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Attitudes toward Coronavirus Protection Measures among German School Students: The Effects of Education and Knowledge about the Pandemic

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Abstract: This article addresses the question of what attitudes school students in Germany hold regarding the Coronavirus protection measures taken by policymakers. Based on this, it investigates to what extent the students' assessment of the pandemic is impacted by a better understanding of the spread of the virus, as well as their objective knowledge and their self-perceived subjective knowledge about the pandemic. Using a sample of 563 German school students (ages: 12–26), Part I of our analysis shows that after more than 2 years of the COVID-19 pandemic, (1) a significant exponential growth bias (EGB) (i.e., a systematic underestimation of the speed at which COVID-19 spreads) still exists, and (2) this bias can be reduced by giving simple educational nudges, but (3) this treatment has neither a major effect on the general approval of anti-COVID-19 measures nor on the willingness of the participants to apply specific protective measures themselves. Furthermore, Part II of our study illustrates that both subjective and objective knowledge increase the approval of or willingness for most protective measures. The same holds true for fear of infection. Therefore, an educational approach that combines rational, cognitive, and emotional elements is likely to be best suited to raising young people's awareness of the dangers of a pandemic such as COVID-19.

Keywords: exponential growth bias; educational nudges; COVID-19; Coronavirus; statistical literacy; intended behavior; Germany; school students

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1. Introduction

This article addresses the question of how school students in Germany perceive the Coronavirus protection measures taken by policymakers. Based on this, it investigates to what extent the students' assessment of the pandemic is impacted by a better understanding of the spread of the virus as well as their objective knowledge and their self-perceived subjective knowledge about the pandemic.

In comparison with other European countries such as Italy or Spain, Germany implemented a relatively mild version of a shutdown with the overall goal of avoiding overburdening the health system (Lu et al. 2021). Due to the federal structure of the political system, the COVID-19 protective measures also differed, at least to some extent, between the individual states throughout the pandemic (Büthe et al. 2020). While these measures helped contain the spread of COVID-19, they also had significant social and psychological consequences (Naumann et al. 2020). For school students in particular, the measures represented profound interventions in their lives. Schools were closed for several months in total in Germany in 2020 and 2021, and there were long periods of hybrid and online classes. Several studies showed that this was a difficult period for many school students (Christner et al. 2021; Million 2021).

Previous studies have shown that at a comparatively early stage in the pandemic, a clear exponential growth bias (EGB) prevailed (i.e., people clearly underestimated the speed at which COVID-19 spreads) (Lammers et al. 2020; Schonger and Sele 2020). Furthermore, these studies show that the more people underestimated the speed of the virus' spread, the more they opposed government containment measures. Thus, the EGB, at least during the first months of the pandemic, clearly affected people's risk assessment and their acceptance of protective measures with regard to COVID-19, which in turn impacted the possibility of effectively combating the pandemic.

However, these works also demonstrate that there is certainly reason for hope: through relatively simple educational support, it is possible to significantly reduce the EGB in order to increase the population's understanding of the pandemic's exponential spread (Jäckle and Ettensperger 2021; Lammers et al. 2020). Thus, studies to date suggest that an "educational program" driven by specific educational nudges may be central to achieving a greater understanding of potentially freedom-restricting protective measures among the population. However, the population group on which the provision of educational programs is mainly focused has been largely excluded from these studies: school students. Yet, it is precisely this group that plays a central role in controlling the pandemic. At the peak of the pandemic in 2020 and 2021, school students were particularly affected by government measures (compulsory testing, compulsory masking, online instruction, etc.). For example, recent meta-studies in the German-speaking context demonstrate that online education associated with school closures had significant negative effects on students' achievements and their learning process (Hammerstein et al. 2021; Helm et al. 2021). At the same time, school students can bring knowledge acquired at school about the pandemic back to their families and thus influence the position of society as a whole.

Within a sample of school students, Part I of this article therefore tests whether (1) an EGB is still present after more than 2 years after the start of the pandemic, and if so, whether (2) the EGB can be reduced among young people with the help of simple educational nudges and (3) to what extent this can influence the school students' attitudes toward COVID-19 protection measures, specifically those that affect life at school. In order to obtain adequately comparable results, this study uses a similar research design to that of Jäckle and Ettensperger (2021) but extends it by some school-specific elements. In more general terms, Part II analyzes to what extent self-perceived subjective knowledge as well as objective knowledge about the COVID-19 pandemic shape the way school students think about the measures.

2. Previous Studies

A number of studies focused on the effects of certain educational approaches or modes of data presentation in order to increase people's understanding of the COVID-19 pandemic and its consequences. Most of them focused on the EGB. Fansher et al. (2022), for example, found a significant EGB in forecasting future cases, showing that people who are presented with infection data displayed as line graphs are more confident in their estimates, although they actually come to less accurate estimates than people who see the data in tabular or text-only form. Schonger and Sele instead focused on the way exponential growth itself is presented. They found, that it is vital to communicate this growth in terms of "doubling times rather than growth rates" (Schonger and Sele 2020, p. 11). Online experiments further illustrated the COVID-19 EGB to have implications for future economic prospects and riskiness of people's investment strategies (Banerjee et al. 2021; Banerjee and Majumdar 2020).

