

IEA Research_ and Development_

SMART: Survey Mode and Response Trends in TIMSS and PIRLS Context Questionnaires

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Summary

This R&D project uses two decades of data from the IEA's TIMSS and PIRLS studies to examine how shifting context questionnaires from paper to online administration influences participation rates on home, teacher, and school questionnaires.

The key finding is that moving to online questionnaires substantially reduces participation, especially for parents. Home questionnaire response rates declined by about 20 percentage points when administered online, while teacher and school questionnaire response rates fell by only 2–4 percentage points. Importantly, we did not find evidence that the lower response rates in the online mode disproportionately impacted particular student groups based on achievement, gender, or socioeconomic background.

For IEA studies such as TIMSS, PIRLS, ICCS, ICILS, and LaNA, the findings highlight a critical trade-off between the efficiency of digital data collection and the risk of reduced participation. Follow-up evidence from national research coordinators suggests that technical issues, technological barriers, and reduced personal engagement in online modes contribute to lower parental participation rates. Strategies such as tracking systems and targeted reminders, school-based support, mixed-mode administration, and stronger communication about study importance were recommended to help mitigate these challenges as IEA questionnaires continue their transition to digital platforms.

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From Paper to Digital: Administration Mode and Response Rates in International Large-scale Surveys

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Abstract

This study investigates the implications of transitioning from paper-based to online survey administration on response rates in international large-scale surveys, focusing on home, teacher, and school questionnaires administered in the Trends in International Mathematics and Science Study (TIMSS) and Progress in International Reading Literacy Study (PIRLS). Using data from two decades of assessment cycles, we applied difference-in-differences models to estimate the effect of survey administration mode on questionnaire response rates. Results showed evidence of significant declines in response rates in countries using online administration. The most substantial drops in response rates were observed in the home questionnaire (approximately 20 percentage points), while teacher and school questionnaires showed smaller declines (2 to 4 percentage points). The survey mode effect on response rates did not vary by observable student characteristics. A follow-up survey identified key implementation challenges of online surveys and strategies to address them. Together, the findings provide empirical evidence and operational insights on online survey administration in international large-scale surveys.

Keywords

Survey mode, response rate, online surveys, international large-scale surveys, TIMSS and PIRLS

Introduction

Low response rates remain one of the central threats to survey research because they undermine both the unbiasedness and precision of estimates. When some groups are systematically less likely to participate, even sophisticated weighting and imputation routines may not fully restore the parameters of interest (e.g., [Biemer & Lyberg, 2003](#); [Groves, 2006](#)). At the same time, the infrastructure of survey research is undergoing a rapid shift from paper-based to online administration. Statistical offices, academic projects, and commercial surveys increasingly rely on online questionnaires. Digital modes promise lower fieldwork costs and faster data processing, but syntheses of experimental studies suggest that online surveys can lead to lower response rates than paper surveys ([Daikeler, Bošnjak, & Manfreda, 2020](#); [Manfreda, Bošnjak, Berzelak, Haas, & Vehovar, 2008](#); [Weigold, Weigold, & Natera, 2019](#)). This raises the question of whether gains in administrative efficiency come at the price of increased non-response bias (e.g., [Dillman, Smyth, & Christian, 2014](#)).

Survey mode is not a neutral “delivery channel” but structures the social situation in which a request for survey participation is received (e.g., [Dillman, 2020](#)). Two mechanisms are particularly relevant for educational surveys. First, social accountability and local monitoring differ across modes: a paper questionnaire handed out by a teacher and collected in class makes nonparticipation visible, whereas an emailed link or portal accessed from home is easier to ignore. Second, online administration requires access to appropriate devices, internet connectivity, and basic digital skills. Unequal access to digital infrastructure may differ across

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social groups. Together, these mechanisms suggest that moving from paper to online modes can lower participation overall and may do so differentially across social and participant groups introducing bias into estimates.

