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Parental background and children's view of civic science education – narrowing the education gap by idealism?

PARENTAL BACKGROUND AND CHILDREN'S VIEW OF CIVIC SCIENCE EDUCATION – NARROWING THE EDUCATION GAP BY IDEALISM?

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Abstract

Despite essential progress in recent years, the education gap still prevails even in European industrial nations like Germany. Children of parents with a university background have a higher probability of finishing high school and university. Unfortunately, also civic science education outside school attracts mainly pupils from well-educated families. Thus, the question arises how we can reach children with a lower educational background. As a first step to answer this question, we interrogated the participants of an annual school competition (by means of an online survey) for their evaluation of potential incentives, their personal values to participate in the school competition, and their general view of science and scientific controversies. We compared the answers of pupils with a privileged parental background (i.e., at least one of their parents was at university) with the answers of pupils with a non-privileged parental background. The aim was to receive insights into how we can foster the participation of children with a lower educational background. To summarise, children with a non-privileged parental background had partly more idealistic values and were slightly less oriented toward their later careers. Additionally, they reported less trust in science and had a more suspicious view of scientific controversies. This might reflect a higher desire to make a change in science and society. That means, if we want to reach children with a non-privileged parental background, we should emphasise less the benefits for their later careers but rather should concentrate on their ambitions for society and their idealistic but suspicious view of science.

Keywords: Civic science education, education gap, parental background, idealism, perceptions of science, science communication, science popularization.

1 INTRODUCTION

1.1 Open Education and the Education Gap

Open education as an important part of open science is based on the idealistic goal of education as a fundamental human right because education is seen as the basis for peace, social inclusion, human dignity, and environmental sustainability [1] [2]. Attempts toward open education aim at open access to educational resources, the possibility to collaborate with others across formal boundaries, open creation and co-creation of knowledge, and the integration of formal and informal learning practices [1]. Accordingly, open education and social justice are strongly related to each other [3]. Thus, open education can be seen as an important instrument for narrowing the education gap [4].

Despite essential progress in recent years, the education gap still prevails even in European industrial nations [5] [6] [7] [8]. Children of parents with a university background have a higher probability of finishing high school and university than children with an educationally disadvantaged background. Similar, there is also an education gap in access to shadow education, i.e., privately organised extra lessons outside school [9] [10]. Different reasons for the education gap are discussed, for example, the parents' financial resources, the countries' different school systems and parental support [11] [10]. Besides these circumstances, the perspective of children and their educational aspirations are important elements in narrowing the education gap, not only within the given educational structures of the school system [12] but also by motivating children from educationally disadvantaged backgrounds to participate in open educational initiatives [13]. Unfortunately, so far, educational initiatives outside school, commercial shadow education as well as free-of-cost educational opportunities, attract mainly children from well-educated families [14]. However, in the face of the high importance of science communication in society [15], it is essential to reach all socioeconomic strata and not only a privileged part of society. Therefore, it is important

to explore how we can attract and motivate the broad public, namely children from diverse educational backgrounds, to take part.

1.2 Practical Use Case

We address this question in the context of the evaluation of an annual school competition on economic topics, namely the YES! project in 2021 (https://www.young-economic-solutions.org/en/about-yes/). During this school competition, the school teams develop their own solution to the current key challenges of economics and society by close exchange with experts and scientists [16]. Thus, it is more than just a simple competition of school children but rather can be described as "civic science education" in the sense of Levy, Oliveira, and Harris [17], "that is, educational experiences that support individuals' ability to understand, explore, and take informed action on public issues related to science" [17, p. 1054].

Even though the YES! project is open for every type of school and all possible travel and accommodation costs are covered by the project, mainly pupils from schools of a higher educational level participated, namely most participants came from "Gymnasium" which is the highest school track of secondary education in the German stratified school system [6] [18]. In comparison to the other school types in Germany, the Gymnasium is the usual one with "Abitur" as the regular final certificate that provides direct admission to university. However, the YES! project aims at addressing a broader socioeconomic and educational spectrum. Thus, it is of special interest how to motivate also pupils from other school-tracks (like comprehensive school or vocational school) and children with a lower educational background to take part in this open educational initiative outside school.

