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Low Education, Low Impact? The Effects of Voting Advice Applications on an Underexposed Segment of Users

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Abstract

Voting Advice Applications (VAAs) play a crucial role in the democratic pre-election period, positively affecting political interest, voter participation, and political knowledge. A number of studies show that they are predominantly used by people with formal higher education levels and a high level of political interest. This article takes this as a starting point to examine the mechanisms that lead individuals to feel motivated to participate in an election, feel reinforced in their voting decision, or even be converted to vote for another party through a VAA. Using data collected before the 2021 German Federal Election and drawing on path models, we find that formal education does not directly impact VAA-induced electoral mobilization or vote conversion at first glance. More specifically, we find a negative effect of average or lower formal education levels on being reinforced in an existing voting decision by the Wahl-O-Mat. However, an analysis of the mechanisms reveals that learning effects attributed to the Wahl-O-Mat usage play a key role. We observe that individuals with medium or low education gain increased awareness of party positions and differences. This, in turn, significantly raises the likelihood of being mobilised, reconsidering party choice, or reinforcing an existing decision. The findings are highly relevant for VAA research as they examine the specific preconditions and mechanisms of the effects of such a tool. For individuals with lower education levels, the learning experience through VAAs seems to be particularly crucial. For the development of VAAs, the findings show how crucial the respective learning environment is for the user experience.

Keywords

education; knowledge; political sociology; public opinion; voting; voting behaviour

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1. Introduction

Over the past two decades, a new type of online tool has proliferated in European democracies and beyond: Voting advice applications (VAAs). These applications assist users in casting their votes by aligning their policy preferences with the programmatic stances of political parties or candidates running for election (Garzia & Marschall, 2016). Users complete a questionnaire, expressing their views on a series of policy proposals selected for their relevance to the current campaign. The users' responses are then compared to the positions of the parties or candidates on these same issues. "Advice" is subsequently generated, typically presented as a rank-ordered list. By providing a ranking of viable options, VAAs clarify the political landscape for users, highlighting how their preferences align with the competing political entities. In many countries, VAAs have become obligatory elements in pre-election times on which large shares of the electorate draw.

The research on the effects of VAAs has a long and established tradition (Garzia & Marschall, 2019). A key focus of this body of work has been the "preaching to the converted" thesis, which suggests that VAAs primarily reach out to those who are already politically engaged and those who are formally highly educated (Albertsen, 2022; Marschall, 2014). Given that education is a key determinant of political participation and interest (Smets & van Ham, 2013; Verba et al., 1995), this highlights the aspect of a selective reach of VAAs and asks the question of how individuals with different educational backgrounds engage with these tools. Studies in VAA research have predominantly worked with representative user samples or experimental groups dominated by individuals who are already mobilised, with the tendency to focus on those who are not yet engaged in the political process (Munzert & Ramirez-Ruiz, 2021). This approach limits the understanding of VAAs' potentially differentiated impact on voter engagement and participation and ignores their potential effects on different user groups.

There are significant studies discussing the strength and extent of VAAs' influence on voting decisions across different demographic and social groups (Germann et al., 2023; Tromborg & Albertsen, 2023). While some correlations have been established, the nuances of these effects remain unclear. The impact of VAAs may vary widely among different groups, but the precise mechanisms and character of these variations are not well understood.

It is essential to gain a deeper insight into how these tools function within various groups: The specific mechanisms through which VAAs influence voter behaviour are often described as a "black box" (Enyedi, 2015, p. 1000; van der Linden & Dufresne, 2017). We argue that learning processes play an important role when it comes to the effectiveness of VAAs. Then again, the extent to which users learn from these applications is likely influenced by their political sophistication. Users with different levels of political awareness and understanding may profit differently from interacting with VAAs. Understanding these learning dynamics is crucial for assessing how VAAs can be designed to be more effective for a broader audience.

Opening the "black box" requires a specific methodical approach: The bulk of research in this field has primarily relied on simple correlation analyses, which do not capture the complex interplay of factors that contribute to VAAs' effectiveness (Munzert & Ramirez-Ruiz, 2021). To gain a deeper understanding of how VAAs work, there is a need for more sophisticated methods, such as path analysis. Such an approach could uncover the intricate relationships between various factors influencing voter behaviour and the specific

pathways through which VAAs exert their effects. Moreover, by explicitly incorporating educational background as a moderating factor, we aim to shed light on whether VAAs reinforce or mitigate structural inequalities in political engagement. In short, while there is a substantial body of research on the effects of VAAs, significant research gaps remain. Focusing on the seemingly "non-convertible" individuals, clarifying the strength of VAA effects across different groups, and unpacking the "black box" of mechanisms through more complex analyses might represent essential steps forward. Additionally, examining the role of learning processes and how they are influenced by users' prior knowledge will be critical for understanding the impact of VAAs on voter engagement and decision-making.

In this article, we begin by outlining the role of education as a key structural factor shaping political participation, voter engagement, and ideological alignment. We build on existing research that highlights education as a central determinant and explore its impact on the likelihood of using VAAs. Given that higher formal education levels are associated with greater political interest and sophistication, while lower levels are linked to political disengagement, we examine whether VAAs help bridge this divide or reinforce existing disparities. In doing so, we take the "preaching to the converted" hypothesis as a starting point, asking whether VAAs primarily benefit already mobilised, highly educated individuals or whether they provide a learning effect that is particularly relevant for less educated users.

In order to do so, we will draw on data collected before the 2021 German Federal Election; in the data analysis, we will be utilising path models to identify the mechanisms through which learning effects instigated by the most popular German VAA—the Wahl-O-Mat—operate. These findings suggest that the learning experience provided by VAAs is particularly important for individuals with medium or low formal education levels. For the development of VAAs, these results are significant, as they highlight the critical role of the learning environment provided by these tools.