Over the past decade, major international educational survey programs have increasingly transitioned from paper-based to online data collection. Studies like the Programme for International Student Assessment (PISA), the Trends in International Mathematics and Science Study (TIMSS), and the Progress in International Reading Literacy Study (PIRLS), which were traditionally administered as paper-based assessments, have progressively introduced computer-based delivery in recent cycles (Mullis & Martin, 2019, 2021; OECD, 2016), marking a major shift in international large-scale student testing. Teacher and adult surveys like the Teaching and Learning International Survey (TALIS) and the Survey of Adult Skills (PIAAC) as well as the context questionnaires administered in conjunction with the student assessments in PISA, TIMSS, and PIRLS have also progressively expanded digital administration (OECD, 2013, 2019). Together, these developments illustrate that the transition from paper to online survey modes reflects a broader trend across international educational surveys. Interestingly, while the rationale for these transitions is well documented, issues of non-response have received little attention in the documentation of these studies.

In this study, we examine whether the transition from paper to online or mixed-mode survey administration is connected with response rates in international large-scale surveys using trend data from two international comparative studies, TIMSS and PIRLS. We estimate difference-in-differences models with country and year fixed effects to estimate the impact of switching survey administration modes on response rates to context questionnaires that collect valuable information on the educational contexts of tested students from parents, teachers, and principals. Because

non-response may be more consequential when it is unevenly distributed across social strata, we further examine whether these effects differ by observed student background. We complement the quantitative analyses with insights from open-ended responses to a follow-up survey of national research coordinators, responsible for implementing the international studies in their countries. Responses identify potential mechanisms behind the observed impacts of survey administration mode on response rates and suggest practical strategies for sustaining participation as large-scale surveys continue to move online. The analysis seeks to expand current knowledge regarding survey administration mode and response rates by using international data from multiple respondent groups (parents, teachers, and principals), leveraging important cross-national and respondent variation to better understand the mechanisms behind survey non-response in the digital realm. The findings also provide practical implications for survey operators and researchers by quantifying how digital administration affects questionnaire response rates in large-scale educational surveys as well as synthesizing strategies used by data collectors that show promise in mitigating response-rate declines.

Theoretical Framework

Survey mode is not merely the delivery channel, it shapes who is covered, who participates, and how respondents interpret and answer questions (Dillman, 2020; Dillman et al., 2014; Groves et al., 2009). In survey methodology, surveys can be thought of as falling into one of two groups: interviewer-administered and self-administered surveys. Interviewer-administered surveys include face-to-face interviews that record answers on paper or with computer assistance and telephone interviews with computer assistance. These enable rapport, clarification, and encouragement, but they can also increase socially desirable response patterns as well as implementation costs. Self-administered surveys

include paper questionnaires returned by mail or through schools and online questionnaires completed on desktop computers, tablets, or smartphones. Self-administration gives participants greater flexibility. Respondents can choose when and where to answer and can pause and resume the survey at any time. At the same time, self-administration reduces interviewer effects and cost but also places greater demands on instrument usability, access, and respondent motivation. Within each survey type, multiple modes can be used. In this study, we compare two self-administered survey modes, paper and online, which differ in the degree of direct interpersonal exchange involved in survey distribution as well as in the barriers to participation associated with their administration.

Survey mode structures the social situation within which respondents interpret the survey request, assess its legitimacy, and decide how to act. Survey mode may affect two aspects of survey response: selection and measurement (de Leeuw, 2018). Selection concerns who chooses to respond. Measurement concerns how answers are produced and given. As such, changes in mode can affect statistical inferences and are a particular concern for analyses of survey data over time.

In this study, we focus on the ways in which survey mode shapes participants' decision to respond to surveys (i.e., selection), rather than how answers are produced or given (i.e., measurement). Selection becomes a major concern when response is non-random. In the total survey error framework, mode and device alter response propensities across subgroups and result in unit and item non-response. Following Groves et al. (2009), it is therefore essential to distinguish non-response that is approximately at random from non-response that is selective with respect to key outcomes. Non-response, often influenced by factors like gender, socioeconomic status, and student performance, is typically non-random (Anders, Has, Jerrim, Shure, & Zieger, 2021; Andersson & Sandgren Massih, 2023; Borger, Johansson, & Strietholt, 2024; Jerrim,

2021). And this non-random non-response may be exacerbated by changes to online surveys given that some of these characteristics are linked to device availability and digital literacy (Kennedy, Strello, & Strietholt, 2025).