1.3 Research Aim and Research Questions

As mentioned above, the overall research aim of the presented study is to receive a more detailed insight on how we can also motivate children from a lower educational stratum to participate in open educational initiatives. On a concrete practical level we investigated if and to what extent the already available elements and incentives are appreciated. Additionally, we investigated the schoolchildren's personal values to understand the pupils' perspective and their personal decision to participate in the school competition. Furthermore, we wanted to receive insights into the children's perception of science and scientific controversies because this might help sharpen appropriate science communication and identify further possibilities for engaging pupils with a lower educational background.

Since mainly pupils from "Gymnasium" participated in the YES! project, we focused on the educational transitions over generations, i.e., we investigated the differences between children of parents with versus without a universal degree, that means if at least one of their parents was at university (privileged parental background) or not (non-privileged parental background). Children with a non-privileged parental background already made a first initial step toward a higher level of education compared to their parents (without university degrees) because "Gymnasium" and the final exam "Abitur" was the necessary entrance to university in Germany. Beyond this background, we wanted to receive insights on possible differences between children with a privileged versus non-privileged parental background in relation to four aspects: Appreciation of existing elements and incentives of the school competition, personal values for the own participation in the school competition, personal attitudes towards their own influence and scientific issues, and perception of scientific controversies.

Thus, we formulated the following four research questions (RQs):

RQ1: Which existing elements and incentives of the school competition are especially attractive to children with a non-privileged parental background?

RQ2: Which personal values for the own participation in the school competition are especially important for children with a non-privileged parental background?

RQ3: If and how do personal attitudes towards their own influence and scientific issues differ between children with a privileged versus non-privileged parental background?

RQ4: If and how does the view of scientific controversies differ between children with a privileged versus non-privileged parental background?

2 METHODOLOGY

The variables of the study were assessed by the help of an online survey. The accordingly questions were included in the regular evaluation survey for the continuous monitoring of the annual school competition. The participation in the survey was voluntary and took place in a break during the regional finals of the school competition. As a reward, the pupils could win an iPad or a Bluetooth speaker/music box in a lottery. The duration of completing the survey (including the general evaluation of the school competition) was about 15 minutes. For all questions, we provide the option “don’t know” or the possibility to skip the question if the participant was not willing to answer it.

The survey started with some basic sociodemographic variables (age, gender, school type). Additionally, we asked for the parental background, which means if at least one of their parents had studied at university (privileged parental background) or not (non-privileged parental background). Most of the subsequent questions related to the evaluation of the school competition (e.g., practical experiences the young school pupils made in the last few months, global evaluation of the school competition, etc.). These questions had no relevance for our research aim, and we will not present them here. (The interested reader can contact the first author for further details.)

The measurement of the dependent variables (i.e., appreciation of existing elements and incentives, personal values of the own participation, personal attitudes towards their own influence and towards science, and perception of scientific controversies) was done by the help of a 7-point Likert scale. For the assessment of the appreciation of the existing elements and incentives of the school competition, the pupils received a list of elements and incentives (e.g., teamwork in a group, expert talk; all rated elements and incentives can be found in table 1). The pupils had to rate, how much they liked the listed elements and incentives (from 1 = not at all to 7 = very much). For the measurement of the personal values for the own participation, we gave the pupils a list of potential values (e.g., benefit for my later professional career, value for my idealistic goals; all rated values are listed in table 2) and asked them to rate these values (from 1 = very low to 7 = very high). To measure the pupils’ personal attitudes towards their own influence and towards science, we asked them to give an estimation (from 1 = very low to 7 = very high) of several listed attitudes (e.g., own influence on shaping the future, general interest in science; the complete list of attitudes can be found in table 3). For the assessment of the pupils’ perception of scientific controversies, they had to rate how much they agree with four different statements (from 1 = do not agree at all to 7 = agree completely). Two of the statements were negative items, i.e., they reflected a negative, suspicious view of scientific controversies. (The concrete wording of the statements can be found in table 4.) At the very end of the questionnaire, the participants had open space for further comments and were offered the possibility to take part in the lottery (as a reward for their participation).

