MIND, BRAIN, AND EDUCATION

Investigating Opinions about the Relevance of Genetic and Environmental Research in Education: The Role of Parental Status, Working in Education and Heritability Ratings

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ABSTRACT— Genetic research has a potentially increasing impact on educational practices. This study investigated attitudes towards the utility of genetic and environmental research in personalising education, with comparisons between parents/non-parents and educators/non-educators, as well as how these attitudes may relate to heritability ratings of educationally relevant traits (N = 6,304). Data was collected using the International Genetic Literacy and Attitudes Survey (iGLAS). Overall, participants endorsed environmental research more than genetic research to personalising education. Parents were slightly less likely to endorse genetic (but not environmental) research than non-parents. Educators tended to endorse environmental research over genetic research when compared to non-educators; however, effect sizes were minimal. Participants ranking educational traits as more heritable were more likely to endorse genetic (but not environmental) research in education. Future work should focus on promoting the importance of genetic and environmental research in education.

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We are now living in the genomic era, with an associated increase in the accessibility of genetics. Applications of genetic research are already seen in many domains, including healthcare and legal systems, with a considerable potential in education (Government Office for Science, 2022).

Educational genomics research utilises quantitative and molecular techniques to investigate the relative contributions of genes and environments to population variation in complex traits such as intelligence, school achievement, motivation and behaviour (Krapohl et al., 2014). Quantitative studies primarily consider 'heritability'; how much of trait variation in a population can be attributed to genetic factors (Visscher, Hill, & Wray, 2008). More recent work is starting to consider specific molecular genetic variants and their association with these same educational traits (e.g. Selzam et al., 2017); both of these approaches are explored in more detail below. With such extensive research being conducted in educational genomics there is a real potential for practical and positive educational reform. However, the transition from research to practice requires careful consideration and productive collaboration with all stakeholders, especially if the benefits of educational genomics are to outweigh potential risks.

By considering the opinions of both educators and parents simultaneously, this paper hopes to add to a small but emerging literature seeking to promote the positive utility of educational genomics in educational practices.

UNDERSTANDING HERITABILITY AND GENE–ENVIRONMENT PROCESSES IN EDUCATION

Decades of quantitative behavioural genetic research has shown that variability in students' educational characteristics stems from a complex interplay between genes and environments (Kovas et al., 2007). Research indicates that a substantial proportion of individual differences in educational abilities, motivation, personality and achievement can be explained by genetic factors (Kovas et al., 2015; Rimfeld et al., 2018; Rimfeld, Kovas, Dale, & Plomin, 2016; Shakeshaft et al., 2013). Studies have also shown that specific abilities, including reading and mathematics, are at least moderately heritable (Asbury & Plomin, 2013), and learning disabilities (e.g. dyslexia or dyscalculia) are similarly heritable (Mahmud, Rosli, Maat, & Zainal, 2020; Raskind, Peter, Richards, Eckert, & Berninger, 2013).

Multivariate studies have also uncovered complex mechanisms underlying educational processes. For example, the same genes largely affect performance in different subjects, explaining why children often perform similarly across school subjects – genes have general effects, whilst environments are specialist (Kovas & Plomin, 2006, 2007). Longitudinal research has uncovered developmental trends, for example, showing that achievement impacts subsequent self-evaluation, and this link is influenced by genetic factors (Luo, Kovas, Haworth, & Plomin, 2011). Research has also found that the same genes can act differently in different environments; for example, the heritability of educational traits may be higher or lower in different educational systems (Byrne, Olson, & Samuelsson, 2019; OECD, 2013; Selita & Kovas, 2019; Uchiyama, Spicer, & Muthukrishna, 2022).

POLYGENIC SCORING

Molecular genetic studies extend the general principles discovered through quantitative methods by seeking to pinpoint specific genetic variants associated with individual differences in educationally relevant traits (Selzam et al., 2017). Obtained from Genome Wide Association Studies (GWAS), a polygenic score combines alleles from an individual's DNA to provide an estimate of genetic predisposition to developing difficulties (e.g. learning disability) and characteristics (e.g. athletic ability) (Plomin & von Stumm, 2022).