2. Theory

2.1. The Educational Divide?

While socio-structural characteristics are often viewed primarily from the perspective of classical cleavages (Elff & Roßteutscher, 2022), education has developed into a "master structural variable" (Hooghe & Marks, 2025, p. 7). In particular, the highly educated represent a socio-structurally relevant group substantively concerned with political behaviour and social inequality. Overall, higher education attainment is influenced by a complex interplay of socioeconomic background, institutional structures, cultural values, and individual abilities. Families with higher socioeconomic status can provide academic support and instill long-term educational aspirations, making parental education and financial resources critical factors (Bourdieu & Passeron, 1990; Plutzer, 2002). Additionally, institutional mechanisms such as school tracking systems, government funding, and scholarship opportunities play a significant role in determining who can access tertiary education (Pfeffer, 2008). Beyond these structural elements, societal values regarding meritocracy, gender norms, and ethnic disparities further shape educational trajectories (Breen et al., 2009).

Given these mechanisms, it seems logical that education is a central determinant in explaining respondents' political interests and knowledge (Hansen & Pedersen, 2014; Smets & van Ham, 2013). The higher the level of formal education, the more likely individuals are to participate in different forms of political engagement

(Verba et al., 1995). This is particularly evident in voter turnout, where a consistent effect of the education level can be observed over time, further reinforced by family socialisation (Dassonneville & Hooghe, 2017; Plutzer, 2002). Especially among younger cohorts, differences in formal education levels play a substantial role in predicting whether individuals participate in elections (Schäfer et al., 2020). Overall, the gap in voter turnout between citizens with low and high levels of education has expanded over time, particularly in countries experiencing sharper declines in electoral participation. The influence of education on the likelihood of voting has doubled, leading to an increasingly less representative electorate, with highly educated individuals significantly more likely to cast their ballots (Dassonneville & Hooghe, 2017). Dimensions of social inequality reflected in education levels thus become increasingly politically entrenched over time (Schäfer et al., 2020). These shared experiences not only foster a sense of group identity among individuals with similar levels of education (Westheuser & Zollinger, 2025). Education contributes to structuring social identities by shaping how individuals feel connected to specific groups. This effect is particularly pronounced along the universalist–particularist divide, which increasingly shapes European party systems. Individuals tend to feel a stronger affinity with others of a similar educational background, a pattern observed among highly and less-educated individuals (Bornschier et al., 2024). Additionally, de Jong and Kamphorst (2025, p. 1533) provide evidence that "large proportions of higher—and lower-educated citizens report no close relationships with individuals from different educational backgrounds."

At the same time, education shapes the values and attitudes individuals adopt. Those with higher levels of formal education are more likely to embrace universalist, post-materialist, and cosmopolitan values, distinguishing themselves from those with lower levels of education, who are more inclined towards traditional, conservative, and materialist values (Elff & Roßteutscher, 2022; Hooghe & Marks, 2025; Marks et al., 2023). As a result, this structural characteristic undoubtedly influences political party competition (Abou-Chadi & Hix, 2021), being reinforced by educational disparities that progressively widen over successive generations (Schäfer & Steiner, 2025). For example, Stubager (2013) finds that an education-based cleavage has emerged as a key structuring force in Danish politics, driven by the increasing salience of authoritarian–libertarian values and reinforced by party competition, contrasting highly educated, libertarian-leaning voters with less-educated, authoritarian-leaning voters. More broadly, Bornschier et al. (2024, p. 30) find that "education is at the heart of cleavage formation," as it interacts with group loyalties, identities, and in-group favouritism. However, the educational level achieved is not static; it can transform over time due to increased educational attainment. Higher education levels have a causal effect on reducing prejudice and fostering more liberal attitudes (Scott, 2022). It is, therefore, only logical that educational background can explain voting behaviour for certain parties and a lower likelihood of adopting populist attitudes (Häusermann & Kriesi, 2015; Koch et al., 2021).

At the same time, higher levels of formal education reduce strict party loyalty and significantly increase the consistency of individuals' ideological positions (Nie et al., 1979). The highly educated are, therefore, more easily mobilised. Still, they are also more selective in their political choices and less bound by long-term determinants compared to those with lower levels of education (Elff & Roßteutscher, 2022). This can be explained by the fact that higher education levels promote political sophistication and critical thinking, making individuals more likely to question party loyalty rather than remain attached to a single party (Dalton, 2012). Mayer and Schultze (2019) show that more educated individuals are more likely to have multiple party identifications within a given political camp.

Politically critical and ideologically consistent, individuals with higher levels of education represent a segment of the electorate that is challenging to address through one-dimensional campaign strategies or to mobilise comprehensively. While they tend to process political information more quickly, the intensified flow of information during election campaigns can enable those with lower levels of education to somewhat reduce this informational gap (Hansen & Pedersen, 2014; Wurthmann & Marschall, 2022).

2.2. Overcoming the Educational Divide Using VAAs?

VAAs have increasingly assumed a central role in conveying party positions (Heinsohn et al., 2016), motivating electoral participation (Germann et al., 2023; Tromborg & Albertsen, 2023), and even fostering non-election-related forms of participation (Manavopoulos et al., 2018). In this section, we will examine the significance of VAAs in greater detail and outline why we assume that they also play a relevant role in addressing the educational divide.

VAAs are digital tools designed to help voters make informed electoral decisions by aligning their policy preferences with the positions of political parties or candidates. By answering a series of issue-based questions, users receive a personalised recommendation indicating which party or candidate best reflects their views. While primarily developed to encourage political engagement (Garzia, 2010; Garzia & Marschall, 2019; Wall et al., 2014), VAAs have become indispensable instruments in modern election campaigns, shaping voter behaviour and strategic party competition (Wurthmann & Marschall, 2022).