Potential mechanism 1: Social control We next explore potential mechanisms that can explain why survey mode affects participants' decisions to respond to a survey. One potential mechanism can be referred to as social control (Couper & Kreuter, 2013; Durrant & Kreuter, 2013; Tourangeau & Yan, 2007). In interviewer-administered surveys, the interviewer creates a social presence that increases respondents' sense of accountability and the perception of being evaluated. Self-administered surveys reduce this presence and raise the perception of anonymity. Within self-administered designs, perceived anonymity and social contexts can still vary by implementation. For example, a paper questionnaire returned via a teacher may feel less anonymous than an online form that is sent through a web portal. In school settings, paper questionnaires returned to a teacher create local observability and also allow for routine reminders, whereas a home web portal can be less visible.

This pattern of social control aligns with the tailored design approach (Dillman, 2020; Dillman et al., 2014). In this approach, participation is expected to increase when design elements raise perceived benefits, reduce perceived costs, and build trust through visible, legitimate sponsorship and coordinated contacts. Such trust arises in school settings when teachers are responsible for collecting paper surveys from parents because there is a clear and expected exchange present. In contrast, shifting to an online mode can weaken perceived local sponsorship and the sense that non-response will be noticed. This is echoed in Ajzen and Fishbein (1980)'s theory of reasoned action: beliefs about the expectations of known others, such as a child's teacher, shape intentions, including the decision to return a questionnaire. According to Coleman (1990), recurrent interactions

within organizations create mutual expectations, and the authority of the teacher provides a focal point for such obligations. Likewise, research on accountability suggests that individuals are more likely to conform to perceived norms when they expect to justify their actions to known others (Lerner & Tetlock, 1999). Hechter (1987) argues that group solidarity is maintained when behavior is subject to monitoring. While teachers (and classmates) can readily see which students have returned paper questionnaires from parents, a web portal accessed from home is far less visible to that local audience. At the same time, the responding parent might perceive the sender of the survey as having moved from a known person (the teacher) to an impersonal institution, potentially linked to lower likelihood of response. A similar situation arises when teachers and principals choose to respond to surveys from researchers conducting studies within their schools.

Potential mechanism II: Technological barriers A second mechanism to explain survey mode effects on response rates involves device access and related digital literacy (Antoun, Couper, & Conrad, 2017; Tourangeau et al., 2017). In online surveys, smartphones impose small screens and touch input that increase burden and unit or item non-response. Larger screens mitigate some of these pressures, but respondents still need operational skills and sufficient digital literacy to find links, enter access codes, and navigate skips. As such, online surveys may require additional technical support to help respondents navigate web-based survey platforms, increasing the time and cost of survey completion. This is further complicated by the visibility of survey contacts in online administered surveys as the source for technical support may be unfamiliar or unknown. Paper surveys, while lowering the device and digital literacy barriers, may still also require support, however, as mentioned in the social control argument, the source of that support would be known and more familiar to the respondent. It is also important to recognize that digital

literacy levels may vary substantially across participants and be connected to a number of social factors, which raises the risk of selective non-response. Device experiments indicate that completing online surveys on smartphones versus PCs affects completion, although effects depend on instrument design and respondent characteristics.

Empirical Evidence

Online surveys are increasingly common, as documented by comparative studies and meta-analyses (Daikeler et al., 2020; Daikeler, Silber, & Bošnjak, 2022; Manfreda et al., 2008). The move toward online surveys promises, among other benefits, lower costs and greater geographic coverage (Dillman, 2011; Tourangeau et al., 2017). Test or survey designers can use computer technology to streamline responding by skipping irrelevant questions or tailoring questions to earlier answers. These features reduce burden and potentially help prevent missing or inconsistent data through immediate feedback. Online surveys also have an advantage in that they can lower printing and processing costs and automate editing and routing, although device heterogeneity (e.g., smartphones versus computers) can introduce usability differences in navigation and completion (Couper & Kreuter, 2013). Paper surveys, by contrast, require distribution, collection, and scanning or data entry but can provide a natural reminder for completion when the questionnaire remains visible on the table. Finally, online surveys enable real-time monitoring of respondent progress and the collection of digital trace data, including items viewed and answered, timestamps, clicks, cursor movements, and time on task. Such data have been used in online experiments to address substantive research questions and motivate assessment and survey design.