Research has obtained polygenic scores that can provide probabilistic prediction of educationally relevant traits, including academic attainment, achievement and general cognitive ability (Allegrini et al., 2019; Savage et al., 2018; Selzam et al., 2017; Smith-Woolley, Selzam, & Plomin, 2019). For example, a recent polygenic score predicted 14% of variance in educational achievement in 16-year-old students (von Stumm et al., 2020). While it is likely that such scores will become more predictive as research advances, a recent simulation study suggests upper limits to polygenic scores, with related limited potential utility in educational contexts (Shero et al., 2021). While polygenic predictions are far from deterministic and may have limited utility in educational individualisation, they have the potential to provide a useful tool in educational practice and reform that is more responsive to individual strengths and needs.

These findings have important educational implications, including: increasing our understanding of sources of variability among learners; re-examining our conceptions of reward and punishment in education; and developing teaching approaches based on a better understanding of educational processes. However, partial understanding or incorrect interpretations of genetic findings may lead to harmful views and actions by learners, parents and educators. As more educationally relevant genetic information becomes available, it is important to explore what educational stakeholders think about its applications.

VIEWS OF EDUCATIONAL STAKEHOLDERS

In recent years, there has been increasing interest in genetic knowledge and attitudes across a variety of domains (e.g. Chapman et al., 2019; Likhanov et al., 2023). Some studies have also considered these aspects in relation to education. Walker and Plomin (2005) found that the majority of teachers and parents believed that genetics and environments were equally important in influencing educationally relevant traits such as intelligence, learning difficulties and personality. Only 1–9% of teachers rated traits as all genetic, and 0–1% rated traits as all environmental. The exception to this was 'Behavioural Problems', estimated by 57% of teachers as having a greater environmental underpinning (Walker & Plomin, 2005). Similar findings have been reported more recently, with teachers estimating that traits such as intelligence and cognitive ability are on average influenced equally by genetics and environments (Crosswaite & Asbury, 2019; Martschenko, 2020).

Several studies have considered the perceptions and attitudes of teachers on the implementation of behavioural genetic findings in education. One study in the United States found that teachers wanted to learn more about behavioural genetics, seeing the potential relevance to educational policies, although there were some concerns regarding feasibility and disparities that could arise (Martschenko, 2020). Some research has also investigated how beliefs about the malleability of traits (mindset) may affect teachers views on the aetiology of educational traits and abilities. For example, one study with state and private United Kingdom primary and secondary school teachers found that teachers with more of a growth mindset leaned towards environmental explanations for educational traits and had lower genetic knowledge, as compared to those with a more fixed mindset on average (Crosswaite & Asbury, 2019). These results may reflect a misunderstanding that heritable equals determined (Crosswaite & Asbury, 2019). The study also found that although overall behavioural genetic knowledge was somewhat low, openness to learning more was high.

Recent qualitative research explored teacher and parent concerns and perspectives regarding genetic applications to education (Tan, Markov, Mourgues, & Grigorenko, 2022). Both teachers and parents demonstrated similar basic genetic knowledge. Teachers saw positives in how they would be able to better educate a child, whilst parents viewed the main benefit as protective, safeguarding their child from harmful consequences. Additionally, parents and teachers saw potential for learner empowerment but were concerned about factors including negative labelling and the ownership of genetic data. Linguistic analysis revealed parents had an increased emotional edge to their concerns, based on personal experiences (Tan et al., 2022).

One paper examined the possible risks of misunderstanding key behavioural genetic principles in relation to education (Larsen, Little, & Byrne, 2022). The paper applied the mixed-blessings model (Haslam & Kvaale, 2015), explaining that there could be both positive and negative repercussions to applying behavioural genetic research to education. For example, genetic explanations of learning and behaviour may reduce blame on an individual. However, knowing that genes are important for educational traits may lead to social exclusion or pessimism about learning progress – if educators, parents and students erroneously view genetic effects as fixed and unchangeable. Larsen et al. (2022) emphasised the importance of teachers gaining a proper understanding of genetics in education, reducing potential misinterpretations.

Research into educational stakeholders' views on applications of genetics in education is limited. Few studies have examined attitudes of teachers, and even less research is available with parents. This is a striking omission, as parents are important stakeholders in their children's education (Kordi & Baharudin, 2010; Spera, 2005).