This study uses two studies from 2020 in particular as points of departure. During the first wave of the COVID-19 pandemic in mid-March of 2020, Lammers et al. conducted three online experiments about the EGB in the USA via Amazon MTurk. In the first study, the authors found substantial evidence for an EGB when it came to the spread of SARS-CoV-2. The participants "erroneously perceive the virus's exponential growth in largely linear terms" (Lammers et al. 2020, p. 16266). The two other sub-studies demonstrated not only that comparatively simple educational measures were suitable for minimizing the EGB but

also that participants who received this additional help showed greater agreement with social distancing measures than the people in the control group. The support intervention in their study was provided in the form of additional arithmetical steps, allowing for an easier step-by-step estimation of the final number of infected persons.

Jäckle and Ettensperger replicated this analysis among German first-year university students in November 2020 (after about 10 months of living with the pandemic), thus lowering the chances of finding an EGB.[1] However, they still found their participants to be similarly unable to predict the number of individuals infected with COVID-19 as the participants in Lammers et al. Nevertheless, according to their results, this EGB could also be reduced by a simple educational intervention that helps participants conceive the exponential progression of contagions more easily. Furthermore, the participants who received these educational nudges showed a considerably higher approval rating for contact restrictions. This effect has also been examined with respect to different analytical techniques and the inclusion of several socio-political controls (e.g., political left-right position, general social trust, or the perceived burden of the COVID-19 pandemic), and it turned out to be robust (Jäckle and Ettensperger 2021, pp. 816–17).

3. Research Design, Materials, and Methods

This study entails two parts. In Part I, we use the same experimental set-up as and identical experimental wording to those of Jäckle and Ettensperger (2021) and Lammers et al. (2020) in their third study. We then test for an EGB in the estimation of COVID-19 infections and whether educational nudges can reduce this bias, thereby also changing participants' attitudes and behavior regarding COVID-19 protective measures. The results of this experiment are therefore directly comparable to the two previous studies. In Part II, we examine to what extent the students' attitudes and behaviors are impacted by extensive information on the COVID-19 pandemic in general (i.e., what school students actually know about it (further referred to as objective knowledge)) as well as their (subjective) self-assessment of their knowledge (i.e., what they think they know about the COVID-19 pandemic (further referred to as subjective knowledge)).

3.1. Part I: Educational Nudges and the EGB

The research approach of this analysis can be described as a pronounced least likely design. Since the calculations of the growth processes in general and exponential growth in particular are included in the educational curricula of grades 9 and 10 of all school types[2] in Baden-Württemberg (Ministerium für Kultus, Jugend und Sport Baden-Württemberg 2016), it can be assumed that school students of this age are familiar with the theoretical concepts of these growth processes. School students should therefore be able to fall back on this knowledge more easily than a group of university students, whose last lesson on exponential growth was further back in their past (as in Jäckle and Ettensperger 2021) and clearly be able to do so more easily than a random sample of MTurk users (as in Lammers et al. 2020). In addition, after more than 2 years of the pandemic, it can be assumed that the vast majority of school students have at least basic knowledge of the fundamental aspects of COVID-19, such as the exponential mode of propagation. Taken together, these points suggest that it is comparatively unlikely to find a similarly high EGB to those found in previous studies.

The experiment was included in an online survey about the realities of the lives of school students during the COVID-19 pandemic. Our main target group consisted of school students from grade 9 onward at all secondary schools in the administrative district of Freiburg, Germany. A few students from grades 7 and 8 also answered the survey and were also included in the analysis (see Table S1 in the Supplementary Material). We recruited the students primarily via their social studies teachers. They were given sufficient time to complete the online questionnaire during class time. During the survey period between 31 January and 11 February 2022, a total of 808 school students started the questionnaire. The drop-out rate (i.e., the percentage of those who did not complete the questionnaire in its entirety) was approximately 21 percent. Furthermore, some school students did

not give answers to all relevant questions. Thus, the final number of cases that could be analyzed amounted to 563 students. About 57 percent of the participants were female, and the vast majority (ca. 88 percent) were between 14 and 18 years old (see Table S1 and Figure S1 in the Supplementary Material for a descriptive overview of the participants). Some school students (particularly those from vocational schools) were older than this (max. 26 years). The average time required to complete the entire survey was approximately 9 min. The survey itself was conducted using a standardized online questionnaire consisting of closed-ended questions about young people's political attitudes, their experiences during the pandemic, and their judgments regarding the decisions made by policymakers. In addition, sociodemographic information was requested, and a small quiz integrated into the questionnaire also tested their knowledge about COVID-19.

The experiment itself was the last question of this quiz. The participants were randomly assigned to either a control or a treatment condition. Both groups received the following information (identical to that in (Jäckle and Ettensperger 2021)):

> "As of 22 March, there were about 25,000 confirmed infections in the United States, according to Johns Hopkins University. Three days later, on 25 March, there were about 50,000." (Translated from German.)

None of the groups received explicit information about the fact that the virus spreads exponentially, but in the first question of the quiz, the school students were asked how the Coronavirus spreads without taking any countermeasures. For this question, 83.3% gave the correct answer ("exponentially")[3], which shows that the vast majority of school students had at least heard about the virus' exponential nature, which admittedly does not mean that everyone understood what exponential growth meant. Within the experiment, both groups were asked to estimate the total number of infected persons 15 days later on 9 April without using a calculator or other mathematical tools (e.g., written calculation). The control group had to complete this task without any further help. The treatment group, however, received the information that the easiest way to estimate this number was to double the number of infected persons every 3 days. The participants in the treatment group also had the possibility to write down the number of expected cases after 3, 6, 9, and 12 days before they had to give their estimate for the number of infected persons on 9 April. Figure 1 gives an overview of the treatment and control conditions translated to English.