3 RESULTS

3.1 Description of the Sample

The original sample of all pupils from German-speaking countries contained 380 schoolchildren. Most participants were from Gymnasium (314 children, 82.6%). Like pointed out in the chapter on the research question, we focus on pupils from German Gymnasium because schoolchildren from Gymnasium with a non-privileged parental background already made a first step toward a higher educational level (since Gymnasium is the usual entrance to a later university degree). Additionally, we excluded people who did not know their parental background (university or not). This resulted in a sample of 302 children from Gymnasium (182 females; 118 males; 2 divers). All children were between 15 and 21 years old (m = 16.72; s = 0.85). The majority reported a privileged parental background (180 children with a privileged parental background; 122 children with non-privileged parental background). We had no forced answers. Thus, the number of valid cases was partly lower than the total number of participants.

3.2 RQ1: Appreciation of Existing Elements and Incentives

The ratings of the existing elements and incentives were partly correlated with each other. Thus, we calculated a MANOVA for the complete item battery (instead of single ANOVAs). Table 1 shows the descriptive results of the ratings of the elements and incentives.

Table 1. Evaluation of elements and incentives (7-point Likert scale) in dependence of the parental background (privileged versus non-privileged): Means and standard deviations (in brackets).

Elements and Incentives	Parental Background		
	Privileged (n = 104)	Non-Privileged (n= 59)	All (n= 163)
Teamwork in a group	5.64 (1.25)	5.83 (1.37)	5.71 (1.29)
Kick-off	5.32 (1.29)	5.39 (1.39)	5.34 (1.33)
Expert talk	5.57 (1.36)	5.49 (1.55)	5.54 (1.42)
General support for students by researchers or through scientific mentoring	5.43 (1.47)	5.31 (1.57)	5.39 (1.50)
Supporting the pupils through learning modules	4.73 (1.57)	4.81 (1.56)	4.76 (1.56)
Personal guidance and support of pupils by teachers	5.49 (1.57)	5.69 (1.56)	5.56 (1.56)
Coordination of the YES! project through the YES!-Team	5.55 (1.39)	5.53 (1.41)	5.54 (1.39)
Personal guidance and support from the YES!-Team	5.24 (1.41)	5.25 (1.47)	5.25 (1.43)
Work on the pupils' own ideas and proposals for solutions (instead of given ones)	5.90 (1.19)	5.83 (1.21)	5.88 (1.19)
Pupils take the lead in working on their own ideas	6.06 (1.09)	5.75 (1.31)	5.94 (1.18)
Pupils can develop their own solutions (with the help of researchers) on a scientific basis	5.92 (1.13)	5.81 (1.18)	5.88 (1.15)
Pupils also have the opportunity to consult repeatedly with researchers	5.69 (1.34)	5.59 (1.46)	5.66 (1.39)
Competition between the teams	5.23 (1.39)	5.24 (1.56)	5.23 (1.45)
Presentation of the developed ideas and approaches during the regional finals	5.67 (1.24)	5.76 (1.21)	5.71 (1.23)
Presentation of the developed ideas and approaches in English and the corresponding experience with a foreign language	5.37 (1.64)	5.19 (1.78)	5.31 (1.69)
An exchange between the teams at the regional finals	4.79 (1.55)	4.95 (1.82)	4.85 (1.65)
A chance for pupils to present their ideas and solutions at the national finals in front of national and international experts, researchers and politicians	5.55 (1.32)	5.59 (1.29)	5.56 (1.31)
Incentive through the prize for the winning team	5.62 (1.35)	5.83 (1.56)	5.7 (1.42)
Incentive through the public honouring of the winning teams at the Federal Ministry for Economic Affairs and Energy	5.78 (1.46)	5.64 (1.52)	5.73 (1.47)
The incentive to receive a certificate of attendance for CVs	5.93 (1.41)	6.05 (1.32)	5.98 (1.37)
Free participation opportunity incl. payment of travel and accommodation costs	5.93 (1.43)	6.03 (1.39)	5.97 (1.41)

There were no significant differences between children with a privileged versus non-privileged parental background in relation to the incentives and elements of the school competition. All elements and incentives received rather high likeability ratings. The highest rating were given for the incentives that related to the participative part of the pupils (work on pupils' own idea; pupils take the lead in working on their own ideas; pupils can develop their own solutions), the certificate of attendance for the CVs, and the free participation opportunity.