THE ROLE OF HERITABILITY RATINGS

Another factor that may relate to attitudes towards genetic and environmental research in education is genetic knowledge and views on heritability. Some research has explored how genetic knowledge and views on heritability impact genetic attitudes (Carver, Castéra, Gericke, Evangelista, & El-Hani, 2017). In a medical context, Rose, Peters, Shea, and Armstrong (2005) found that greater knowledge about genetic testing for cancer risk related to more positive attitudes towards genetic testing. However, another study reported no significant association between genetic knowledge and attitudes towards genetic testing (Henneman, Timmermans, & Wal, 2006). Therefore, the relationship between genetic knowledge and opinions, including views on heritability, and applications of genetic research, appears complex and possibly domain specific. To date, no research has looked at how 'heritability ratings' (the extent to which an individual views a trait or behavior as heritable) associate with opinions on genetic research in educational contexts.

THE CURRENT STUDY

The current study aims to investigate opinions about the implementation of genetic and environmental research in education in a large sample of key educational stakeholders – parents and those who work in education. This study examines how these opinions may differ from those not directly involved in children's education by comparing parents/non-parents and those who do/do not work in education (educators/non-educators). Additionally, it investigates how heritability ratings of educational traits may associate with these opinions.

We hypothesise that: (1) participants will generally consider understanding environmental influences on academic achievement as more important to educational personalisation than genetic influences; (2) educators will consider understanding academic achievement (genetically and environmentally) as being more important than non-educators; (3) parents will consider understanding academic achievement (genetically and environmentally) as being more important than non-parents; (4) There will be significant correlations between heritability ratings and opinions, specifically that participants who rate the heritability of educational traits higher will be more likely to endorse the importance of understanding genetic, but not environmental, influences on academic achievement.

METHODS

This study gained ethical approval from a university ethics committee (reference: PSY10102016).

Materials

The International Genetic Literacy and Attitudes Survey (iGLAS) was used to collect data (Chapman et al., 2017). iGLAS was developed in 2015 and is in its tenth version. It measures public genetic knowledge as well as attitudes towards genetics and its applications in a variety of contexts (medicine, law, education etc.). The intention of iGLAS is to provide an engaging research tool open to the public. Details on the validation of iGLAS can be found in Chapman et al. (2017). iGLAS is available in 8 different languages and has maintained its validation, for example, in a recent Japanese study (Yoshida et al., 2023). Given the robustness of the translation procedure (bilingual translation, back translation and expert review) and validation in different languages, differences based on the language of completion are not expected.

Demographic Information

Participants were asked to identify if they work in education and/or if they have any children; these data were then used to generate the educator/non-educator and parent/non-parent variables. Participants were also asked to provide their age, gender, education level, etc.

Heritability Ratings

Participants rated the heritability of 14 traits. They were asked "On a scale of 0–100 how important are genetics differences between people in explaining individual differences in the following traits". This study focused on responses to 3 educationally relevant items: IQ, Motivation and School Achievement.

Opinions on the relevance of genetic and environmental processes to personalising education were explored with the following items:

- Understanding how certain genes influence academic achievement is important for understanding how to best tailor education to individuals.
- Understanding how certain environments influence academic achievement is important for understanding how to best tailor education to individuals.

Response options were: 1 = strongly disagree, 2 = disagree, 3 = somewhat disagree, 4 = neither agree nor disagree, 5 = somewhat agree, 6 = agree, 7 = strongly agree.

Participants

Our sample consisted of 6,304 participants who completed iGLAS online on a voluntary basis, receiving no compensation. Participants were recruited in various ways, for example advertising the study on social media and online, as well as approaching university students and other targeted collections.

The number of participants responding to the variables reported here varies, as participants had the option to skip any items they did not wish to answer. 36.1% (N = 2,251) identified as male, 62.3% (N = 3,885) as female, 0.7% (N = 46) as non-binary and 0.8% (N = 50) preferred not to say. Ten participants reported ages between 97 and 116, likely reflecting input errors during data collection. As age is not a test variable in this study, and to provide descriptive statistics that speak more accurately to the sample, age data were removed for these participants. The mean age of the remaining participants (N = 6,062) was 31.66 (SD = 10.47, range 18 to 80). The highest education level that participants had achieved or were working towards was: pre-GCSE (N = 36, 0.6%); GCSE or equivalent (N = 60, 1%); A-level or equivalent (N = 557, 8.9%); Undergraduate (N = 3,762, 60.1%); Masters (N = 1,199, 19.2%); Doctoral (N = 581, 9.3%); and postdoctoral (N = 64, 1%).