Widely used in European democracies, VAAs have demonstrable effects on voter turnout, political engagement, and party competition (Garzia, 2010; Germann et al., 2023; Marschall & Schultze, 2012; Wall et al., 2014). Research suggests that they help mitigate information asymmetries, particularly among individuals with lower levels of political knowledge or engagement (Kamoen et al., 2017; Tromborg & Albertsen, 2023). Moreover, VAAs have been shown to mobilise individuals who are younger (Germann & Gemenis, 2019), traditionally less engaged in politics, and unlikely to be reached by conventional party outreach efforts (Israel et al., 2017; Marschall & Schultze, 2012).

However, in line with the "uses and gratification theory," the actual effects could be moderated by the concrete motivation of users to resort to VAAs. Van de Pol et al. (2014), for example, demonstrate that highly educated users report lower learning effects because they often employ VAAs primarily as confirmation tools rather than as instruments for knowledge acquisition. Similar dynamics are observable in more recent contexts. Evidence from Austrian VAAs in 2024 shows that a considerable share of users, both occasional and frequent, report that they "already know how they will vote" (Dieing, 2025, p. 9)—regardless of their educational backgrounds. Such findings indicate that only a subset of users is genuinely open to impacts made by VAAs, e.g., to preference change or political learning.

The extent to which VAA-impact varies—also based on education—remains an open question, as individuals with higher levels of formal education may process political information differently from those with lower levels. VAAs are crucial in promoting issue-based voting by clarifying party positions and helping voters navigate an increasingly complex political landscape. They provide users with structured access to party manifestos, facilitate reflection on key policy debates, and encourage deeper engagement with politics (Heinsohn et al., 2016; Kamoen et al., 2017; van de Pol, 2016).

VAAs allow users to familiarise themselves with political party positions, reflect on their own views, and develop a more informed electoral choice. Empirical findings indicate that VAAs can enhance political knowledge, particularly among those with lower prior political engagement levels (Germann et al., 2023; Mendez, 2017; Munzert et al., 2020; Stadelmann-Steffen et al., 2023). Additionally, Tromborg and Albertsen (2023) find that politically less engaged individuals without strong party identification are more likely to adjust their voting preferences after using VAAs. This effect is further supported by evidence that individuals with lower levels of prior political information are more susceptible to preference shifts following VAA usage (Germann et al., 2023). Such findings suggest that how highly and less educated voters respond to VAAs may stem from variations in political interest, media consumption, and prior knowledge levels. VAAs have also been linked to increased political media use, fostering broader political engagement (Manavopoulos et al., 2018).

While VAAs seek to make political information more accessible to all voters, their measured impact based on education remains inconclusive. Some studies suggest that VAAs effectively increase political knowledge across educational levels (Gemenis & Rosema, 2014; Heinsohn et al., 2016; Kamoen et al., 2017). However, it remains unclear how subjectively perceived learning effects influence political behaviour, particularly regarding the educational divide. Since higher-educated individuals tend to be more sceptical of politics in general, it is reasonable to assume that their perception of VAAs—either as a mere "gadget" or as a valuable tool for political education (Marschall & Israel, 2014)—differs significantly. Depending on respondents' educational levels and drawing on early research on election campaign effects (see, e.g., Lazarsfeld et al., 1944), as well as the growing importance of VAAs as an election tool in recent years (Wurthmann & Marschall, 2022), we have the following assumption: individuals may (a) be motivated to participate in an election—a process known as mobilisation, (b) have their existing voting decision reinforced, or (c) alter their intended vote choice, a phenomenon referred to as conversion. We consider this heuristic equally applicable to learning effects resulting from the use of the Wahl-O-Mat, as this VAA is widely used in election campaigns. Again, van de Pol et al. (2014) highlight how VAA usage is often perceived as a confirmation of existing preferences, functioning as a form of checking rather than changing voter behaviour. Consequently, we assume that a reinforcement effect is also relevant in this context. Mobilisation, reinforcement, and conversion are thus key dimensions of political behaviour that may be influenced by the use of VAAs. This debate leads us to our first hypothesis:

> H1: There are significant differences between individuals with lower levels of formal education and those with higher levels of formal education in reporting that their political behaviour is influenced by VAA usage.

Given the role of prior political information, we assume that the interaction between VAA usage and political learning could mediate the relationship between education and political behaviour. Less educated voters, who often exhibit lower levels of political interest and efficacy, may particularly benefit from the educational potential of VAAs. Mahéo (2017, p. 511) highlights this dynamic, arguing that "VAAs work differently for more or less educated citizens," with the interaction between attention and educational level showing a positive relationship—yet only for less educated individuals in their sample. Building on this, we expect that the potential of VAAs to enhance political learning is particularly pronounced among less educated individuals. Consequently, this learning effect may act as a mediating factor, shaping their political behaviour:

H2: Individuals with lower levels of formal education are more likely to experience a learning effect from VAA usage, which in turn mediates the influence of VAA usage on their political behaviour compared to individuals with higher levels of formal education.

3. Research Design

3.1. Case Selection

The Wahl-O-Mat has become one of the most established VAAs and is now an almost indispensable feature of the pre-election public sphere—before the 2021 German Federal Election, it was used over 21.3 million times. Since its introduction in 2002, the Wahl-O-Mat has steadily gained popularity, achieving a high level of recognition and significant political relevance in Germany (Albertsen, 2022; Wurthmann & Marschall, 2022).

At the same time, the 2021 German Federal Election differed from previous ones in its exceptional openness. It remained uncertain which party would ultimately emerge as the frontrunner, who would assume the Chancellery, and which coalition would form the next government. This uncertainty heightened public interest in how voters, particularly amid the ongoing Covid-19 pandemic, sought political information and ultimately arrived at their electoral decisions (Wurthmann & Marschall, 2022).

Against the backdrop of increasing party system heterogeneity, growing fragmentation, and concurrent uncertainty surrounding political processes in the Federal Republic of Germany (Debus, 2022), VAAs like the Wahl-O-Mat serve as crucial mediators (Garzia & Marschall, 2019). Given this context, it is worth examining the role such a widely used tool plays—especially in times of political and social uncertainty.