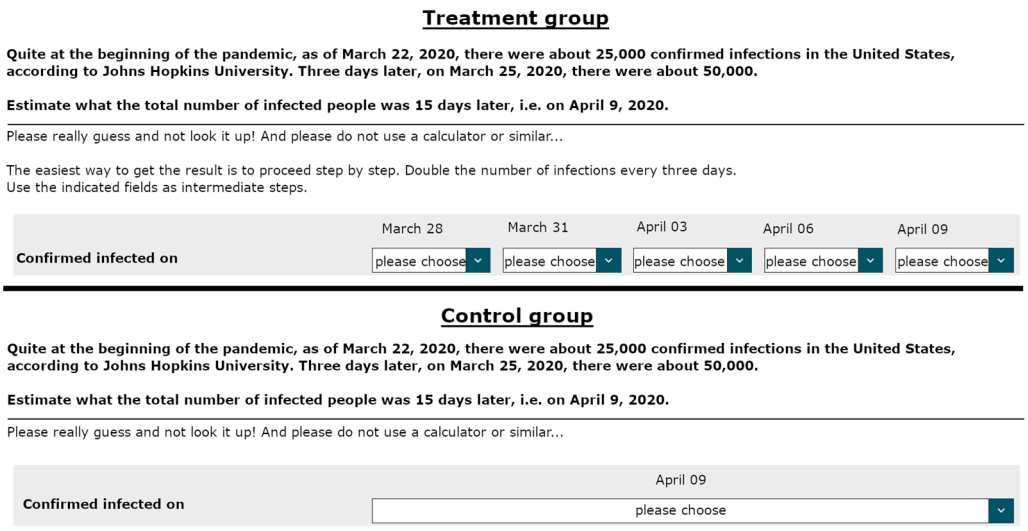

Figure 1. Treatment and control conditions of the experiment (translated from German).

Thus, the participants in the treatment group received educational nudges. They still had to perform their own simple step-by-step calculations for their final estimations, but the participants in the control group had to understand the mathematical task on their own before estimating the final value within one single step. If an EGB were present, the

participants in the treatment group would have to report higher average estimates of the number of persons infected with COVID-19 for 9 April than those in the control group. A total of 563 participants provided information on the experimental question. Of those, 289 were in the control group, and 274 were in the treatment group.

After this estimation, the participants were asked about their approval of five tangible anti-Coronavirus measures that had been discussed or implemented at that time in Germany, focusing particularly on those measures relevant to school students: contact restrictions in general, the mandatory use of face masks at schools (also while seated), general obligation for COVID-19 tests for school students, alternating between online and classroom lessons at school, and a general obligation to be vaccinated. The approval ratings were recorded on a 10-point Likert scale (1: strongly oppose; 10: strongly support). In addition, the participants were asked to what extent they could imagine taking one of the following five actions themselves in the wake of the COVID-19 pandemic: keeping themselves informed of current developments regarding the Coronavirus pandemic, testing for COVID-19 including during school holidays, getting vaccinated against the Omicron variant, always wearing a mask at school, and reducing private contacts. These questions regarding one's own anticipated behavior used a 4-point Likert scale (1: no, in no case; 4: yes, in any case). We used both the approval ratings of the anti-COVID-19 measures as well as the statements regarding possible future actions as dependent variables in the following analyses. In doing so, we wanted to test whether a possible EGB still shaped the way school students thought about COVID-19 and to what extent the educational intervention therefore not only reduced the bias but also had further implications for the ways in which young people are dealing with the COVID-19 pandemic in Germany. Analyzing this second dependent variable seems particularly compelling, as preliminary studies have shown that while measures to reduce exponential growth bias lead to cognitive improvements, the treatments do not change either the intended nor actual behavior (Yu 2022).

Our analysis in Part I proceeds in three steps. First, we compare the estimations for the number of persons infected with COVID-19 made by the control group and the treatment group in our set-up with the results from the Lammers et al. as well as Jäckle and Ettensperger papers in order to test for an EGB. In the second step, we examine whether the treatment group shows higher approval rates than the control group for the five anti-Coronavirus measures and the five concrete possible actions the students could take to counter COVID-19. Both of these dependent variables were queried within the survey after the experiment. In a third step, we control for other factors that could explain a difference in the approval rates in a regression model to isolate a possible educational nudging effect as much as possible. This set of control variables includes social trust, political left-right self-evaluation, and perceived personal burden due to COVID-19, which were all retrieved during the survey before the actual experiment. This allows for an evaluation of whether simple educational nudges help the school students to better grasp the consequences of an exponentially spreading virus and if this stimulus also impacts their perception of (school) specific anti-Coronavirus measures as well as their own implementation of such measures. Using information on further variables also enables us to compare the strength of the effect of educational nudges to that of other potentially relevant factors.

3.2. Part II: Objective and Subjective Knowledge about the COVID-19 Pandemic

In this part, we test, in more general terms, to what extent knowledge and being well-informed about the COVID-19 pandemic determine the attitudes and Coronavirus-related behaviors of students. For this purpose, we asked the participants of the survey in a first step how well informed they considered themselves to be with regard to the COVID-19 pandemic (subjective knowledge). In a second step, they had to take a short quiz of four single-choice questions on the pandemic. The results of this quiz were our measure of objective knowledge about the COVID-19 pandemic. In order to conceal its intention from the participants in this quiz, the experiment described in Part I was also integrated as the last (fifth) question.