Participants listed residence in >80 countries. However, varying sample sizes prevented cross-cultural comparisons in this study.

Table 1 shows the number of participants by parent and teacher statuses, as well as overall numbers and proportions.

Table 1
Overlaps Between Parent and Educator Status.

	Educator	*Non-Educator*	*Total*
Parent	328	1955	2,283 (36.6%)
Non-Parent	597	3,364	3,961 (63.4%)
Total	927 (14.7%)	5,377 (85.3%)	

Note. Some missing data means total N in this table differs from total and subsamples.

Procedure

Data was collected online using iGLAS on Qualtrics between 31-October-2016 and 9-June-2018. Prior to completing the survey, participants provided informed consent. To reduce the influence of disengaged participants and related missing data, analyses were conducted only with participants who completed at least 70% of iGLAS overall and attempted at least 75% of the genetic knowledge items. These are standard procedures when working with iGLAS data. Any remaining missing data are taken to be missing completely at random as all participants had the same opportunities to skip items. As such, and given the large sample size, missing data were dealt with by listwise deletion for each of the analyses presented below (Myrtveit, Stensrud, & Olsson, 2001).

RESULTS

Descriptive statistics for the two outcome variables are in Figures 1 and 2, and Table 2, by parental and educator status. Across all groups, average responses are above 4 ('neutral'). As such, most participants agreed to some extent that genetic and environmental information is relevant to education.

There was some skewness and kurtosis, but in acceptable ranges of −2/+2 for skewness and −7/+7 for kurtosis (Byrne, 2013; Hair, Black, Babin, & Anderson, 2010).

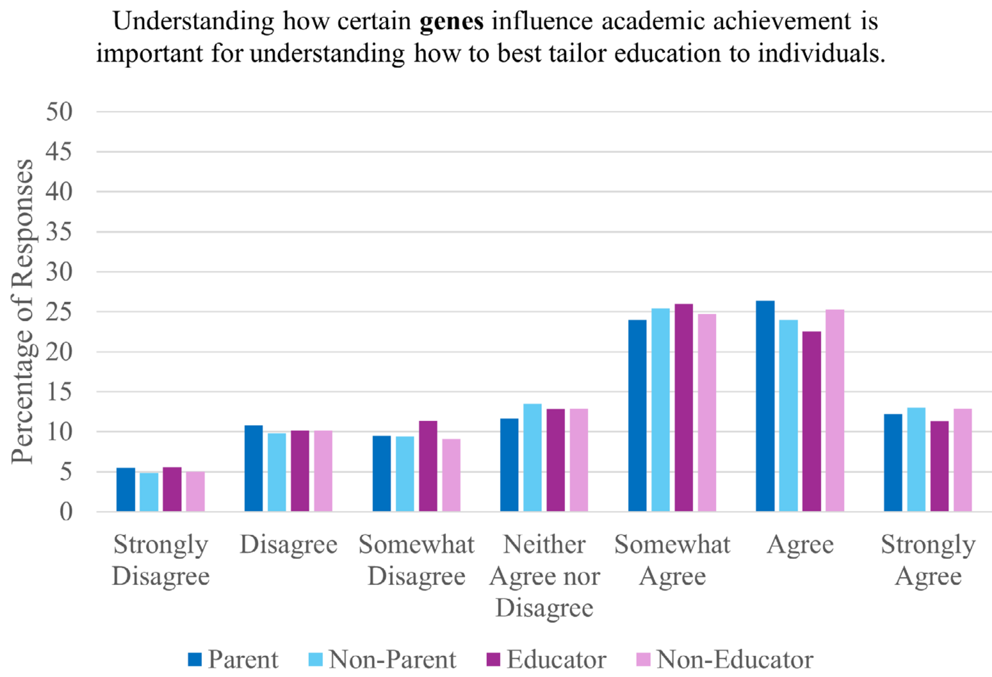

Fig. 1. Distribution of agreement with the genetic opinion item.