3.2. Data

The data utilised in this study were collected as part of a four-wave panel survey on the 2021 German Federal Election, designed to measure public attitudes and political behaviour across multiple waves. The survey was conducted using the Bilendi online access panel, with respondent recruitment based on a quota sampling method aligned with population-representative parameters.

The first wave of the survey was strategically conducted between 9 and 14 August, prior to the final phase of the campaign and voter mobilisation efforts. A total of 2,270 respondents participated, of whom 2,206 were eligible voters. The second wave, administered between 17 and 25 September—just one day before the Bundestag election—secured responses from 1,533 individuals, reflecting a panel mortality rate of about 30.5 percent.

As outlined in Section 2, this article seeks to examine the underlying mechanisms through which the Wahl-O-Mat influences voter behaviour, whether by mobilising individuals to participate in the election, reinforcing existing voting intentions, or prompting a switch from one party to another. Given this focus, familiarity with the Wahl-O-Mat is a prerequisite for inclusion in the analysis. Among the second-wave respondents, 1,235 respondents met this criterion, necessitating the exclusion of 298 individuals who were unfamiliar with the tool. Furthermore, 976 respondents had actively used the Wahl-O-Mat at some point, leading to the exclusion of an additional 259 who had not.

Among the remaining 976 respondents, 260 were excluded as they had previously used the Wahl-O-Mat, but not specifically for the 2021 Federal Election. This left a sample of 716 cases before the final data cleaning process. At this stage, respondents who failed to answer any of the key indicators employed in the study or who provided only non-substantive responses were further excluded. Ultimately, this refinement resulted in a final analytical sample of 667 respondents.

Regarding the indicators used in the analysis, demographic variables such as age, formal education level, sex, and place of residence were drawn from Survey Wave 1. In contrast, variables susceptible to campaign influences, including party identification and political interest, were derived from Survey Wave 2. The same applies to Wahl-O-Mat-related factors, which were only introduced in the second wave, as the tool was launched online after the initial survey wave had been completed.

3.3. Operationalisation

3.3.1. Dependent Variables

We have introduced our threefold concept of political behaviour, which we assume is influenced by the use of VAAs. We operationalise our indicators as follows:

(1) Mobilisation: The Wahl-O-Mat motivated me to participate in the federal election.
(2) Reinforcement: The Wahl-O-Mat reinforced my existing voting decision.
(3) Conversion: As a result of the Wahl-O-Mat outcome, I am likely to change my vote choice.

Respondents were asked to express their position using the scale (1) *strongly disagree*, (2) *disagree*, (3) *neither agree nor disagree*, (4) *agree*, and (5) *strongly agree*.

3.3.2. Independent and Mediator Variables

The central variable of interest in this case is the formal educational level of the respondents. Respondents were presented with a series of options to classify their respective educational qualifications. They were provided with the following selection:

(1) Finished school without school school-leaving certificate.
(2) Lowest formal qualification of Germany's tripartite secondary school system, after 8 or 9 years of schooling ("Hauptschulabschluss," "Volksschulabschluss").
(3) Intermediary secondary qualification, after 10 years of schooling ("Mittlere Reife," "Realschulabschluss"/ "Polytechnische Oberschule mit Abschluss 10. Klasse").
(4) Certificate fulfilling entrance requirements to study at a polytechnic ("Fachhochschulreife [Abschluss einer Fachoberschule etc.]").
(5) Higher qualification, entitling holders to study at a university ("Abitur"/"Erweiterte Oberschule mit Abschluss 12. Klasse [Hochschulreife]").
(6) Another type of school leaving qualification, specifically: _____ (free text field).
(9) I am still attending school.

Responses provided under option (6) were recoded within the existing coding scheme whenever possible. If recoding was not feasible, these responses were omitted from the analysis. Additionally, since option (9) does not provide information on previously obtained qualifications, respondents selecting this option were excluded from further analysis. To create a dichotomous variable for educational attainment, responses from options (2) and (3) were grouped into the category *No higher education* (coded as 1), while responses from options (4) and (5) were classified as *Higher education* (coded as 0). Collapsing options (2) and (3) was necessary because, after panel attrition and data cleaning, only 55 respondents remained in category (3) compared to 417 in category (1) and 240 in category (2). A separate handling of options (2) and (3) would not have allowed for reliable analyses, particularly given the complexity of the path modelling approach employed. As a result of panel attrition and data cleaning, no respondents who had completed schooling without obtaining a diploma remained in the final dataset.

Additionally, we incorporate two mediator variables, which we expect to be influenced by formal educational attainment and, in turn, affect the dependent variables. These mediators capture the learning effects that respondents report when using the Wahl-O-Mat.

The first mediator (awareness) reflects whether respondents became aware of party positions that were previously unknown to them. The second (party differentiation) measures respondents' perceived ability to discern differences between parties as a result of using the Wahl-O-Mat. The indicators employed for these variables are as follows:

(1) Party Position Awareness: The Wahl-O-Mat made me aware of party positions that I was previously unaware of.
(2) Party Differences: The Wahl-O-Mat helped me identify differences between parties.

Participants were requested to indicate their stance on a scale ranging: (1) *strongly disagree*, (2) *disagree*, (3) *neither agree nor disagree*, (4) *agree*, and (5) *strongly agree*.

While awareness of party positions and awareness of party differences are conceptually connected—since recognising differences arguably presupposes at least some knowledge of positions—we treat them analytically as distinct mediators. This distinction enables us to assess whether both aspects of perceived learning exert independent effects on political behaviour. A strictly sequential relationship in which position awareness precedes difference awareness would indeed reflect a plausible cognitive process. However, explicitly modelling this sequence would substantially increase the complexity of the analytical framework and introduce potential endogeneity with other covariates (e.g., party identification). We therefore maintain the specification presented here, while noting that the two mediators are moderately correlated (see Figure A5 in the Supplementary File).