Despite these benefits, research has shown that survey participation tends to be lower in the digital mode. The evidence on response rates is consistent across syntheses. In a meta-analysis of experimental

comparisons, [Manfreda et al. \(2008\)](#) estimated that online surveys achieve, on average, a roughly 11 to 12 percentage point lower response rate than paper surveys in controlled experiments. A decade later, [Daikeler et al. \(2020\)](#) replicated and extended the synthesis and reached a similar conclusion: on average, online response rates remained about 12 percentage points lower than those of comparison modes. Cross-national meta-analytic work shows that the magnitude of the online disadvantage varies with country-level conditions (e.g., internet and mobile coverage, population age structure, and general “survey climate”) ([Daikeler et al., 2022](#)). A separate meta-analysis by [Weigold et al. \(2019\)](#) explored similar questions and found that those completing paper surveys were almost twice as likely to return surveys than those filling them out on computer. Several explanations have been offered to explain the lower response in the online mode, with studies citing lack of personalization and barriers to technology use as some potential reasons behind reduced response rates on digital surveys ([Décieux, 2024](#); [Fan & Yan, 2010](#); [Nulty, 2008](#)). These closely connect with the mechanisms described in the [Theoretical Framework](#). Importantly, lower response does not mechanically imply greater non-response bias; however, mode- or device-related selection can affect representativeness in specific contexts ([Brick & Williams, 2013](#); [Rybak, 2023](#)).

Empirical evidence suggests that survey mode effects on response rates may vary across subgroups ([Grewenig, Lergetporer, Simon, Werner, & Woessmann, 2023](#); [Lythreatis, Singh, & El-Kassar, 2022](#)). Older adults are less likely to participate online where coverage and digital skills are limited, whereas younger adults are more reachable via the web. Compared with the general population, online respondents tend to have higher education levels. Online surveys often underrepresent less educated and lower income individuals, particularly those without reliable internet access. Lower education and lower income predict

reduced online participation, partly through access and skill pathways documented in digital inequality research. Limited proficiency in the survey language and immigrant status are also associated with lower participation in self-administered online surveys. Comparative studies report lower response among immigrant and migrant background groups when targeted accommodations are absent. At the same time, younger adults are more reachable online as internet penetration and mobile use increase, though device heterogeneity can introduce usability differences that interact with age and skills.

Additionally, mode effects can vary by respondent group (Anseel, Lievens, Schollaert, & Choragwicka, 2010). Within the educational context, parents experience teacher and peer visibility in the paper workflow but not online, and home internet or device access and digital literacy may constrain participation under online administration. Teachers, in contrast, respond within a professional role and institutional chain of accountability. Principals' responses are often part of formal administrative routines. Furthermore, teachers and principals have immediate access to technology to complete online surveys within their school setting. Meta-analytic evidence from organizational settings shows that respondent role and organizational embeddedness predict participation rates and the effectiveness of contact strategies.

Although direct research examining the relationship between student characteristics and the survey response of their connected respondents (i.e., parents, teachers, and principals) remains limited, survey completion can be conceptualized as a form of school involvement (Barger, Kim, Kuncel, & Pomerantz, 2019; Epstein, 1986), similar to parental involvement or teacher engagement beyond instructional duties. Three student characteristics have been empirically linked to patterns of parental involvement: gender, academic performance, and socioeconomic status (Alter, Fényes, & Pusztai, 2025). Gender effects are particularly salient,

with girls generally experiencing greater parental engagement in school activities (Muller, 1998), suggesting these dynamics may extend to survey response behavior as parents could be differentially motivated to respond based on their child's gender. Academic performance represents another important factor, though the relationship between involvement and achievement is complex (Pomerantz, Moorman, & Litwack, 2007). Parents often intensify engagement when children experience academic difficulties, suggesting they may also be more attentive to school communications, including surveys (Alter et al., 2025), yet students' high performance may result from high parental engagement. Finally, socioeconomic status fundamentally shapes both the capacity for and forms of involvement, with lower-SES families facing practical barriers, including time constraints and limited resources, that reduce engagement (Tan, Lyu, & Peng, 2020), and these same constraints may create systematic differences in survey response rates across socioeconomic groups.