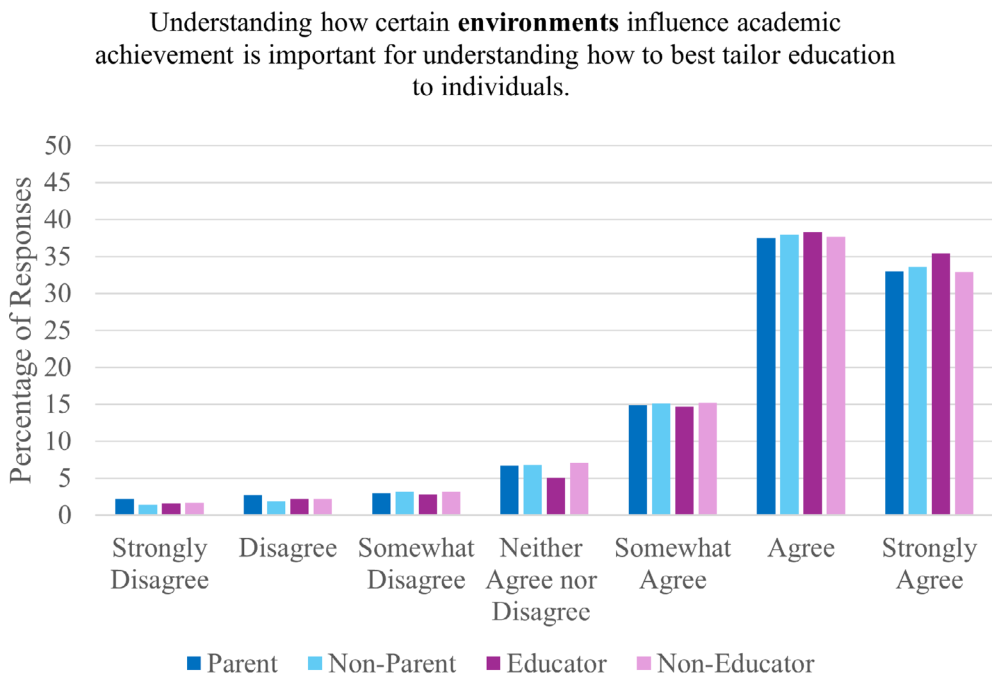

Fig. 2. Distribution of agreement with the environmental opinion item.

Table 2
Descriptive Statistics for Opinion Items

		N	*M (SD)*	*Range*	*Skewness*	*Kurtosis*
Understanding how certain genes influence academic achievement is important for understanding how to best tailor education to individuals	Overall	6,273	4.67 (1.70)	1–7	−.57	−.64
	Educator	927	4.56 (1.70)	1–7	−.49	−.71
	Non-Educator	5,346	4.69 (1.70)	1–7	−.58	−.62
	Parent	2,277	4.66 (1.73)	1–7	−.58	−.69
	Non-Parent	3,955	4.69 (1.68)	1–7	−.56	−.59
Understanding how certain environments influence academic achievement is important for understanding how to best tailor education to individuals	Overall	6,263	5.78 (1.33)	1–7	−1.52	2.36
	Educator	926	5.86 (1.30)	1–7	−1.67	3.00
	Non-Educator	5,337	5.76 (1.34)	1–7	−1.50	2.26
	Parent	2,275	5.74 (1.39)	1–7	−1.53	2.26
	Non-Parent	3,950	5.80 (1.30)	1–7	−1.50	2.38

Note. Means and standard deviations may differ slightly from inferential analyses due to slight reduction in *N* for group comparisons.

A paired samples t-test showed that 'understanding environments' was on average considered more important than 'understanding genes' $t(6259) = 46.59$, $p < .001$, with a medium effect size ($d = .59$).

Relevance by Parent/Educator Status (H2 and H3)

ANOVAs were conducted to explore the effect of parent/educator status on opinions regarding the relevance of genetic and environmental information to education.

A 2 (Parent vs. non-Parent) × 2 (Educator vs. non-Educator) ANOVA was conducted on the dependent variable 'Understanding how certain genes influence academic achievement is important for understanding how to best tailor education to individuals'. Levene's test suggested Homogeneity of Variance based on both the mean ($p = .143$) and median ($p = .251$). The main effect of parental status was significant, $F(1, 6{,}228) = 5.00$, $p = .025$. Non-parents viewed genetic information as slightly more relevant than parents. The main effect of educator status was also significant, $F(1, 6{,}228) = 7.68$, $p = .006$. Those who did not work in education viewed genetic information as slightly more relevant than those who did. There was a significant interaction between parental status and educator status, $F(1, 6{,}228) = 6.06$, $p = .014$. Parents who did not work in education rated genetics as most relevant to tailoring education ($M = 4.71$, $SD = 1.72$), whereas parents who worked in education viewed genetic information as least relevant ($M = 4.38$, $SD = 1.76$). Although these differences were with very small effect sizes ($\eta_p^2 = .001$).