3.3.3. Controls

First, we address key variables by considering respondents' age, sex, and place of residence, which have been consistently shown to be highly relevant for political behaviour (Cramer Walsh, 2012; Smets & van Ham, 2013). Additionally, we control for the effects of party identification and political interest, as both have been demonstrated to significantly influence the use of the Wahl-O-Mat and its subsequent implications (Wurthmann & Marschall, 2022).

Regarding sex, we distinguish between (0) male and (1) female. Age was recorded in an open-ended format, with respondents reporting values ranging from 18 to 74 years. For place of residence, respondents selected from a five-point scale: (1) large city, (2) outskirts or suburbs of a large city, (3) medium or small town, (4) rural village, and (5) isolated house in the countryside. Due to the small number of cases in category (5), it has been merged with category (4).

For party identification, respondents were asked whether they identify themselves with a political party and, if so, which one. The variable is coded as (1) for all respondents who indicated a party affiliation and (0) for those who reported no party identification. Political interest is measured on a five-point scale, ranging from (1) *not interested in politics at all* to (5) *very strongly interested in politics*.

3.4. Method and Analysis Strategy

We proceed as follows. First, we present the descriptive findings by examining the distributions of the dependent and mediator variables for the entire sample. Subsequently, we differentiate between the two educational groups based on our dichotomous classification: (0) higher education and (1) no higher education.

Next, we conduct bivariate analyses to explore the relationships between the independent variable (education) and both the dependent and mediator variables. This step provides an initial indication of potential associations before proceeding to more complex modelling.

To further investigate these relationships, we employ path models within the framework of Structural Equation Modelling. This approach enables us to decompose direct and indirect effects, offering a more nuanced understanding of how education relates to the dependent variables. Specifically, we hypothesize that the relationship between formal educational attainment and political behaviour is partially mediated by the learning effects attributed to the Wahl-O-Mat—namely, awareness (whether respondents discovered previously unknown party positions) and differentiation (their ability to discern differences between parties).

Path models are particularly well-suited for this analysis for several reasons. First, they allow us to distinguish direct effects (education's influence on the dependent variables) from indirect effects (mediated by awareness and differentiation). Second, they enable us to test specific mediation mechanisms, assessing whether Wahl-O-Mat learning effects play a role in shaping the influence of education or whether its impact remains largely direct. Third, this method accounts for reciprocal interdependencies between mediators and outcomes, ensuring that observed relationships are not oversimplified.

By integrating descriptive, bivariate, and path model analyses, we establish a comprehensive framework for understanding how differences concerning educational attainment relate to political behaviour via cognitive mechanisms associated with Wahl-O-Mat use. This approach provides deeper insights than standard regression models, which may overlook these underlying patterns of association.

4. Results and Discussion

Given that the Wahl-O-Mat is predominantly used by individuals already possessing higher levels of political interest compared to the general population (Albertsen, 2022; Marschall, 2011), it is unsurprising that the

tool is not widely perceived as a mobilising force. Among respondents, 46.5 percent strongly disagree and 21.0 percent disagree with the statement that the Wahl-O-Mat motivated them to participate in the federal election. An additional 13.6 percent express neutrality, while only 11.4 percent agree and 7.5 percent strongly agree. However, the perception shifts significantly when considering the reinforcement of voting decisions. Here, only 17.8 percent strongly disagree and 11.1 percent disagree that the Wahl-O-Mat influenced their decision. By contrast, 21.9 percent remain neutral, while 25.9 percent agree and 23.2 percent strongly agree, suggesting a notable role of the tool in strengthening pre-existing vote choice. When it comes to conversion—where respondents indicate adjusting their vote based on the Wahl-O-Mat's outcome—the pattern resembles that of mobilisation but with even stronger opposing views. A substantial 57.9 percent strongly disagree and 21.1 percent disagree with the idea that the tool changed their vote choice. Additionally, 11.8 percent are neutral, while only 6.3 percent agree and a mere 2.8 percent strongly agree (see Figure A1 in the Supplementary File). Overall, these findings suggest that while the Wahl-O-Mat is not perceived as a catalyst for changing vote choice, it serves primarily as a tool for reinforcing pre-existing vote choices.

Furthermore, it is worth examining how respondents perceive the self-attributed effects of using the Wahl-O-Mat. Regarding awareness of party positions, 24.7 percent strongly disagree, and 16.3 percent disagree with the statement that the tool made them aware of previously unknown positions. An additional 23.0 percent remain neutral, while just over 27.0 percent agree, and nearly 9.0 percent strongly agree. A different pattern emerges when considering the perceived ability to recognise differences between party positions. Here, significantly fewer respondents reject the notion that the Wahl-O-Mat enhanced their understanding. Only 15.4 percent strongly disagree and 15.1 percent disagree with the statement. Meanwhile, 30.9 percent express neutrality, while 29.5 percent agree and 9.0 percent strongly agree (see Figure A2 in the Supplementary File).

While a substantial share of respondents does not attribute new issue awareness to the Wahl-O-Mat, many acknowledge its role in highlighting differences between parties, underlining its function as a comparative tool rather than a source of entirely new political information.

The frequency distributions, segmented by individuals with and without formal higher education levels, reveal no substantial differences. The same holds true for the average effects attributed to the Wahl-O-Mat. While the two groups exhibit statistically significant differences ($p < 0.001$), the magnitude of these effect differences remains relatively modest (see Table 1).

Table 1. Mean values comparison.