4. Results

4.1. Part I: Educational Nudges and the EGB

Both Lammers et al. as well as Jäckle and Ettensperger found that the subjects who received the educational nudges estimated the number of cases to be significantly higher than the subjects in the control group on average (173% higher (Lammers et al. 2020, p. 16266) and 142% higher (Jäckle and Ettensperger 2021, p. 814)). Figure 2 shows that this difference was smaller in the present study but still existed. The school students in the treatment group estimated the number of cases to be more than twice as high than those in the control condition. As one would expect, the variation of the estimates in the sample steadily increased, which underlines the validity of the results compared with the MTurk sample by Lammers et al. (see Jäckle and Ettensperger (2021, p. 815) for a more detailed discussion of this issue). Although the differences in the estimates of the two groups were smaller than in the earlier studies, they were still significantly traceable (*t*-test: $p = 0.0000$). Interestingly, the estimates of the control groups differed only slightly between the three studies. This supports the idea that the EGB is a substantial and very general effect which is difficult to eliminate even after more than 2 years of the pandemic. Compared with the two earlier studies, the educational nudges had a reduced effect. All in all, these results nevertheless show that the EGB as well as the educational nudging effect in the sample of German school students in February 2022, and thus 2 years after the first COVID-19 cases in Germany, were somewhat comparable in magnitude to the effects found in the earlier studies.

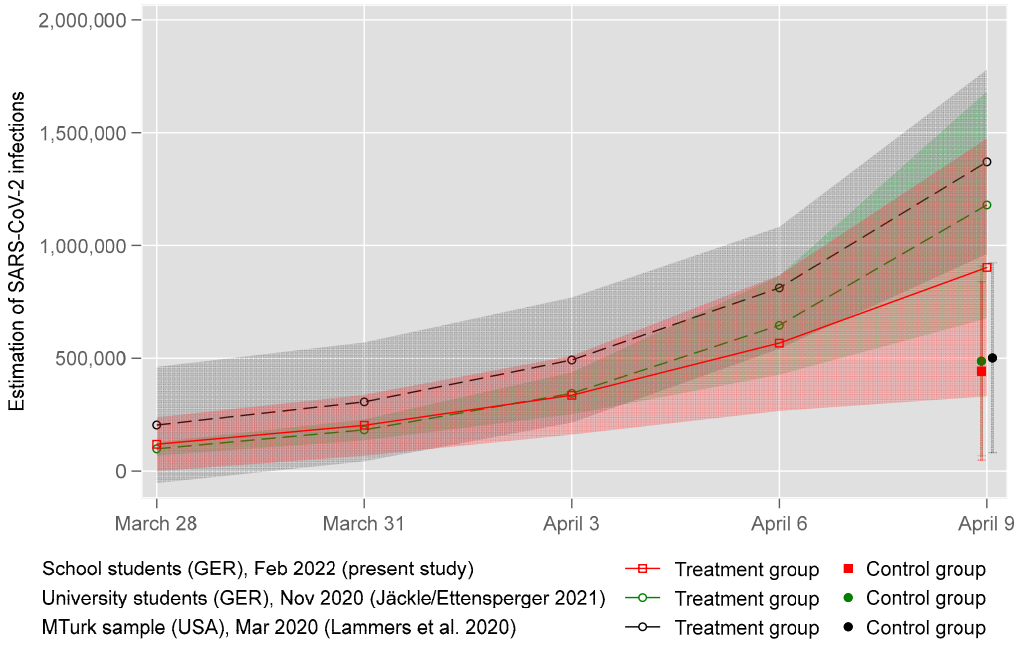

Figure 2. Estimated number of infections with SARS-CoV-2 made by the participants (Mean ± 1 SD).

Up to this point, the results of the experiment among school students show that on the one hand, EGB was still verifiable among this youth group, and on the other hand, educational nudges can significantly help to reduce this bias and thus reach a more realistic interpretation of the situation. Yet, the question remains whether, after more than 2 years of the COVID-19 pandemic, enhancing the understanding of the spread of the virus still has an impact on the general support of anti-COVID-19 measures (particularly on those relevant for school students) and the will of the participants to include these behaviors into their daily routines. In order to test this, we depicted the distribution of responses with respect to the support of the five anti-COVID-19 measures (Figure 3) and the five concrete possible actions the students could take to counter COVID-19 described above (Figure 4). The large majority of school students supported mandatory testing and wearing masks at schools. In contrast, general mandatory vaccination was less strongly supported, as

was alternating between online and in-class teaching. General contact restrictions (e.g., a maximum of five people are allowed to meet at the same time) were the least approved measure by the majority of students.

