach within quantitative research on educational inequality, concentrating on attainment and subject choice. We suggest that, whether or not they explicitly use intersectionality theory, these studies contribute to an intersectional understanding of educational inequality. We also discuss research that attempts to explain these intersectional disparities by considering aspirations, stereotyping and discrimination, and contextual factors (such as location and policy). Reflecting the approach of the majority of studies discussed, we structure this section with specific axes of inequality in mind (e.g. gender and social background; gender and ethnicity). Studies were identified using academic databases and search engines, focusing on research published in the English language.[2]

Attainment inequalities

In terms of inequalities in attainment at school, the intersection between social background and gender has been a prominent theme; across the world, boys and young men appear most susceptible to the effects of disadvantage on educational attainment (OECD, 2015). The vulnerability of boys with less educated parents, from low-income backgrounds and/or with absent fathers has been identified as early as age three. For example, Mensah and Kiernan (2010) show that boys' family and local area characteristics disproportionately affect early test scores compared with girls from similar backgrounds. Entwisle et al. (2007) show that the early reading scores of boys who receive meal subsidies, a measure of family financial disadvantage, are lower than those of girls in similar circumstances. Among children not receiving meal subsidies, there is little gender difference in reading scores. These findings suggest that there is an interaction between social background and gender in relation to educational attainment from the earliest stages.

Ethnicity also interacts with both gender and social background in determining academic outcomes. Using nationally representative UK data from 'Next Steps', Strand (2014a) shows that the socio-economic gradient (the difference in attainment between students from low SES and high SES backgrounds) is particularly large for white boys, compared with other ethnic groups, and compared with girls. At age 16, disadvantaged white and black Caribbean boys are the worst performing groups (Strand, 2014a). The attainment of white, low SES boys declines throughout secondary education at a faster rate than girls from similar backgrounds, and compared

with low SES boys from ethnic minority groups (Burgess et al., 2009). In contrast, advantaged white students do disproportionality well compared with advantaged students from other ethnic groups (except for Indian students). Similar patterns have been found in the Netherlands (Dekkers et al., 2000).

These findings suggest that previous studies showing that social background is related to attainment (e.g. Goldthorpe, 1996; Breen & Jonsson, 2005) may have overlooked important facets of educational inequality by not considering intersections with gender or ethnicity. Findings showing different outcomes for less advantaged students by gender and ethnicity helps to demonstrate a key aspect of intersectionality theory: that not everyone experiences disadvantage in the same way. An intersectional framing of educational inequality also directs our attention to differences among more advantaged students, showing that low attainment among less advantaged white boys should not be the only cause for concern. Among higher SES UK students, Pakistani, black African and Bangladeshi boys, and black Caribbean boys and girls are achieving poor academic results compared with their white counterparts (Strand, 2014b). Similarly, a study in the USA by Bécares and Priest (2015) found that both racial and gender differences in academic outcomes were most pronounced among higher SES students. This shows that the educational benefits of being socially advantaged are not necessarily evenly distributed across ethnic groups, or between males and females. As well as being particularly vulnerable to the effects of disadvantage, white boys seem to derive disproportionate educational benefits from more advantageous social origins.

Subject choice

As noted in the introduction, attainment differences are not the only way inequalities in education are expressed. Students also choose to study different subjects depending on their gender, social background and ethnicity. Research on inequalities in subject choice tends to focus primarily on gender differences in STEM participation (see Boaler et al., 2011). In the UK, while STEM attainment for girls and boys has converged over time, boys remain much more likely to study non-compulsory STEM subjects, particularly Maths, Physics, Chemistry and Engineering (Smith, 2011). Ethnic and social background differences in STEM participation are less well researched. However, white and black Caribbean students have the lowest representation of all ethnic groups in STEM courses, while south Asian students are the most highly represented (Jones & Elias, 2005; Boaler et al., 2011; Equality Challenge Unit, 2017). There is also an emerging literature showing how students' social background is associated with STEM study (Gorard et al., 2008; Campaign for Science and Engineering, 2014; Codiroli Mcmaster, 2017). Research taking an intersectional approach has the potential to shed light on how these factors work together in determining subject choice.