	High education	Low/medium education
Mobilisation	2.12 (95% c.i. = 1.99, 2.25)	2.13 (95% c.i. = 1.97, 2.29)
Reinforcement	3.32 (95% c.i. = 3.18, 3.45)	3.17 (95% c.i. = 3.00, 3.34)
Conversion	1.71 (95% c.i. = 1.61, 1.82)	1.80 (95% c.i. = 1.67, 1.94)
Party position awareness	2.81 (95% c.i. = 2.68, 2.94)	2.77 (95% c.i. = 2.61, 2.92)
Party position differences	3.01 (95% c.i. = 2.89, 3.12)	3.03 (95% c.i. = 2.88, 3.17)

Note: $N = 667$.

This impression is further reinforced by a subsequent correlational analysis. While all mediator and dependent variables exhibit highly significant correlations with one another ($p < 0.001$), no significant effect is observed between education and any of the respective determinants (see Figure A5 in the Supplementary File).

At first glance, this finding may not be surprising, particularly in light of Albertsen (2022, p. 407), who identified a diminishing effect of higher education levels on Wahl-O-Mat usage. However, it raises the question of how these relationships unfold when accounting for the previously mentioned control variables.

Our data analysis aims to examine both direct and indirect effects on three key aspects of electoral behaviour: mobilisation, reinforcement, and conversion. Using path models, our analysis demonstrates that individuals with lower levels of education are significantly more likely to report that the Wahl-O-Mat increased their awareness of differences between parties and their positions. This heightened awareness, in turn, leads to a greater sense of mobilisation. As expected, no direct effect of education on mobilisation is observed. These findings reinforce the idea that the Wahl-O-Mat enhances perceived competence by facilitating incremental knowledge acquisition, which ultimately contributes to a higher perceived level of mobilisation. Notably, the total effect of education, when mediated by awareness of party differences, is slightly stronger (0.129 **; see Figure 1) compared to the effect mediated by awareness of party positions more broadly (0.109 *; see Figure 1).

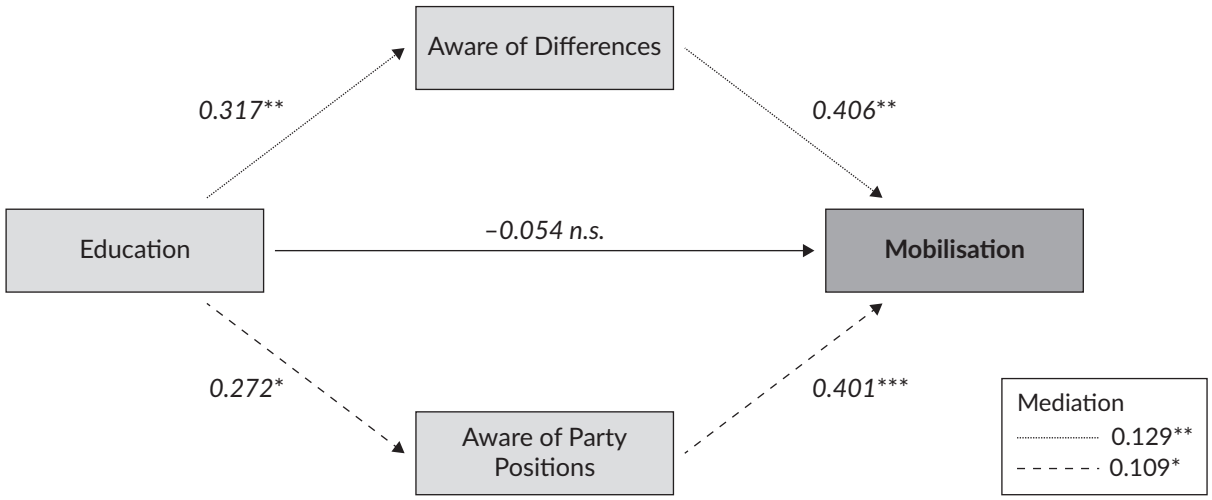


Figure 1. Mediated effects on mobilisation. Notes: $N = 667$ (see Table A1 in the Supplementary File for the full results), + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$,*** $p < 0.001$.

Similar patterns emerge when examining reinforcement. Individuals with lower or middle levels of formal education are more likely than those with higher levels to perceive a competence gain through the Wahl-O-Mat, which in turn strengthens their sense of reinforcement. However, an interesting contrast arises: A negative direct effect is observed between lower education levels and reinforcement. How can this be explained? One plausible reason is that individuals with higher levels of formal education tend to have stronger pre-existing voting dispositions, as previously discussed. Moreover, research on VAAs, such as the study by van de Pol et al. (2014), suggests that highly educated individuals not only report lower learning effects but also primarily use these tools for confirmation rather than for knowledge gain. This group of so-called "checkers"—who engage with VAAs to validate rather than reassess their preferences—consists predominantly of highly educated individuals, accounting for well over two-thirds. Given our descriptive

findings, this result is not surprising. However, it does challenge our initial assumption that direct effects would be negligible (see Figure 2). Notably, the total effect of education, when mediated by awareness of party differences, is considerably stronger (0.147 **; see Figure 2) compared to the effect mediated by awareness of party positions more broadly (0.068 *; see Figure 2).