3.3 RQ2: Personal Values for Participation

We found partly significant correlations between the ratings of the personal values for the own participation. Thus, we calculated a MANOVA for the complete item battery (instead of single ANOVAs). The descriptive results of the personal values for participation are listed in table 2.

Table 2. Rating of the personal values for participation (7-point Likert scale) in dependence of the parental background (privileged versus non-privileged): Means and standard deviations (in brackets).

Personal Values for Participation	Parental Background		
	Privileged (n= 158)	Non-Privileged (n = 91)	All (n = 249)
Value for my personal development	5.04 (1.23)	4.93 (1.31)	5.00 (1.26)
Benefit for my later professional career	4.85 (1.44)	4.55 (1.59)	4.74 (1.50)
Value for my idealistic goals	4.76 (1.50)	4.64 (1.44)	4.71 (1.48)
Benefits for society	5.30 (1.47)	5.71 (1.34)	5.45 (1.44)
Benefits for scientific progress	4.47 (1.68)	4.98 (1.41)	4.66 (1.60)
Benefits for the knowledge transfer between school and science	5.28 (1.45)	5.46 (1.31)	5.35 (1.40)
Benefits for economic education outside the classroom	5.51 (1.42)	5.30 (1.40)	5.43 (1.42)
Value for my ability to work in a team	5.80 (1.19)	5.89 (1.35)	5.83 (1.25)
Boost for my general self-confidence	5.25 (1.34)	5.24 (1.48)	5.25 (1.39)
Boost for my ability to understand scientific contexts	5.12 (1.37)	5.10 (1.47)	5.11 (1.40)
Value for my possibilities to actively participate in shaping the future myself and to bring about a change	5.40 (1.39)	5.35 (1.43)	5.38 (1.40)

The mean ratings for all listed personal values were for both groups of children in the upper half of the scale. That means both groups appreciated the personal values.

The ratings of the personal values for the participation showed significant differences for the values benefits for society ($F = 4.940$; $p = .027$; partial $Eta^2 = 0.020$) and benefits for scientific progress ($F = 5.834$; $P = .016$; partial $Eta^2 = 0.023$). Children with a non-privileged parental background indicated a higher value of their own participation for the benefits for society and for the benefits for scientific progress. Additionally, we found a non-significant tendency that the value of participation for their later professional career was slightly less important ($F = 2.411$; $p = .122$; partial $Eta^2 = 0.010$) for children with a non-privileged parental background.

3.4 RQ3: Personal Attitudes towards Own Influence and Scientific Issues

The ratings of the personal attitudes were partly correlated with each other. Thus, we calculated a MANOVA for the complete item battery. The descriptive results of the personal attitudes are listed in table 3.

Table 3. Rating of the personal attitudes (7-point Likert scale) in dependence of the parental background (privileged versus non-privileged): Means and standard deviations (in brackets).

Personal attitudes	Parental Background		
	Privileged (n= 166)	Non-Privileged (n = 95)	All (n= 261)
Your own influence on shaping the future	4.80 (1.12)	4.67 (1.33)	4.75 (1.20)
Your own opportunities to actively participate in science	4.64 (1.31)	4.44 (1.41)	4.57 (1.35)
Your own opportunities to actively work on social issues and bring about change	5.07 (1.22)	5.04 (1.33)	5.06 (1.26)
Your own opportunities to actively work on economic issues in particular and bring about a change	4.69 (1.34)	4.40 (1.56)	4.58 (1.43)
Your self-confidence in dealing with scientific topics	5.08 (1.21)	4.81 (1.32)	4.98 (1.26)
Your general interest in science	5.62 (1.24)	5.69 (1.13)	5.65 (1.20)
Your special interest in economic affairs	5.46 (1.16)	5.00 (1.45)	5.29 (1.29)
Your trust in science	5.94 (1.04)	5.55 (1.19)	5.8 (1.11)
Your assessment of the general complexity of scientific topics	5.48 (1.08)	5.33 (1.09)	5.42 (1.08)
Your own knowledge and skills in relation to scientific topics	4.78 (1.07)	4.63 (1.05)	4.73 (1.06)
Your need to consult additional experts on scientific topics	5.40 (1.32)	5.21 (1.35)	5.33 (1.33)

All means of the ratings were in the upper half of the scale, that means, both groups of pupils reported relative positive attitudes towards their own influence and toward science.