For socially advantaged young people, gender appears to have less of an influence on subject choice. However, the nature of this relationship varies across countries. The US literature consistently shows that the effect of family background on subject choices is more pronounced for women than for men (Trusty et al., 2000; Leppel et al., 2001; Ma, 2009). Ma (2009) finds that, while family socio-economic status

and gender both have independent effects on the choice to study technical, life and health sciences, and business at university (compared to social sciences), the effect of social background appears stronger for young women. Compared with more advantaged women, women from disadvantaged families were more likely to study subjects associated with more lucrative careers. For young men, social background had little influence on choices. In the UK, Codiroli Mcmaster (2017) also found that the association between social background and subject choice was stronger for young women than for young men, but in a different direction. Less advantaged women were more likely to study social sciences, law, and business (instead of STEM) compared with their more advantaged peers. Van de Werfhorst (2017) found similar patterns in the Netherlands; young men and women from less advantaged backgrounds were more likely to choose 'gender typical' subjects. The reasons for these cross-country differences are not yet clear, and more research is needed to better understand the influence of national context. What is certain, however, is that it is important not to assume results will be similar across contexts, as the main driver of inequalities by characteristics such as gender and social background are not the characteristics themselves, but the systems of power that create and sustain them.

Research also points to differing associations between ethnicity and subject choice for young men and women. In a US study, Catsambis (1994) found that the overrepresentation of boys in mathematics courses in Middle and High school was strongest for Latin American students and smallest among African American students. Codiroli Mcmaster (2017) also found some evidence of an interaction between gender and ethnicity in university subject choice in the UK. While, in general, black African students are more likely than white students to choose STEM over arts and humanities, this disparity is much more pronounced for young women than for young men. However, Ma's (2009) study on subject choice in US universities did not find any interactions between ethnicity and social background. As with gender, it is highly likely that the experience of being from an ethnic minority background differs hugely depending on context. Moreover, the ethnic groups under consideration also vary widely across contexts. Ethnic minority groups studied in the US (usually black, Latin American, or 'other') will often be very different from those studied in the UK (usually a much broader categorisation).

Stereotypes and identification with STEM

Explanations for gender differences in subject choice have typically focused on social norms about which subjects are appropriate for each gender and how these are internalised throughout students' lives. The fact that girls are reluctant to choose STEM subjects may be driven by the stereotypes that ability and interest in STEM are signals of masculinity. This is internalised by children and adolescents and reflected in their education choices. Explanations for ethnic differences in subject choice typically focus on cultural identity, stereotyping and discrimination. For example, there may be cultural differences in which subjects are considered more valuable (Archer & Francis, 2007), or teachers might have preconceived ideas about students' orientations to science based on their gender and ethnicity (Campbell, 2015). Moreover, the

under-representation of women and people from ethnic minority backgrounds in science textbooks could have lasting negative impacts (Frost et al., 2005).

Amid these explanations, there are several concepts that could be operationalised quantitatively to shed light on intersectional differences in subject choices. For example, the concept of 'science capital' has been developed to understand students' engagement in science, defined as the extent to which their families have connections with or knowledge about science (Archer et al., 2012). White students and those from working class backgrounds have the lowest levels of science capital. The more prominent gender disparities in STEM choice among disadvantaged students may be a consequence of multiple barriers to science capital. While a working-class boy may grow up in a family with low science capital, they would also see themselves represented in science in the media, in textbooks, and be exposed to stereotypes about boys' relative competence in science. The negative impact of low science capital and stereotypes around class, academic capability and science suitability may thus be cancelled out. Working class girls, in contrast, would have no 'positive' stereotypes with which to override other barriers.

It could also be that class is directly related to the experience of gender, and to ideas about subjects that are suitable for boys and girls. There is some evidence that more educated mothers are more likely to hold egalitarian gender role attitudes (Farré & Vella, 2013), which may influence their children's subject choices (Van de Werfhorst, 2017). Annette Lareau's (2003) seminal research highlighted the differences in parenting practices between advantaged and disadvantaged parents. Beyond relative differences in science capital, parents with more resources may be more able to combat stereotyping and foster their children's individual interests. Quantitative research exploring parents' gender role attitudes and parenting practices from an intersectional perspective could illuminate whether these factors play a role in the intersectional patterns of subject choice identified.