Current Study

As international surveys in education have begun to transition their questionnaires into online formats, survey mode effects on non-response are a growing concern. Such surveys aim to deliver high-quality data by means of probabilistic school samples and rigorous fieldwork standards, yet exclusions and non-response remain central concerns. These studies apply strict participation requirements and annotate results when school or within-school participation thresholds are not met, underscoring the potential for bias (Meinck, Cortes, & Tieck, 2017). A recent special issue on missingness and unit non-response argues that these issues are now among the most pressing threats to representativeness in contemporary international comparative studies in education (Kjeldsen & Strietholt, 2024). Because context questionnaires collect key background indicators

and conditioning variables used in achievement scaling, declines in participation or composition shifts can affect both descriptive statistics and model-based inferences using such data.

Despite a rich general literature on survey mode effects on response, there is still room to offer new insights. First, most research on survey mode has been conducted in the United States (Daikeler et al., 2020), which limits the generalizability of the findings. Cross-national evidence is rare (Daikeler et al., 2022). Second, the studies listed in the referenced meta-analyses compare online with other modes in general populations or consumer samples, often with email or panel recruitment (Daikeler et al., 2020, 2022; Manfreda et al., 2008). As such, they do not directly capture the “visible accountability” features mentioned in the **Theoretical Framework**. Given the singularly focused respondent populations, little can be done to test for the impacts of this type of accountability on response patterns.

This paper addresses these gaps using international data covering approximately two decades of TIMSS and PIRLS assessments. We analyze within-country changes in survey response patterns as countries transitioned from paper to digital administration, estimating difference-in-differences models with country and cycle fixed effects. We examine heterogeneity by respondent group (i.e., parents, teachers, and principals) and by student background characteristics linked to each respondent (e.g., achievement, socioeconomic background, and gender). We complement the quantitative analysis with a follow-up survey of national research coordinators, individuals responsible for overseeing data collection efforts within their country, asking them to report on their experiences in transitioning survey modes, specifically addressing challenges faced and promising implementation strategies they have identified. Specifically, this study addresses the following research questions:

1. What is the effect of survey administration mode (paper vs. online) on response rates to TIMSS and PIRLS grade 4 home, teacher, and school context questionnaires?
2. Do survey administration mode effects on response rates vary by student characteristics?
3. Based on countries' experience collecting data, what are the challenges experienced and promising strategies used in administering digital surveys in TIMSS and PIRLS?

Data Sources

Overview of TIMSS and PIRLS

TIMSS has assessed grade 4 and grade 8 students' achievement in mathematics and science every four years since 1995, while has PIRLS assessed grade 4 students' reading abilities every five years since 2001. Both studies use harmonized procedures to enable cross-national comparison over time. Country participation in TIMSS and PIRLS is voluntary.

Sampling follows a two-stage clustered design. In the first stage, approximately 150 schools are selected with probability proportional to size, giving larger schools a higher chance of selection. In the second stage, one or two intact classes are sampled at random within each selected school, and all students in those classes are assessed.

Both studies also collect background information via context questionnaires. Students, teachers, and school principals report on home and school resources, instructional practices, and learning attitudes. For grade 4, parents additionally complete a home questionnaire. PIRLS has included a home questionnaire since 2001, and TIMSS added one in 2011. These instruments capture early numeracy and literacy activities, household characteristics, and parental education that younger children cannot reliably self-report.

The transition from paper-based to online data collection can be traced back to 2004 with the development of the IEA Online SurveySystem (OSS) (Sibbern, 2020). Beginning with TIMSS and PIRLS 2011, school and teacher questionnaires could be completed online on computers. Starting with the upcoming PIRLS 2026 and TIMSS 2027 cycles, context questionnaires are planned to be administered through a new system, StudyExpert, compatible with smartphones and tablets, further broadening access.