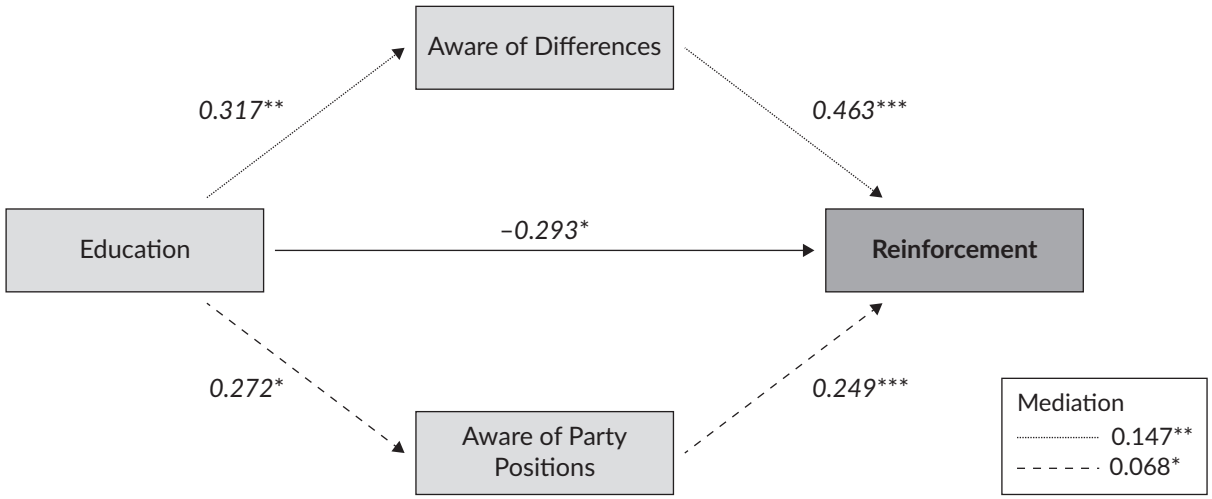


Figure 2. Mediated effects on reinforcement. Notes: $N = 667$ (see Table A2 in the Supplementary File for the full results), + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Regarding self-reported conversion induced by the Wahl-O-Mat, the effects closely resemble those observed for mobilisation. Here, too, indirect effects are clearly present, while no direct effects are found. Notably, among the indirect effects, the impact mediated by awareness of differences between parties (0.085 **; see Figure 3) is consistently stronger across all models compared to the effect mediated by learning about party positions per se (0.071 *; see Figure 3).

Individuals with lower levels of formal education do not measurably report being mobilised by the Wahl-O-Mat, being influenced in their party choice, or feeling reinforced in their voting decisions more than

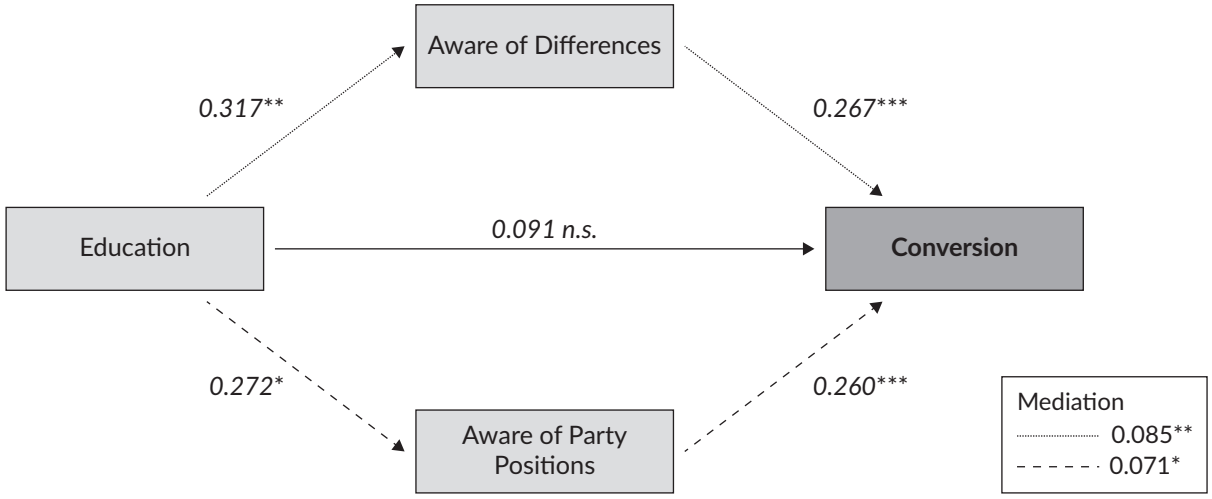


Figure 3. Mediated effects on conversion. Notes: $N = 667$ (see Table A3 in the Supplementary File for the full results), + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

those with higher education levels. Nor do they attribute a general impact on their opinion-forming to the tool. However, individuals with lower levels of education are significantly more likely than those with higher levels to report learning effects from the Wahl-O-Mat. This perceived knowledge gain is strongly associated with a greater sense of mobilisation, reinforcement, conversion, and general influence attributed to the tool. Consequently, when individuals with lower levels of education experience these learning effects, they assign greater importance to the Wahl-O-Mat overall. These findings highlight the varying roles of educational background in shaping how individuals engage with political information and educational tools such as the Wahl-O-Mat.

Regarding H1, which posited that individuals with lower levels of formal education differ significantly from those with higher levels, our results present a mixed picture. While no significant differences emerge between the education groups in terms of mobilisation or conversion, notable variations are observed for reinforcement and the general influence attributed to the Wahl-O-Mat. A negative direct effect is observed for highly educated individuals regarding reinforcement, which may be explained by the tendency of highly educated users to use the Wahl-O-Mat primarily to confirm their existing voting preferences—a behaviour known as "checking" (van de Pol et al., 2014). In contrast, highly educated individuals report a significantly greater general influence of the tool on their behaviour than their less-educated counterparts. However, the mediated effects provide a different conclusion, suggesting that indirect mechanisms play an important role.

This brings us to H2, which hypothesised that individuals with lower levels of education are more likely to experience learning effects from VAA usage, which in turn mediates their political behaviour. Our findings strongly confirm this hypothesis. The data consistently indicate that individuals with lower levels of education experience more pronounced learning effects when using the Wahl-O-Mat. These learning effects, in turn, significantly mediate the relationship between VAA usage and changes in political behaviour, demonstrating that VAAs can play a crucial role in enhancing political knowledge and influencing political engagement among these users.

Overall, Germany—with its former division into West and East—might exhibit a regional bias regarding the effects described above. Distinct regional political cultures, varying levels of institutional trust, and diverging patterns of political engagement and voting behaviour (Pickel & Pickel, 2023; Walke & Wurthmann, 2024) may influence the use of and trust in VAAs such as the Wahl-O-Mat. However, when including place of residence—coded as Western Germany (0) and Eastern Germany (1)—our results remain robust and largely unchanged (see Tables A4–A6 in the Supplementary File).