Educational and career aspirations

One possible explanation for inequalities in attainment and subject choice is students' aspirations, preferences, motivation, personality, and so-called 'non-cognitive skills' (Gutman & Schoon, 2013). Indeed, raising aspirations and improving pupils' confidence, motivations, and resilience are popular policy recommendations for tackling low educational attainment among disadvantaged groups (Sharples et al., 2011). Studies focusing on these traits are sometimes based on samples lacking ethnic and social diversity, a clear barrier to an intersectional approach. However, it is becoming more common for researchers to study concepts such as educational aspirations using nationally representative data (Goodman et al., 2011). Applying an intersectional framework to the analysis of aspirations and associated traits could shed more light on the intersectional patterns of attainment and subject choice described above.

Berrington et al. (2016) explored differences in students' aspirations to attend university as a potential explanation for attainment inequalities. Although their research did not identify any intersectional patterns in aspirations, it highlights the utility of studying intersectionality in relation to mechanisms that are thought to be key for educational attainment, alongside attainment itself. Moreover, the interaction

between characteristics in relation to aspirations may be highly contextually specific, likely depending on differences in historical context. In contrast to Berrington et al., Howard et al. (2011) found interactions between US students' ethnicity and both social background and gender in determining career aspirations. For Native American and Asian/Pacific islander students, family income was associated with aspirations to enter prestigious careers, whereas for other groups this was not the case.

It is possible that differences in aspirations arise from students' realistic assessment of the barriers they will face when they leave schooling. It is well established in the literature that women and people from ethnic minority backgrounds are disadvantaged in the labour market, even when accounting for academic attainment (e.g. Crawford and Greaves, 2015). In England, women, people from lower income families and people from ethnic minority groups earn less upon graduation regardless of subject studied at university (Britton et al., 2016). Students (and parents) may be aware of the additional barriers they may face and feel that they need to work harder and accomplish higher grades if they want to achieve a comparable position to more advantaged peers. Students who initially come from a more advantaged position in terms of labour market outcomes (for example, white, middle class boys) may be aware they do not need to work as hard. However, students' awareness of broader labour market inequalities is difficult to capture with quantitative data, and to our knowledge has not been attempted in large-scale, nationally representative studies. It should also be acknowledged that broader labour market inequalities and discrimination not only inform aspirations; they may also serve as a barrier to aspirations being achieved. Intersectional studies of educational aspirations should consider the role of both structure and agency in shaping how educational and career aspirations are formed and realised (Schoon & Lyons-Amos, 2017).

Furthermore, Strand (2014a,b) suggests that some ethnic minority groups have greater resilience to lower socio-economic status because they possess 'ethnic capital'. Ethnic capital is a term coined to explain how attitudes towards education and a stronger work ethic within ethnic minority families leads to higher aspirations and attainment, especially when economic capital is low (Modood, 2003; Strand, 2014a; Khattab, 2015). This may operate through several mechanisms, for example selective immigration of highly motivated individuals, or as a response to the labour market discrimination discussed above. This is particularly important considering the differences in associations between social background and performance across various different ethnic minority groups.

Ethnic capital requires further investigation in quantitative research, perhaps by measuring social background along different dimensions, including education level of parents or social position before immigration. Research could also explore the impact of other factors associated with ethnicity, such as generation of immigration (e.g. Lessard-Phillips & Li, 2017). Interestingly, patterns in the US are very different. Alon (2007) shows that the effects of disadvantage are far worse for black students than for white students. Researchers could exploit these cross-national differences to help pinpoint mechanisms. For example, differences in the impacts of social background by ethnicity may in part be explained by different policy responses to multiculturalism, or differences in immigration patterns and forms of discrimination. Also, more work needs to be done to analyse different patterns of 'non-cognitive skills' and resilience across multiple ethnic groups, rather than a binary comparison of white versus non-white.