A 2 (Parent vs. non-Parent) × 2 (Educator vs. non-Educator) ANOVA was then conducted on the dependent variable 'Understanding how educational and other environments influence academic achievement is important for understanding how to best tailor education to individuals'. Levene's test suggested Homogeneity of Variance based on the median ($p = .197$) but not the mean ($p = .003$). As this was met using the median, recommended for samples with some skewness (Brown & Forsythe, 1974; Carroll & Schneider, 1985), the ANOVA was conducted. Parents did not differ significantly from non-parents, $F(1, 6{,}221) = 0.50$, $p = .481$. The main effect of educator status however was significant, $F(1, 6{,}221) = 4.20$, $p = .040$. Those who did work in education viewed environmental information as slightly more relevant than those who did not. However, the effect was negligible ($\eta_p^2 = .001$). There was no significant interaction between educator and parent status $F(1, 6{,}221) = .55$, $p = .460$.

Relationships with Heritability Ratings (H4)

Pearson correlations were conducted to investigate the relationships between heritability ratings and opinions regarding the relevance of genetic and environmental information to tailoring education (Tables 3 and 4).

There were weak, significant positive correlations between agreement scores with the statement 'Understanding how certain genes influence academic achievement is important for understanding how to best tailor education to individuals' and heritability ratings for IQ, motivation and school achievement.

No significant correlations were observed between agreement scores with the statement 'Understanding how certain environments influence academic achievement is important for understanding how to best tailor education to individuals' and heritability ratings for IQ, motivation and school achievement.

DISCUSSION

This study investigated public attitudes on the use of genetic and environmental research to tailor education, exploring how these opinions may differ between parents/non-parents and educators/non-educators, and based on participant heritability ratings of educationally relevant traits.

Table 3
Descriptive Statistics of Heritability Items

	N	*M (SD)*	*Range*	*Skewness*	*Kurtosis*
IQ	6,085	57.94 (23.97)	0–100	−.34	−.32
Motivation	5,690	31.82 (24.05)	0–100	.60	−.26
School Achievement	5,746	37.32 (23.86)	0–100	.29	−.54

Table 4
Correlation Results.

	IQ	*Motivation*	*School Achievement*	*Genetic Opinion Item*	*Environmental Opinion Item*
IQ	1				
Motivation	.362**	1			
School Achievement	.453**	.619**	1		
Genetic Opinion Item	.170**	.192**	.232**	1	
Environmental Opinion Item	.002	.012	−.003	.253**	1

Note. *$p < .05$, **$p < .01$.

Participants tended to agree more than disagree that genetic and environmental research into educational tailoring is important, with particularly high endorsement of environmental research. These results are consistent with previous research finding that both parents and teachers view genetic and environmental influences as important for educational traits (Crosswaite & Asbury, 2019; Martschenko, 2020; Walker & Plomin, 2005). Our results also supported our first hypothesis that participants would view environmental information as more relevant to education than genetic information. This difference was significant in the full sample, with a medium effect.

We also hypothesised that educators would consider the relevance of both genetic and environmental information as greater than non-educators. This hypothesis was only partially supported. Educators considered environmental information to be more relevant than non-educators with a small effect, but genetic information as less important, also with a small effect. This is perhaps expected as educators can provide environmental but not genetic interventions in their teaching practice.

We next tested whether parents would consider the relevance of genetic and environmental information as greater than non-parents. The hypothesis was not supported: where significant (genetic) the effects were negligible and not in the expected direction. It is likely that this significant result is a product of the large sample size and that parental status has no effect on opinions regarding the relevance of genetic and environmental information for personalising education. This is somewhat surprising, given it could be expected that parents would agree more with both due to being key stakeholders in their child's education. This unexpected result could come from a heightened emotional edge in parent opinions towards the use of genetic information in education (Tan et al., 2022).