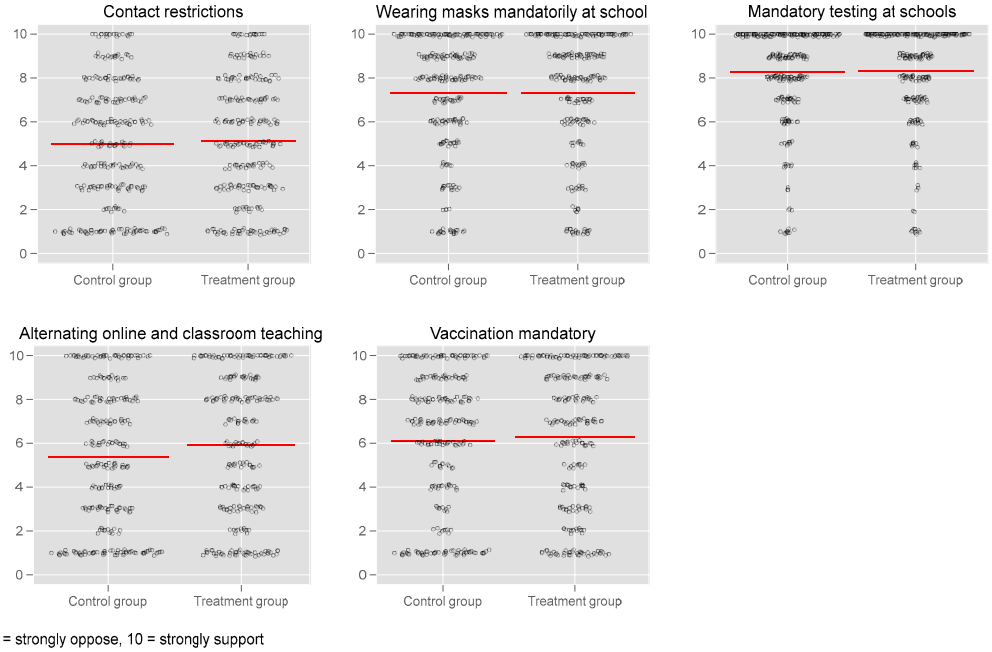

Figure 3. Approval ratings of general anti-COVID-19 measures in treatment and control groups (+group means).

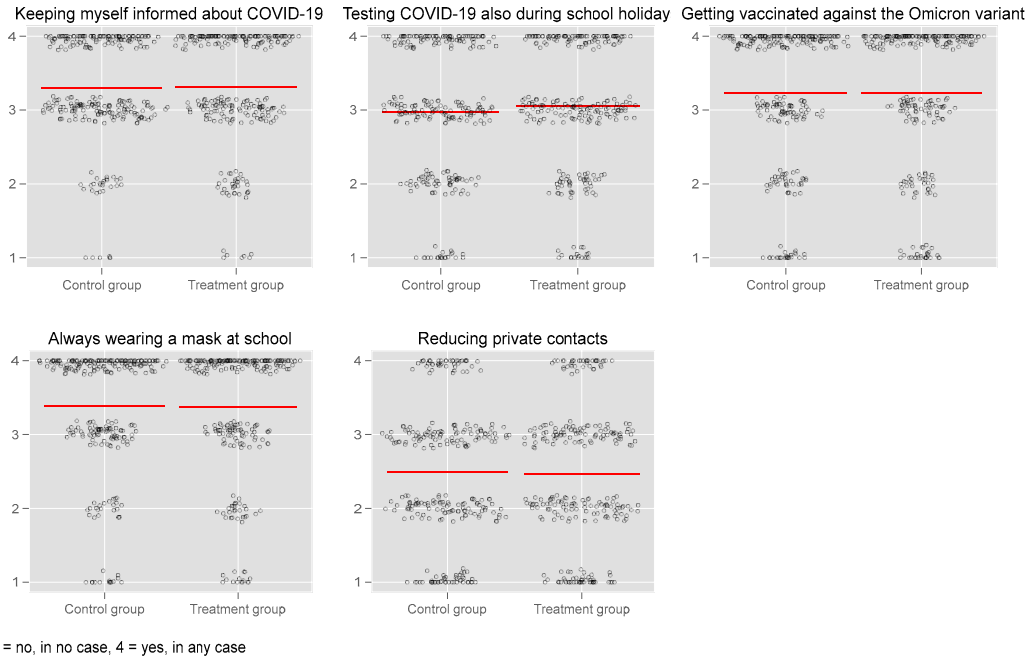

Figure 4. Willingness to perform specific anti-COVID-19 measures in treatment and control groups (+group means).

Figure 3 also shows that there were certain differences in the approval ratings between the control and the treatment group. This suggests that for all five measures, support was higher in the treatment condition, yet only for the alternation of online and in-classroom teaching was this difference significant at the 95% confidence level (*t*-test: $p = 0.0442$; Mann–Whitney U test: $p = 0.0390$). For the other four approval rating variables, the differences

between the two groups were much weaker (mandatory vaccination) or virtually nonexistent (contact restrictions, mandatory masks, and mandatory testing).[4] The experiment therefore only partially supports the earlier findings by Lammers et al. and Jäckle and Ettensperger that the reduction in the EGB via educational nudges has further implications for the participants' perceptions of protective measures. For most measures, the differences found were too small to demonstrate a real educational nudging effect.

With respect to the willingness to perform specific anti-COVID-19 measures, the school students were particularly supportive of wearing masks at school, keeping themselves informed about the pandemic, and also getting vaccinated against the Omicron variant. Testing for COVID-19 during school vacations received slightly less approval, while the question of whether participants would voluntarily reduce their own private contacts produced by far the clearest split between the two groups. However, for all five variables, the differences between the control and treatment groups were very small and not significant, irrespective of whether the variable was treated with an ordinal or interval scale.[5] These bivariate results show that a more realistic assessment of infection dynamics induced by educational nudges did not lead to divergent views about the school students' future behavior with respect to the COVID-19 pandemic.

Although participants were randomly assigned to the control and treatment groups, it is still possible that some differences existed between the groups before the educational nudges were given. These differences could also have an impact on the approval ratings and the willingness to perform specific anti-COVID-19 measures. To control for possible group differences, the participants were asked to answer questions about themselves, their perceptions of social interaction, and their own affectedness by the pandemic before the actual experiment (see Table S2 in the Supplementary Material for an overview of all variables).