5. Conclusion

In conclusion, this study illuminates the nuanced impact of VAAs on individuals with varying levels of formal education. Given the importance of education for political interest, knowledge, and engagement, the study's objective was to examine this key factor in the usage of VAAs. While one might assume that VAAs like the Wahl-O-Mat are predominantly used by highly educated individuals and therefore, pointedly put, a closer look at less educated users seems to be less instructive, empirical findings indicate (a) that their impact extends across different educational backgrounds, influencing both highly and less educated users, and (b) that educational level makes a difference when it comes to mechanism of the effect of VAA usage. The findings reveal that while individuals with higher education levels are more likely to perceive a general

influence of VAAs on their voting behaviour, those with lower or middle education levels report greater learning effects from using such tools. This learning experience, in turn, leads to a perceived increase in competence and a higher likelihood of feeling mobilised, reinforced, or politically converted by the VAA.

The study has several shortcomings. One notable limitation is that the analysis of the VAA users was conducted before a very special election held during the pandemic, which may have generated influences not to be found in typical election cycles. Additionally, the study relies on self-reporting, which can introduce biases and inaccuracies, as participants' responses may be influenced by their perceptions, memory, and willingness to disclose accurate information. This also raises a more substantial issue of measurement validity. All key outcomes of this study—including learning effects, mobilisation, and vote change—are based on self-reporting. While such indicators are valuable for capturing participants' subjective experiences, they are vulnerable to social desirability and recall biases. Without objective measures of political knowledge or independent validation of actual behaviour, it remains uncertain whether the reported effects reflect real changes or primarily respondents' self-assessments. This is obviously not a VAA-related measurement problem but rather a fundamental question of measurement methodology in the field of effect research. Another significant shortcoming of the study might be the question of its generalisability to other national contexts. Germany has a unique party system, electoral system, and "VAA culture." This context is shaped by comparatively high levels of digital literacy and a comparatively stable multiparty system, both of which may increase the salience and accessibility of VAAs. Therefore, the question remains open as to whether the findings from this study, conducted in such a distinctive environment, can be effectively applied to other countries with different political landscapes, electoral systems, and levels of VAA integration. Moreover, the timing of the study poses an additional limitation. The 2021 German Federal Election was held during the Covid-19 pandemic, a period marked by elevated political uncertainty, widespread reliance on digital tools, and unusual campaign dynamics. It is possible that these extraordinary circumstances modified the relevance and use of VAAs in ways that may not recur in typical electoral cycles (Wurthmann & Marschall, 2022). These issues call for more comparative research. Comparative designs could provide evidence on how institutional and cultural settings condition the effects of VAAs, while longitudinal approaches could test whether the patterns observed here are valid beyond the specific context of the 2021 German Federal Election. By focusing on the educational aspects and their mediated effects, VAA research can more effectively contribute to measuring the contribution of these tools, also for the democratic process. Future research should continue to explore the varying effects of VAAs across various demographic segments.

Another limitation concerns sampling and sample attrition. The use of an online access panel enables us to reach a broader spectrum of respondents compared to widespread university-based samples, but this approach does not fully resolve the problem of representativeness. As there are currently no systematic data on the socio-demographic profile of Wahl-O-Mat users, we cannot check to what extent the sample reflects the broader user base. Potential self-selection into the panel between survey waves may bias the composition of respondents toward individuals who are politically more interested and who possess higher levels of formal education.

Moreover, although the study employs a robust four-wave panel design, the final sample was reduced to 667 respondents. In particular, panel mortality—as in our study—is typically correlated with political interest and formal education (Müller, 2025). Several respondents had to be excluded because they either did not know the Wahl-O-Mat or had never used the tool before. Such patterns, however, are also strongly shaped

by levels of political interest, knowledge, and education, which are themselves closely interrelated. This raises the possibility of attrition bias, particularly along educational lines, which are central to our analysis. Prior research has noted that VAAs are disproportionately used by better-educated citizens who often employ them to confirm existing preferences rather than to reconsider them (van de Pol et al., 2014).

The dynamics described may have reinforced the already existing educational skew. This is also reflected in the fact that we could not differentiate more finely within the lower education categories and had to merge them into a single group to provide analytical reliability. Future research should seek to differentiate more finely between different levels of education, as this would allow a deeper understanding of how VAAs operate across more differentiated educational backgrounds. To sum it up: A more finely grained operationalisation of education could reveal additional variation in political behaviour.

Finally, there is some significant learning that makers of these tools can draw from the study. The findings underscore the importance of designing VAA research to consider its educational components in detail, particularly for users with lower educational backgrounds. As the learning experience provided by tools such as the Wahl-O-Mat seems to be particularly important for individuals with medium or low levels of formal education, the specific design of VAAs should take didactical approaches more strongly into consideration. By doing so, VAAs might be much more attractive and capable of not only "preaching to the converted" but also of reaching out to those who are much more in need of political information and orientation. Indeed, we started with the assumption that people with low levels of education would experience only a low impact of using VAAs, but our study indicates that this is not the case; rather, the opposite.

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Conflict of Interests

The authors declare no conflict of interests. In this article, editorial decisions were undertaken by Diego Garzia (University of Lausanne / Bologna University), Mathias Wessel Tromborg (Aarhus University), and Andreas Albertsen (Aarhus University).

Data Availability

Research data can be requested via the project link and the responsible persons listed there: https://www.sozwiss.hhu.de/institut/abteilungen/politikwissenschaft/politik-ii/prof-dr-stefan-marschall/wahlen-in-stuermischen-zeiten

Supplementary Material

Supplementary material for this article is available online in the format provided by the authors (unedited).

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