The comparison of children with a privileged versus non-privileged parental background showed significant differences for the special interest in economic topics ($F = 7.788$; $p = .006$; partial $Eta^2 = 0.029$) and for the trust in science ($F = 7.700$; $p = 006$; partial $Eta^2 = 0.029$). Children with a non-privileged parental background indicated a lower interest in economic topics and a lower trust in science. It is important to note that both groups indicated a relatively high trust in science, i.e., also children with a non-privileged background had a relatively high trust in science, but schoolchildren with a privileged parental background were even more trustingly. Additionally, we found a non-significant tendency that pupils with a non-privileged parental background reported slightly lower self-confidence in dealing with scientific topics ($F = 2.760$; $p = .098$; partial $Eta^2 = 0.011$).

3.5 RQ4: Perception of Scientific Controversies

We calculated a MANOVA for all four items on the view of scientific controversies because the items were partly correlated with each other. The descriptive statistics are listed in table 4.

Both groups of children indicate agreement with the two positive items (means in the upper half of the rating scale) and disagreement with the two negative items (means in the lower half of the rating scale).

Table 4. Perception of scientific controversies (7-point Likert scale) in dependence of the parental background (privileged versus non-privileged): Means and standard deviations (in brackets).

Perception of Scientific Controversies	***Parental Background***		
	Privileged (n= 140)	***Non-Privileged (n = 80)***	***All (n= 220)***
Conflicting findings show that more research is needed because the issue is more complicated than initially thought.	5.70 (1.34)	5.64 (1.13)	5.68 (1.26)
Scientific controversies show how unreliable science and the scientists involved are. (negative / inverted item)	3.10 (1.88)	3.69 (1.98)	3.31 (1.93)
Scientific controversies show that you cannot rely on individual scientific findings but must consider the whole field of research.	5.49 (1.39)	5.45 (1.33)	5.47 (1.37)
Contradictory findings show that scientists have falsified data to gain an advantage for themselves. (negative / inverted item)	2.90 (1.84)	3.50 (2.09)	3.12 (1.95)

We found no differences between the two groups of pupils for the two positive items that reflected a differentiated trustful view of scientific controversies. However, pupils with a non-privileged parental background indicated lower disagreement with the two negative, suspicious statements. They disagree less that scientific controversies show how unreliable science and the scientists involved are ($F = 4.790$; $p = .030$; partial $Eta^2 = 0.021$). In addition, they indicated lower disagreement with the statement that contradictory findings show that scientists have falsified data to gain an advantage for themselves ($F = 4.893$; $p = .028$; partial $Eta^2 = 0.022$).

4 CONCLUSIONS

Overall, we had two main insights. First, children appreciate the current elements and incentives of the school competition independently of their educational background. Second, children with a non-privileged parental background had partly a more idealistic view of their own participation in the school competition and partly a more critical view of science and scientific controversies.

The first insight on the current elements and incentives indicates that there is no need for integrating special incentives in dependence on the parental background. After children had decided to take part in civic science education in form of the school competition, they appreciated the elements in an equal way, and their parental background does not matter. Interestingly, the participative elements were among the most appreciated incentives (besides the free participation and the certificate for the CV) and were rated even higher than the support by scientists.