The importance of context

Most of the studies reviewed have focused on either the USA or UK, and few quantitative studies have addressed the contextual specificity of intersectional inequalities. However, situating intersectional inequalities in their institutional context could help to explain how and why they occur. Part of the definition of intersectionality is that inequalities are contextually specific (Crenshaw, 1989, 1991; Browne & Misra, 2003; Gross et al., 2016a). The characteristics and practices of schools and universities, such as programme structure and the tracking of students into different educational pathways based on their abilities or interests, shape young people's routes through the education system (Charles & Bradley, 2004; Kutnick et al., 2005; Frenzel et al., 2010; Mann & DiPrete, 2016). With multi-level data including school or university information, researchers could explore whether these institutional practices are also associated with intersectional gender, ethnic and SES differences in attainment and subject choice.

This article has noted some key differences between countries, which could be explored further. In terms of educational attainment, the key disadvantaged groups in the UK are socio-economically disadvantaged white and black Caribbean boys, whereas in the USA, black male students are particularly disadvantaged. These cross-country differences could be related to several factors, including history, culture, politics, or institutions. Future research exploring cross-national differences in intersectional inequalities could build upon existing research, which has identified, for example, that more standardised education systems promote social background and ethnic equality (Pfeffer, 2008; Van de Werfhorst & Mijs, 2010; Montt, 2011), and that male over-representation in STEM fields of study in higher education, and gender differences in aspirations for STEM study, are particularly pronounced in more economically advantaged nations (Charles & Bradley, 2009; Charles, 2017). On a smaller scale, regions within countries could be compared.

These considerations suggest that cross-country or regional patterns of intersectional gender, ethnic and SES differences in attainment and subject choice would be a fruitful area for future research. An intersectional approach therefore has great potential to illuminate the links between social structure and a combination of individual characteristics in determining educational outcomes (Gross et al., 2016a). Given the availability of representative longitudinal cohort studies, the charting of intersectional inequalities over the educational life-course and across cohorts is another clear next step and will be a vital addition to our understanding of when and how intersectional inequalities emerge, as well as how they are changing across successive generations.

Descriptions of intersectionality

As noted previously, few of the studies we have outlined explicitly refer to intersectionality as a theory, method or hypothesis. While some studies do mention intersectionality theory (Strand, 2014a,b; Berrington et al., 2016; Codiroli Mcmaster, 2017), many simply note the reasons there may be an interaction along a particular axis of inequality. This raises the question of whether the studies described can be

considered fully 'intersectional'. Moreover, some may take issue with studies referring to intersectionality without empirically considering structural factors and systems of power that give rise to inequalities (Gillborn et al., 2017). While recognising these critiques, we believe that the studies discussed still constitute an important step in our understanding of intersectional inequalities, and should not be dismissed simply for not applying the theory comprehensively. Not only do these studies improve the description of educational inequality, they also identify many areas for further investigation.

Gross et al. (2016a) suggest that the need for empirically verifiable hypotheses in most quantitative research hampers the explicit application of intersectionality. For such hypotheses to be developed, relevant interactions need to be specified in advance and justified theoretically.

Although this approach is less common and more challenging, we wish to draw attention to quantitative studies that have made progress in this direction by providing a more explicitly intersectional framing of their analyses and results. A study by Van de Werfhorst (2017), on gender differences in fields of study, sets out to test an intersectionality hypothesis, supported by an in-depth discussion of why the influence of gender may vary by social background. He also considers contextual factors influencing this intersectional hypothesis, by exploring changes over time. He finds that, over the period 1931–1989, gender segregation into fields of study decreased, and the relationships between gender, social background and field of study also changed over time. Being more explicit about the use of an intersectional approach not only makes the research easier for other academics to discover and synthesise, but also facilitates better interpretation of results alongside theoretical work. We believe that more quantitative researchers should be taking this type of explicit approach. However, studies can be even more overt than this, by incorporating broader knowledge about where specific intersections are likely to be found as part of the formulation of hypotheses, rather than in a post-hoc discussion. In this way, studies can go beyond superficial use of the intersectionality concept.