Participating countries select the survey administration mode. Survey respondents are asked to complete the questionnaire online, on paper, or are given the opportunity to choose depending on their country's mode selection. According to IEA's Survey Operations Procedures, after student testing each student receives a home questionnaire and a letter for parents explaining its purpose. Paper questionnaires should be returned within one week, with follow-up by phone or email if necessary. For online questionnaires, parents receive login instructions linked to the student's ID, and paper copies are provided upon request to minimize non-response. When school and teacher questionnaires are administered online, principals and teachers receive printed directions with identification labels and secure-access instructions. Schools are responsible for ensuring that all questionnaires, whether paper or online, are completed by the student testing date.

Survey Mode and Response Rates

Data For the analysis relating survey administration mode to response rates, three datasets are constructed. These include information on all home, teacher, and school questionnaires administered as part of TIMSS or PIRLS spanning the years 2001 to 2023 and involving the participation of 86 unique countries. Because TIMSS and PIRLS are not administered annually but in 4-year and 5-year cycles, respectively, we refer to the

time component in terms of study-specific cycles (e.g., PIRLS 2001, TIMSS 2003, etc.) and use the term “cycle” to denote the time points in trend analyses.* Our datasets include information from up to 11 cycles (only nine cycles are available in the home questionnaire dataset as the home questionnaire was only introduced in TIMSS in 2011). The datasets include information related to the Grade 4 population of both TIMSS and PIRLS. In total, the dataset includes information collected from 2,194,609 home questionnaires, 163,873 teacher questionnaires, and 95,000 school questionnaires (see [Table A1](#) for details).

For each country-cycle combination in our dataset, the mode of survey administration is identified. Survey mode can take one of three values: paper, online, or mixed (combination of paper and online modes). In practice, the mixed category was utilized differently across countries and cycles. For some country-cycles, the mixed mode involved the administration of surveys mainly online, with some paper copies at the request of respondents. For other country-cycles, the opposite was true, the mixed mode involved the administration of paper survey copies, with an optional link provided to fill in the survey online.

For each respondent type – parent, teacher, or school leader – an indicator for whether they responded to at least one question on their questionnaire is created. We define the response rate as the average of the indicator for a given country-cycle. That is, this represents the percentage of respondents who answered at least one question on their questionnaire. [Table 1](#) presents response rates by survey administration mode for each cycle and questionnaire type. The table reveals some clear patterns. Response rates under the online and mixed modes tend to be lower response rates than those under the paper mode. This is most obvious with the home questionnaire where response rates in the

*Note that in 2011, both TIMSS and PIRLS were administered during the same year, yet represent distinct cycles in our analysis.

online mode tend to be between 15-20 percentage points lower than those observed on paper.

To assess the heterogeneity of mode effects by student characteristics, information collected through the TIMSS and PIRLS assessments, survey tracking forms, and student questionnaires is used. While ideally we would use respondent characteristics (i.e., characteristics of the parent, teacher, or principal), this information is unavailable for non-responders, therefore student background is used instead as they are generally available for a higher percentage of respondents. This information is merged with each of the questionnaire datasets and aggregated to the respondent level. That is, all student characteristics are averaged to the class- or school-level when connected to the teacher or school questionnaire datasets. Student characteristics are linked one-to-one to each home questionnaire respondent (only one was sent per family). Several student characteristics are explored and we summarize them at the student-level: gender (50.6% female) and number of books in the home (55.9% report having greater than 26 books in the their home). The response on the number of books in the home has been commonly used as an indicator of socioeconomic status in international educational studies (Heppt, Olczyk, & Volodina, 2022; Jerrim & Micklewright, 2014). Additionally, student performance on the TIMSS/PIRLS assessment (set to an international mean of 500 and standard deviation of 100) was also used as another student characteristic in the heterogeneity analysis. We limit the set of examined characteristics to those that were consistently asked across all cycles and countries under study. Notably, we are not able to include language use in the home as a characteristic as it was not administered in some country-year combinations. Therefore, the extent that we can examine the heterogeneity of survey administration mode effects on response rates is constrained by data availability.