In the following, we control for these variables in OLS regressions that estimate the effect of the educational nudges on the 10 dependent variables. The models only include the 563 participants who answered the experimental questions. Since most of the variables in the survey contained some missing values, regression models that applied listwise deletion would result in a considerably smaller number of cases undermining meaningful analyses. The missing values were thus imputed using multiple imputation by chained equations (MICE with 25 imputations).[6] All Likert-scaled variables were treated as continuous in these models. The results of the 10 regression models can be found in Tables S3 and S4 in the Supplementary Material. Focusing on the experimental design, we found that the treatment dummy had a significant effect only in the model estimating the approval of alternating online and in-classroom teaching. This model is presented in detail in Figure 5.

The regression model shows that the effect of the educational nudges in the treatment group remained relevant, at least by trend, even when controlling for other factors. It came close to the targeted α-level of 0.05. The point estimate could thus be interpreted in the following way: Receiving the educational nudges increases the approval of alternating online and in-classroom teaching ceteris paribus by an estimated 0.47 points. Some of the control variables showed stronger effects. All other things being equal, the participants who felt no high burden because of the pandemic and who had COVID-19 previously exhibited higher approval. The same was true, at least by trend ($\alpha = 0.1$), for those school students who viewed their general health status as rather poor.

Further models on the subsample of those who had not previously had COVID-19 show that the participants who had a high fear of contracting COVID-19 were significantly more supportive of the anti-COVID-19 measures or willing to perform the respective measures themselves. Conversely, the models that included only the subsample of participants who had COVID-19 previously showed that the severity of COVID-19 symptoms was not systematically related to the approval of measures (see Figures S4 and S5 in the Supplementary Material). Other controls such as gender, migration background, general social trust, political left-right position, COVID-19 affectedness of one's own family and friends, or the school type showed no effects.

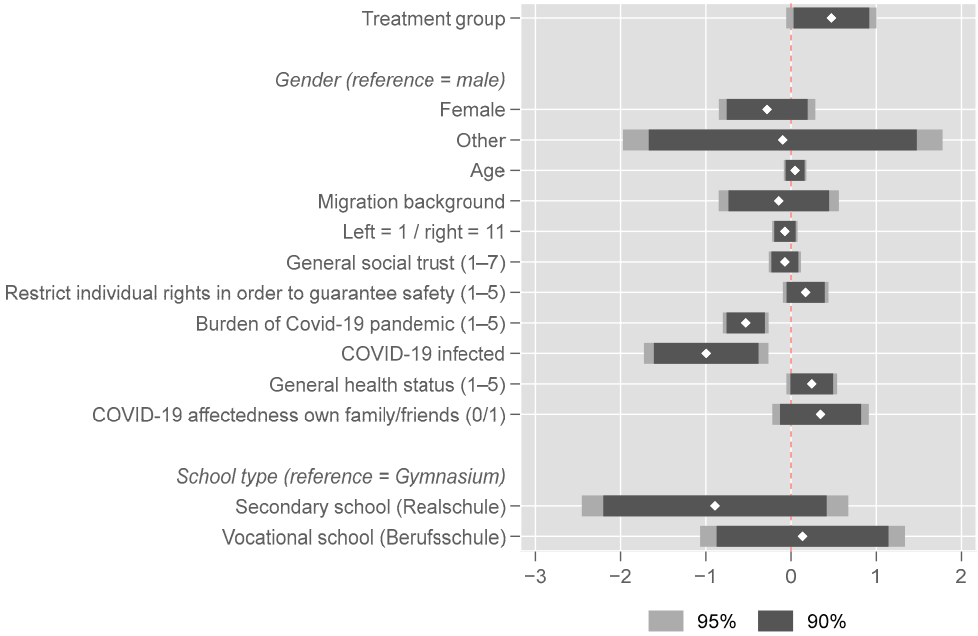

Figure 5. Approval of alternating online and in-classroom teaching, shown through OLS regression (b-coefficients + confidence intervals).

For the other nine dependent variables, we did not find a significant effect from the educational nudges. All in all, we therefore have to conclude that while the educational nudges clearly helped to reduce the EGB, the school students who were in the treatment group showed largely the same attitudes toward anti-COVID-19 measures. This raises the question of the extent to which, in general, being informed about the pandemic influences people's attitudes regarding the protective measures. This question is explored in the following.

4.2. Part II: Subjective and Objective Knowledge about the COVID-19 Pandemic

In the survey, the school students tended to rate their own subjective knowledge about the COVID-19 pandemic as relatively well informed. On a scale from 1 (not at all informed about the COVID-19 pandemic) to 7 (very well informed), they averaged around 5.0.[7] Interestingly, this subjective knowledge and the objective knowledge measured via the overall score achieved in the COVID-19 quiz (see Figure S2 in the Supplementary Material for the results of the single questions) were hardly correlated (r = 0.15). Thus, it makes sense to test to what extent both subjective and objective knowledge about the COVID-19 pandemic influences attitudes and the willingness to perform specific anti-Coronavirus measures themselves.

We re-estimated the models from Part I for this purpose. This time, however, we included the measures of subjective and objective COVID-19 knowledge instead of the treatment dummy. Figure 6 presents only the effects of these two variables. Subjective knowledge had a significant effect ($\alpha < 0.1$) in 8 out of 10 models. For objective knowledge, this effect was significant ($\alpha < 0.1$) only in 6 out of 10 models. All these significant knowledge effects showed a positive sign (i.e., participants with higher objective or subjective knowledge of the COVID-19 pandemic were more favorable of anti-Coronavirus measures). There was only one single negative coefficient overall—albeit not significant: objective knowledge in the alternating online and in-classroom teaching model.