Challenges and innovations

While some scholars have argued that the rigid nature of quantitative research masks the truly complex relationships between individuals' characteristics and outcomes (Trahan, 2011), we have described an emerging body of quantitative educational research that operationalises intersectionality in compelling and impressive ways. However, there are some methodological difficulties with applying an 'intercategorical' approach to quantitative research on educational inequalities. The first concerns the categorisation of individuals into pre-defined groups. This could obscure the true relationship between individuals and power structures within society and will undoubtedly lead to mis-classification of some individuals, who may face more or less disadvantage than the findings suggest. For example, a person is not just female and from a working-class background, but many other things besides. Indeed, a fundamental aspect of the intersectional approach is to question the very nature of categories such as gender, ethnicity and class (McCall, 2005; Gross et al., 2016a).

Methodological innovations in survey research can mitigate the categorisation problem to a certain extent. For example, 'Next Steps' contains detailed indicators of parents' and neighbourhood characteristics that can be combined to construct a multi-dimensional measure of social background (e.g. Anders, 2017; Codiroli Mcmaster, 2017). These include parents' occupation, education, entitlement to Free School Meals (FSM), home ownership and neighbourhood deprivation. 'Next Steps' also contains measures of aspirations and attitudes, which can be explored as potential explanations of inequalities. Earlier cohort studies can also be used to analyse the multi-dimensionality of social background (parental class, status and education) and its effect on educational outcomes (Bukodi & Goldthorpe, 2013). Furthermore, UK longitudinal studies often over-sample ethnic minority groups, as does the German National Educational Panel Study, meaning that robust conclusions can be drawn, as there are sufficient numbers of cases available. Finally, the move to increasingly link survey data with administrative sources, such as tax and health records, will be hugely beneficial for research into intersectional inequalities.

But despite the rich data available for studying intersectional inequalities in education, further innovation is needed. Most large-scale surveys do not over-sample on characteristics that are relatively uncommon, but which impact educational outcomes. Increasingly longitudinal studies over-sample people from ethnic minority backgrounds, however and many older birth cohorts (for example the British Cohort Study (BCS70), initiated in 1970, and the National Child Development Study (NCDS), initiated in 1958, do not have large enough samples to allow complex analysis of differences by ethnic group.

Important aspects of inequality can be overlooked because of data limitations. For example, despite policy interest in students with caring responsibilities and the influence of these responsibilities on educational trajectories (Department for Education, 2016), this has not, to our knowledge, been explored in large-scale quantitative research. Nor have we been able to find any quantitative research that considers the intersectional experience of students whose gender identity differs from that which they were assigned at birth, or parents and children with disabilities. The information is often simply not collected, and where it is, sample sizes are too small. Studies considering the experiences of smaller (yet very significant) groups of students would benefit from more targeted data collection, and researchers can do more to inform the data collection process by suggesting that the necessary questions are asked when survey questionnaires are in development.

A second potential problem concerns the statistical methods used to identify intersectional inequalities in quantitative analysis, which were described earlier. The use of interaction effects is not always straightforward in non-linear regression models, which estimate the probability of an outcome or event occurring, such as logit and probit models. As Ai and Norton (2003) point out, the coefficient on an interaction term is not easily interpreted in such models, and the true relationship could even go in the opposite direction (positive or negative). Researchers therefore need to be careful about how they present results. For example, instead of just reporting coefficients, researchers can construct charts to visualise the marginal effects of relationships between the focal variable and outcome, broken down by the moderator variable, and assess the direction and extent of any relationships. Moreover, there are limitations

on the number of interaction terms that can be included in quantitative research from a practical point of view. For example, the inclusion of 10 dimensions of inequality would lead to 1013 possible interaction terms. Researchers therefore need to be careful about the categories they choose to focus on and the way they present results.

Another way for researchers to avoid assigning individuals to predetermined groups, and to avoid the pitfalls associated with interaction terms and sub-group analysis, is by using latent variable methods. Latent variables are hypothetical constructs that are measured quantitatively using multiple manifest indicators (Bollen, 2002). For example, social background could be operationalised using a combination of parents' education, parents' income and access to cultural resources in the home or community. One could then see whether gender or different categories of ethnicity are statistically associated with a particular combination of disadvantages. Latent variable methods could also be used to explore complexity within a given social category (for example, pupils on free school meals), operationalising what McCall (2005) terms an 'intra-categorical' approach to intersectionality.