Table 1. TIMSS/PIRLS context questionnaire response rates by survey administration mode

Survey Mode:	Paper		Online		Mixed	
Cycle	N Cty	Resp. Rate	N Cty	Resp. Rate	N Cty	Resp. Rate
<i>(a) Home Questionnaire</i>						
PRL2001	32	86.2%				
PRL2006	39	88.2%				
PRL2011	47	90.0%				
TMS2011	34	92.4%				
TMS2015	40	87.5%			8	64.8%
PRL2016	40	90.5%			5	85.0%
TMS2019	42	93.2%	5	71.9%	7	78.1%
PRL2021	37	91.1%	5	71.8%	12	79.2%
TMS2023	26	90.3%	20	75.2%	8	81.9%
<i>(b) Teacher Questionnaire</i>						
PRL2001	34	96.7%				
TMS2003	26	93.2%				
PRL2006	40	96.4%				
TMS2007	37	96.7%				
PRL2011	38	95.9%	7	96.1%	4	90.8%
TMS2011	40	96.4%	9	94.4%	3	91.3%
TMS2015	31	97.0%	1	99.6%	16	93.6%
PRL2016	30	98.0%	13	98.4%	4	93.8%
TMS2019	32	98.0%	23	92.1%	3	96.3%
PRL2021	22	96.3%	28	92.3%	4	93.0%
TMS2023	8	95.1%	47	91.3%	3	84.4%
<i>(c) School Questionnaire</i>						
PRL2001	34	96.5%				
TMS2003	26	94.6%				
PRL2006	39	95.3%				
TMS2007	37	97.4%				
PRL2011	38	96.4%	8	95.0%	3	97.6%
TMS2011	40	96.9%	8	96.1%	4	96.6%
TMS2015	31	96.6%	3	100.0%	14	93.2%
PRL2016	28	96.9%	14	98.2%	5	95.8%
TMS2019	32	98.3%	23	93.7%	3	98.7%
PRL2021	22	97.4%	30	95.1%	5	88.7%
TMS2023	8	95.0%	47	92.5%	3	88.6%

Note. N Cty = Number of countries that chose to administer the questionnaire under the specified administration mode (paper, online, mixed - combination of paper and online). Resp. Rate = Response rate (% of respondents who returned a survey with at least one item completed). PRL = PIRLS, TMS = TIMSS. The home questionnaire was not administered in TIMSS prior to TIMSS 2011.

Methods The descriptive trends presented in [Table 1](#) appear to reveal that mode effects exist in the TIMSS/PIRLS context questionnaires with quite substantial differences observed in the home questionnaire. This pattern is further explored using a difference-in-differences model to account for selection of countries into survey administration mode and cross-cycle changes to survey content and length ([Angrist & Pischke, 2009](#)). Formally, the following regression model is estimated when analyzing response to the home questionnaire:

$$RESP_{ict} = \alpha + \mu_c + \delta_t + \beta \text{MODE}_{ct} + \gamma X_{ict} + \varepsilon_{ict} \quad (1)$$

where $RESP_{ict}$ is a 0/1 indicator for whether student i 's parent responded to the home questionnaire in country c during cycle t . OLS (linear probability models) is used to estimate these models. While non-linear models would be standard for such a binary outcome, they have some issues with fixed effect model estimation ([Cruz-Gonzalez, Fernández-Val, & Weidner, 2017](#); [Fernández-Val & Weidner, 2016](#); [Neyman & Scott, 1948](#)). μ_c and δ_t are fixed effects that control for all country-specific time-invariant and global time-specific factors, respectively. Both fixed effects are included to offset bias driven by selection of countries into survey administration mode and cross-cycle changes to survey content and length. X_{ict} is a vector of student characteristics (i.e., age, gender, books in the home, achievement, and whether a computer is present in the home). MODE_{ct} is a categorical variable representing the survey administration mode chosen by country c in cycle t . The parameter of interest is β which represents the estimated effect of survey administration mode on response rates. For analysis of response to teacher and school questionnaires, similar models are estimated using datasets aggregated to the teacher- or school-level.