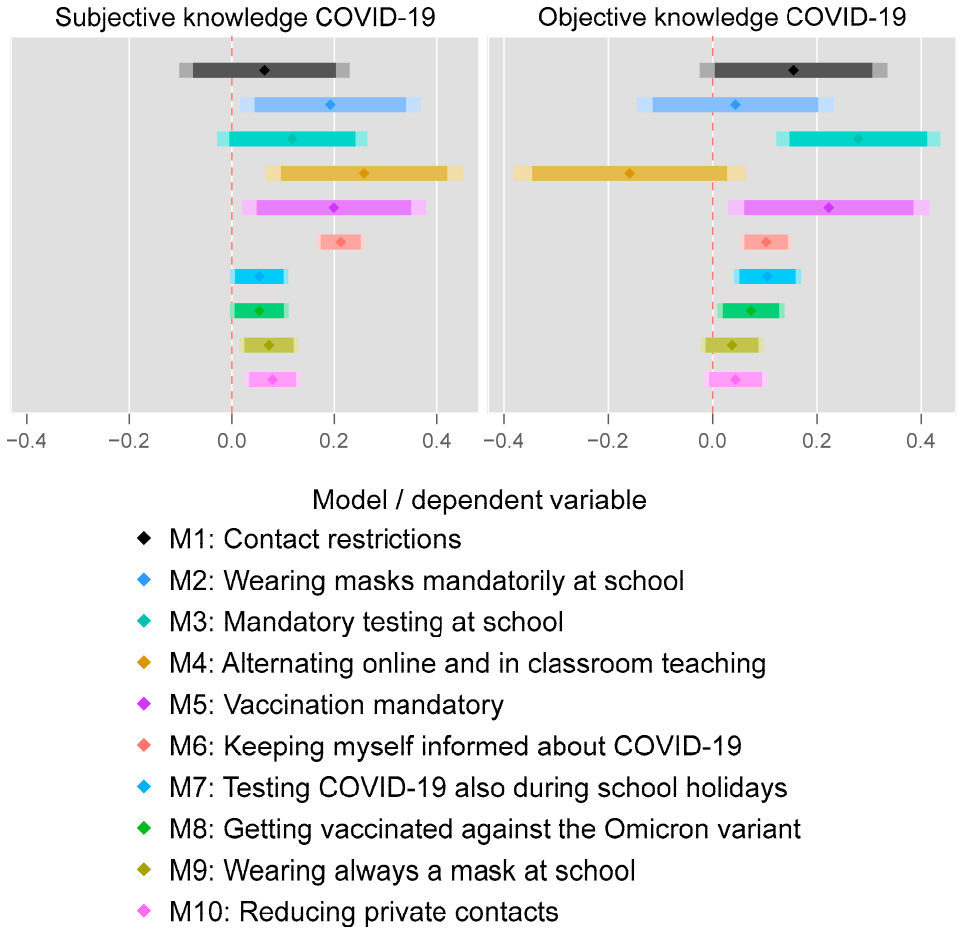

Figure 6. Effects of subjective and objective knowledge about the COVID-19 pandemic, shown with OLS regression (b-coefficients + 90% (darker colors) or 95% (lighter colors) confidence intervals).

5. Discussion

This article was based on findings from previous analyses, which showed that people have great difficulty adequately understanding the speed of COVID-19's exponential spread, a bias that could be significantly reduced by simple educational nudges (Jäckle and Ettensperger 2021; Lammers et al. 2020). These studies also showed that people who have had such educational assistance, thus achieving a better understanding of the dynamics of the virus's spread, were generally more receptive to government measures to contain the pandemic. By basing this analysis on a sample of school students (ages 12–26) from all types of secondary schools in Germany (high school, secondary school, and vocational school), this study focused on a group of people who were particularly affected by Coronavirus protective measures during the pandemic in Germany, as well as in many other countries (Engel de Abreu et al. 2021; Hammerstein et al. 2021), and who, due to their situations, were the natural subjects for any educational programs.

The experiment shows that even after 2 years of the ongoing pandemic, school students were still subject to a significant exponential growth bias when asked to estimate trends in the number of persons with COVID-19. Without any help, their estimation came closer to a linear trend than an exponential one. The simple educational nudges given in the treatment group, which explained how to perform this estimation in an easy way, significantly helped to reduce this EGB. Yet, compared with the earlier studies mentioned above, the effect of the educational nudges turned out to be a bit weaker.

In order to test to what extent these educational nudges not only enhanced the ability of the participants to correctly predict exponential growth but also impact the attitudes regarding anti-COVID-19 policies, we examined the general approval of five concrete

measures, focusing particularly on those measures relevant to school students. Apart from this general support of anti-Coronavirus measures, the school students were also asked whether they were willing to implement five specific anti-COVID-19 measures in their own lives. For 9 of these 10 variables, the participants in the experimental group did not show any different agreement or willingness scores from those students in the control group who had not received the educational nudges. Only for the approval of alternating online and in-classroom teaching did the treatment show, at least by trend ($\alpha = 0.1$), a positive effect. Online teaching was one of the most serious consequences for school students during the first waves of the pandemic in Germany, but it was also a protective measure which most people recognized as obviously effective. It is plausible that if educational nudges have any effect at all on attitudes toward the measures, then it is on alternating online and in-classroom teaching.