Although latent variable methods are not always informed by an intersectional approach, the methods are well suited because they emphasise the complexity and configurations of characteristics.[3] They also do not impose assumptions, instead allowing patterns to emerge from the data. An example of this is a study by Alon (2007), which uses latent variable techniques to analyse inequalities in college graduation. Alon finds that multiple social, economic and academic disadvantages interact in complex configurations, and have a combined effect on students' graduation likelihood, which is also moderated by gender and ethnicity. While one needs to be careful about the extent to which complex combinations of characteristics identify meaningful groups, latent variable methods are a promising and currently under-used quantitative method for studying intersectional inequalities in education.

Presentation and framing of analysis is key in communicating results from quantitative studies focusing on interactions between characteristics, particularly when relaying results to audiences less experienced in interpreting quantitative research. Academics should always be mindful of which groups they are foregrounding, which groups are being sidelined, and the political and policy implications of those decisions. For example, the foregrounding of white working class boys in some studies has drawn policy attention to this group at the expense of other groups. Another example of this, not in the field of education, is a highly publicised study by Chetty et al. (2018), which focused on the outcomes of black men compared to white men from similar social origins, arguing that women were not affected to the same extent by racial inequalities. However, this conclusion rested upon the particular comparison they were making (black men versus white men) and the outcome they chose to focus on (income). Researchers should be careful to be explicit about what can and cannot be inferred from their research, based on the methodological decisions they have made.

While we are optimistic about the application of intersectionality within quantitative studies of educational inequality, we do recognise the limits to this approach. As Gross et al. (2016a) argue, quantitative research is less well placed to investigate the 'anti-categorical complexity' aspect of intersectionality. Interrogating the nature of social categories requires recording individuals' subjective experiences and capturing

concepts such as discrimination, stereotyping and prejudice. These concepts can be challenging to measure using quantitative data. For example, nuanced measures of the experience of discrimination are rarely available in survey datasets (Harnois, 2013), and it is difficult to capture subjective identity in large-scale, quantitative data. Anti-categorical complexity is therefore best suited to a qualitative research approach and there are many good examples of this, such as Stahl's work on subjective ideas of masculinity, class belonging and education among working-class boys (e.g. Stahl, 2017).

Discussion

Educational inequalities are a major challenge for policy makers, educators, students and their families. In this article, we have described the current status and main contributions of quantitative intersectional research on inequalities in educational attainment and subject choice. We have highlighted important findings from this literature, discussed why the approach is important and considered future innovations that would help strengthen the contribution of intersectionality to quantitative research on educational inequality.

While intersectionality theory is more commonly associated with qualitative research, quantitative researchers are increasingly applying it to their research into inequalities. The increasing availability of large-scale survey and administrative data has facilitated the study of more complex social identities, and we have outlined a number of statistical methods researchers have employed in analysing such data. The majority of these studies take an 'inter-categorical' perspective on intersectionality, focusing on the interactions between gender, social background and ethnicity, and their combined influence on outcomes. Some also take a broader intersectional perspective on inequality, emphasising multi-dimensionality and contextuality.

The research reviewed in this article shows that gender, social background and ethnicity influence educational outcomes in complex, intersecting ways. Researchers should be mindful of these intersections when conducting research into the themes of educational attainment and subject choice. Specific intersections have been highlighted as particularly important. First, socio-economic disadvantage has different effects on educational attainment and subject choices depending on gender and ethnicity. For ethnicity, although inequalities can sometimes be 'explained' by the unequal distribution of socio-economic resources across ethnic groups, this is not always the case. In the UK, some ethnic minority students seem more resilient to the effects of disadvantage. Patterns emerging from the combination of ethnicity and social background are different across countries.

Gender differences also seem to be intertwined with social background: working class boys have the lowest attainment, and less advantaged female students are least likely to study STEM subjects in higher education in the UK (but most likely to in the USA). We noted that these findings are primarily descriptive, and that by focusing on psychological drivers of attainment, considering comparative and historical context and incorporating further categories representing different types of disadvantage, quantitative intersectional research into educational inequalities can make a stronger contribution. Some progress has been made in this direction, but further work is

needed. Also, it is likely that gender, social background and ethnicity interact in predicting additional outcomes that have not been covered in this article, but may be equally important; for example, early years development (Walker et al., 2011), and university completion (Crawford, 2014).