There was a significant interaction between educator and parental status for the genetic opinion item. Parent/educators gave the lowest endorsement for genetic research in education and seemed to differ from all other groups, albeit with a small effect size. This suggests that parent/educators may be worthy of further investigation. Perhaps the combination of interacting with one's own child/children and engaging with the education of others brings a unique perspective on the importance of understanding genetic influences in education, resulting in slightly lower endorsement.

Finally, this study investigated whether there was a relationship between opinions and heritability ratings of educationally relevant traits, hypothesising a positive relationship between agreement with the use of genetic but not environmental research to personalise education and heritability ratings. This hypothesis was supported, suggesting that higher ratings of heritability are associated with higher ratings of the importance of genetic research, comparable to research suggesting a relationship between genetic knowledge and positive attitudes (Rose et al., 2005). This suggests that, regardless of actual heritability, the more heritable educational traits are considered to be, the more likely participants are to see genetic research as important. Although this was with small coefficients, so the association should not be over-interpreted. No significant correlations were observed between heritability ratings and the utility of environmental research.

Limitations

There are some limitations to this study. Although data were collected internationally, unequal sample sizes did not allow for cross-cultural investigation. In addition, we were unable to consider different teaching roles (e.g. subject and ages taught). This may influence the results; for example, secondary school biology teachers are likely to have a higher level of genetic knowledge and awareness than primary or secondary school teachers with a different specialism. Further research is needed to explore in a more nuanced way educators' and parents' views on applications of genetic and environmental information in education. It would be particularly interesting to consider views on the use of polygenic scoring for gene-based tailoring, pre-emptive interventions for learning disabilities, and using information on gene–environment processes to revise views on praise and blame.

CONCLUSION

Overall, our study suggests that both genetic and environmental research, but especially the latter, is considered important for understanding how to best tailor education to individuals. Participants who worked in education were least likely to endorse the importance of genetics, but even within this group, the endorsement tended to be positive, supporting prior findings that teachers are typically open to genetics (Crosswaite & Asbury, 2019; Martschenko, 2020). Parents were also less likely to endorse genetic research than non-parents, especially if they were also educators, although endorsement again tended to be positive. This study also identified that views on the heritability of educational traits significantly relate to opinions about the importance of genetic research in education, suggesting the importance of educating members of society in key aspects of genetic knowledge and accurate comprehension of heritability. This includes helping people understand that educational traits are heritable, and genetics are important, but critically, not deterministic. Similar arguments and support for introducing educational interventions and raising awareness have been made elsewhere (e.g. Heine, Dar-Nimrod, Cheung, & Proulx, 2017; Little, Koehly, & Gunter, 2022), and it is hoped the findings of this study will add to these endeavours.

In relation to findings based on parent and educator status, non-significant results and significant results with small effect sizes suggest little need for differential approaches for specific groups. However, Larsen et al. (2022) mixed-blessings model emphasised there could be detrimental effects on students if genetic research is understood poorly by key individuals. It is also well established that teacher perceptions of their role is a motivator for impactful practice. For example, Perryman and Calvert (2019) identified that the primary motivation to pursue a career in teaching is to "make a difference" (reported by 69% of participants). Teacher perceptions of their role have also been found to have implications for student self-concept in relation to both achievement and behaviour (Bodfield, Carey, Putwain, & Rowley, 2023). These factors coupled with the findings of this study, indicate that working with educators to improve awareness around genetic and environmental influences on education, especially individualised educational practices, should be considered a priority for training providers and continuing professional development programmes. The potential limit to polygenic scoring, especially currently, suggests that this work should be done pre-emptively by improving general levels of genetic literacy, rather than reactively if polygenic scoring is applied on a case-by-cases basis. Improving genetic literacy among educators should not only help them make a difference to their practices but will also have potential trickle-down benefits for student self-concept, achievement and behaviour as well as society more broadly.

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CONFLICT OF INTEREST

No funding was received for this research and the authors report no conflicts of interest.

ETHICS STATEMENT

The data presented in the current paper were drawn from a collection utilising the International Genetic Literacy and Attitudes Study (iGLAS). That collection received ethical approval from Goldsmiths, University of London on 10/10/2016, reference: PSY10102016. As collections with iGLAS are ongoing, the data used in this study are available upon request of the corresponding author.

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