Nevertheless, the major finding here is that for school students coming into the third year of the pandemic, such a simple educational nudging approach is not sufficient to boost the approval of anti-COVID-19 measures. Additionally, it did not increase their willingness to perform protective measures which limit their own freedom. In this respect, our results confirm previous studies which also considered the wider effects of educational nudges even on intended behavior—not to speak of actual behavior—to be very small. Yu spoke of two gaps in that regard: a "knowledge-intention gap" and an "intention-behavior gap" (Yu 2022, p. 5). This means that on the one hand, short-term educational approaches are obviously not sufficient to increase the acceptance of freedom-restricting anti-Coronavirus measures among school students. On the other hand, Part II of our analysis also shows that overall knowledge of the pandemic is still significantly positively correlated with the acceptance of protective measures. The implication is that educational approaches aimed at achieving a better long-term understanding of the dangers of infectious diseases such as COVID-19 among school students could help.

Interestingly, the regression results show that it is not only the actual, objective knowledge of the pandemic but also the self-perceived subjective knowledge that increases the general approval of most measures and also of intended behavior (i.e., the willingness of the participants to perform specific anti-COVID-19 measures themselves). With objective knowledge and subjective knowledge being only weakly correlated among the school students, this means that there are actually two types of knowledge effects. First, those participants who achieved the highest scores in the quiz on objective knowledge about the pandemic were more supportive of protective measures such as mandatory testing at schools or a general, mandatory vaccination. This is the effect that ratio-targeted educational approaches seek to achieve. Secondly, there was a different effect for those who subjectively indicated they had good knowledge of the pandemic (which, in many cases, did not match reality). Their approval of protective measures seems to not be based on a foundation of solid knowledge. Against this background, it is quite problematic that students systematically overestimate their own knowledge on the one hand and on the other hand assess the knowledge of their teachers as lower than that of their parents. This, of course, undermines the credibility of any attempt to explain the background, dynamics, and consequences of the pandemic in the school context.

Apart from the effects of educational nudges and objective as well as subjective knowledge about the pandemic, our analysis shows that school students who had already contracted COVID-19—irrespective of the severity of their symptoms—were significantly less supportive of the protective measures than those who had not contracted it. Among the latter, the fear of having COVID-19 turned out to be strongly correlated with the approval of protective measures. This again illustrates that it is not sufficient to focus solely on the cognitive level when talking about the pandemic at school (e.g., a more intensified discussion of exponential growth processes) and to also include the emotional level (e.g., by addressing the fears of school students). This result is supported by a number of studies that show that the emotional level (specifically, fear, social empathy, and trust in fellow human beings) is of fundamental importance, especially for real behavior in the

pandemic (Harper et al. 2021; Jäckle et al. 2022; Pfattheicher et al. 2020). Such a combined cognitive and emotional educational approach can make the risks of a pandemic, such as COVID-19, more comprehensible to school students. This in turn has consequences for the acceptance of governmental rules and measures taken to protect the population from a disease. Furthermore, the better the people's understanding of the severity of a situation, the less invasive governmental regulations would have to be, and the greater the emphasis could be on personal responsibility in dealing with infectious diseases.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/socsci11070280/s1, Table S1: Description of the overall Sample by School Type and Grade; Table S2: Descriptive Overview of the Variables for the Regression Analysis; Table S3: Regressions Explaining Approval Ratings of General anti-COVID-19 Measures; Table S4: Regressions Explaining Willingness to Perform Specific anti-COVID-19 Measures; Figure S1: Description of the Overall Sample by Age, Gender and Vaccination Status; Figure S2: Results of the COVID-19 Quiz; Figure S3: COVID-19 Infections, Symptoms and Fear of Infection; Figure S4: Effect of Fear of COVID-19 Infection among those not Infected; Figure S5: Effect of Symptoms of COVID-19 Infection Among those Infected.

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Notes

1 It is plausible to assume that the participants in the Jäckle and Ettensperger study had a higher level of education than average citizens or the respondents in the Lammers et al. MTurk sample. Furthermore, their participants just finished high school, so the mathematical relationships behind the exponential functions should be much more present for them than for other people. Moreover, politicians, government agencies such as the Robert Koch Institute and the media had repeatedly warned of the danger of exponential growth in the number of infections since March. The concept was thus ever-present, and anyone consuming a minimum of media had to necessarily come into contact with it. For these reasons, they expected an EGB to be less detectable in their survey data than in those of Lammers et al. (2020).

2 This entails high schools (*Gymnasium*), secondary schools (*Realschule*) and vocational schools (*Berufsschule*).

3 Only a few selected one of the other three choices: 7.7% said "linear", 6.1% "polynomial" and 2.9% "logarithmic".

4 Mandatory vaccination (P_t = 0.5272; P_{MWU} = 0.3338), contact restrictions (P_t = 0.6016; P_{MWU} = 0.6009), mandatory masks (P_t = 0.9728; P_{MWU} = 0.8415) and mandatory testing (P_t = 0.7277; P_{MWU} = 0.5805).

5 Keeping oneself informed about COVID-19 (P_t = 0.7728; P_{MWU} = 0.4661); testing during school holidays (P_t = 0.3707; P_{MWU} = 0.4143); getting vaccinated against the Omicron variant (P_t = 0.9757; P_{MWU} = 0.8237); always wearing a mask at school (P_t = 0.8522; P_{MWU} = 0.9980) and reducing private contacts (P_t = 0.7119; P_{MWU} = 0.7190).

6 Dichotomous variables were imputed using logistic regression, categorical variables by multinomial logistic regression and the other variables by predictive mean matching with 10 nearest neighbors.

7 In addition to their own level of information, respondents were also asked to indicate how well informed they thought other people in their daily environment were. The respondents' own parents were considered to have the highest overall level of knowledge (mean = 5.6), and teachers were also perceived to be slightly more informed than themselves (mean = 5.4). In contrast, the students considered their classmates to be less well-informed (mean = 4.3).

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