The article highlighted several challenges associated with applying an intersectional approach to the quantitative study of educational inequalities. We suggested that these challenges are not insurmountable but require a creative approach and more data resources. For example, although the problem of allocating individuals to predefined groups cannot be fully resolved, using multi-dimensional measures of social background and other characteristics can mitigate it. We also suggest that researchers should be careful about the presentation and interpretation of results, and look into techniques such as latent variable methods to analyse the complexity of inequalities. While an 'anti-categorical' approach may be most suited to qualitative research, there is a clear gap in the quantitative literature concerning an 'intra-categorical' approach to intersectionality, analysing disparities within social groups.

We have several recommendations for the future of intersectional, quantitative research on educational inequalities. First, researchers who are interested in studying these complex inequalities should explicitly engage with intersectionality theory, making sure that the intersections they choose to target are well grounded in theory and prior research. It is challenging, but not impossible to develop empirically verifiable hypotheses concerning intersectional inequalities. However, it requires engagement with theory and empirical findings beyond one's immediate disciplinary and methodological bubble. We believe that, if quantitative researchers do this, they can tap into the unrealised potential for intersectionality in quantitative research. Moreover, their research can have a deeper impact, not least by helping to facilitate more inter-disciplinary, multi-method dialogue in educational research.

Secondly, to facilitate a more thorough application of intersectionality to the quantitative study of educational inequalities, the survey and administrative data that is the basis of much quantitative research in education must include more detailed aspects of social location and identity. This will require close working relationships between academics, civil servants, policy makers and data controllers to ensure rich data is available for analysis without jeopardising the privacy of participants. This requires all parties' acknowledgement that intersectional research can make a meaningful contribution to tackling educational inequalities. In the UK, some steps have been made to facilitate this by increased access to linked administrative datasets, which will also help with the analysis of smaller demographic groups. However, there remains a long way to go (Economic and Social Research Council, 2017).

Thirdly, we suggest that more attention should be paid to comparative and longitudinal aspects of intersectional inequalities in education. Quantitative researchers need to go beyond identifying intersectional inequalities, by distinguishing the specific historical and policy context in which they arise. There are several potential challenges here. Practically, the quality of data available in survey and administrative datasets varies across countries, and identifying whether differences in associations arise from genuine intersectional inequalities, or to measurement differences, will be challenging. Furthermore, it will be difficult to pinpoint the reasons for differences in intersectional inequalities across contexts and over time. Nonetheless, this work could help to

inform policy and practice aimed at ameliorating these damaging educational differences, along with enhancing our understanding of systems of power and how they have evolved over time to privilege and disadvantage particular groups.

The value of the research described in this article is, first and foremost, to improve the description of inequalities, showing that 'educational inequality' is not one phenomenon, but many. Although not all the studies discussed explicitly engage with intersectionality theory, they still make a valuable contribution to the field of research on intersectionality and educational inequalities and identify many areas for future research. The approach can also offer explanations of intersectional inequalities and ways to address them. Quantitative researchers now need to go further by embracing intersectionality theory, along with the insights of qualitative research, and using it to develop and test explicitly intersectional hypotheses. While it is still imperative to recognise the overriding impact of singly-defined characteristics such as ethnicity (Gillborn et al., 2017), we trust that this article will motivate quantitative educational researchers to apply the concept of intersectionality in their work. We hope that it will become common practice (where there is justification to do so) to test for interactions when considering inequalities both within and across countries, and over time, motivating and contextualising this approach using intersectionality theory.

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NOTES

[1] The majority of quantitative studies employ a binary definition of gender and this is reflected in our article. As more fluid gender identities are becoming recognised, incorporating more diverse categories would enhance quantitative data collection.

[2] Notable studies have also been published in other languages (e.g. Gottburgsen & Gross, 2012) but have not been consulted for this article.

[3] It should be noted that this approach still requires categorising individuals as a first step, so would still not be fully intra-categorical in the way described by McCall (2005) and Gross et al. (2016a).

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