The second insight on the more idealistic and more critical view of pupils with a non-privileged parental background provides some important suggestions for fostering the participation of pupils with a lower educational background and, thus, enabling more equity in civic science education. Children with a

non-privileged educational background focus more on the benefits for society and the benefits for scientific progress. Contrariwise, the value for their later professional career was slightly less important for them compared with children with a privileged parental background. These findings are very important because many educational initiatives outline the benefit for the later career [19]. Our findings suggest that possible benefits for the later career is not an appropriate incentive for addressing especially children with a lower educational background. Rather, we should highlight the idealistic possibilities of civic science education, i.e., the possibilities to contribute to benefits for society and the progress of science through the own participation. In other words, to motivate children with a non-privileged parental background, civic science education should address their idealistic ambitions to contribute to positive changes in society and to scientific progress. In this context, it is also important to note that we found no differences for the importance of their own personal idealistic goals. At first sight, this seems paradox, however keeping in mind that participative civic science education like the YES! project aims at finding solutions for global key challenges in science and society it perfectly makes sense. The YES! project is widely based on teamwork between the children and the interactive exchange of the school teams with scientists. Thereby the own idealistic goals (which can be very diverse) are not in the focus but rather had (eventually) to be postponed for the shared higher goal.

Overall, the found differences regarding values reflect a higher desire of children with a lower educational background to make a change in science and society. This could be based on their prior experiences that they have several disadvantages in comparison to their peers with a privileged parental background (e.g., they are less involved in shadow education). Furthermore, they might also experience the societal disadvantages of the socioeconomic gap more directly and thus, suffer more from educational inequality and social injustice. Therefore, they might be more oriented towards a real change in society and scientific progress instead of focusing on their own benefits or later personal careers. This fits very well with their lower special interest in economic affairs, which might be associated with a less-materialistic but more idealistic attitude.

Interestingly, children with a non-privileged parental background reported less trust in science and slightly lower self-confidence when dealing with scientific topics. This could be at least partly a consequence of their personal experiences with the education gap due to their parental background. Maybe their own educational restraints resulted in a more down-to-earth view of scientific progress because they learned mainly about scientific progress, when it is already mainstream, and the first obstacles to scientific innovation become overt. Similarly, they might also have less access to scientific and technical innovations and the latest scientific findings.

This interpretation also is in line with the findings of the more suspicious perception of scientific controversies. However, these findings have to be interpreted in a differentiated way. Both groups of children indicated an equal level of agreement on the two positive statements that contain a very reflected and reasonable view of scientific debates. That means, independent of their parental background children acknowledge the complexity of science and normal obstacles in the scientific research process. However, children with a non-privileged parental background also consider the possibility of the unreliability of findings and intentional falsification of data. Thereby it is important to note the absolute ratings: Both groups of children reported disagreement with these negative statements. However, children with a non-privileged parental background disagree less (compared with children with a privileged parental background). Thus, it is a matter of opinion if these differences indicate a lack of confidence of children with a non-privileged parental background or rather a too credulous perception of children with a privileged parental background.

The lower confidence in science and scientists can also be used as a motivator for children with a non-privileged parental background. Together with their more idealistic goals, their critical view of scientific controversies could be a motivator to take part in the scientific progress because this is a possibility to make it better and thereby create benefits for society and scientific progress. Furthermore, the more critical view of scientific debates can also be used for pedagogical interventions and fruitful discussions about scientific issues. Similarly, the lower trustfulness towards science could also be used as a motivator for a deeper understanding of the scientific contexts. As mentioned above, children with a non-privileged parental background have a relatively high trust in science, but they are not credulous – which is in principle a good thing for learning about science and making science. This in turn could be combined with the slightly lower self-confidence in relation to scientific issues by motivating children to receive deeper insight and thereby enhance their self-confidence.

Our study has some limitations. First, we focussed on pupils from Gymnasium and thus, our results have only restricted generalizability for children of other school tracks. Another limitation regards to the use

case of the YES! project that followed a participative approach in the sense of civic science education. This limits the generalizability of the findings on other less participative educational initiatives.

To conclude, our results provide the basis for new, more appropriate incentives to motivate pupils with a lower educational background by addressing their more idealistic values and their partly different view of science and scientific controversies. For attracting especially children with disadvantaged educational background, educational initiatives outside school should highlight the benefit for society and scientific progress. Further, also the insights in scientific controversial issues might be a good motivator to take part. Contrariwise, the potential benefits for the later career are not of higher priority for pupils from lower educational strata.

Finding appropriate motivators for children with a non-privileged parental background is a first step towards more equality in civic science education. We hope other initiatives can build on our experiences and will conduct further research to gain deeper insights into the perspective of children with diverse parental backgrounds.

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