To estimate heterogeneity in the mode effect by student characteristics, [Equation 1](#) is slightly modified. Again, the following equation shows how

it is estimated for the home questionnaire analysis:

$$RESP_{ict} = \alpha + \mu_c + \delta_t + \beta \text{MODE}_{ct} + \phi \text{MODE}_{ct} \times X_{ict} + \gamma X_{ict} + \varepsilon_{ict} \quad (2)$$

Equation 2 adds an interaction term between MODE_{ct} and some measure of student background, X_{ict} . Models are estimated separately for each student background characteristic examined: achievement, gender, and books in the home. ϕ estimates how the effect of survey administration mode on response rates differs based on student characteristics. All categorical variables are dichotomized for ease of interpretation in the model. In analyses of responses by teachers and principals, student characteristics are first aggregated to the classroom- or school-level, respectively, and used in the interaction.

Sampling weights were applied in all analyses.[†] This ensures that cross-cycle changes in response patterns were not due to different samples drawn. Additionally, we apply senate weights so that each country contributes similarly to the estimates. That way, larger countries or countries that decide to draw larger samples will not be disproportionately represented in the estimates. Furthermore, missing values on student background characteristics were treated as separate categories to avoid the need for listwise deletion.

Follow-up Survey

Data Based on the initial quantitative analysis of the changes in response rates associated with survey mode, an online survey was developed with up to seven open-ended questions that addressed several topics related to online survey administration. The goal was to understand the experiences of those behind the data collection as a way to further explore the observations made in the quantitative results. The survey

[†]Results do not substantially change when sampling weights are not applied.

asked participants to comment on their motivations behind the switch to the online format (including the role of General Data Protection Regulation (GDPR), where applicable), the challenges they experienced, and promising strategies they used to ensure high response rates in online survey modes. Where relevant, respondents were also asked about their use of mixed survey formats. Based on the initial quantitative analysis, the survey focused its attention on experiences administering the home questionnaire which had a much steeper drop in response rates in the digital mode compared to the teacher and principal questionnaires (evident in [Table 1](#)). The final question asked respondents to speculate on the potential reasons why smaller declines in response rates were observed in the teacher and school questionnaires. The survey, delivered via the platform www.survey-xact.dk, opened with contextual information on the general and country-specific change in response rates, based on the self-reported combination of country, study, and cycle. The survey text can be found in [Figure A1](#).

The survey was sent to national research coordinators, the individuals responsible for data collection in their countries. Only countries that made the switch to digital administration modes on the home questionnaire in at least one cycle since PIRLS 2016 were invited to participate. While PIRLS/TIMSS 2011 was the first cycle in which the online survey option was available, we chose to focus on more recent cycles to avoid problems with recollection and avoid difficulties in tracking down individuals responsible for data collection more than 10 years ago. Publicly available contact information for each national research coordinator was collected from the IEA website, and 45 individuals across 32 countries were invited to participate, covering 62 different combinations of country, study and cycle that had used either full digital or the mixed mode. Responses were received from 30 respondents covering 26 (of 32) countries with some respondents providing input for multiple studies and cycles, hence

covering 55 (of 62) of the country-study-cycle combinations where a digital or mixed mode had been used.

Methods Responses to the follow-up survey were analyzed using qualitative content analysis (Schreier, 2012). In a first read-through, answers to each of the open-ended questions were read from all respondents. Themes were identified for each question using inductive coding. With the themes for each question identified, all responses were read again and indicators were created to specify whether specific themes were covered in each response. Two different coders took on this task and intercoder differences were discussed and resolved after coding was complete (90% agreement, Krippendorff's $\alpha = 0.80$). Coders also discussed whether any new topics should be created based on the second read-through, however, none were introduced. Based on the coding, recurring themes for each open-ended question were identified and synthesized to develop coherent narratives addressing our research questions.

Results

Survey Mode and Response Rates

Country-level trends in home questionnaire response rates by survey administration mode are presented in Figure 1. Only countries that participated in at least three cycles including at least one cycle since the introduction of the online option (i.e., since PIRLS/TIMSS 2011 for teacher and school questionnaires; since TIMSS 2015 for home questionnaires) are included in the figure (however, all countries with data are included in the regression analysis). Bars are shaded as white or black based on the mode in which the questionnaire was returned (paper or online, respectively). The plot reveals that the online survey mode tends to be associated with lower response rates (e.g., Albania, Canada,

Denmark, Hungary, Kosovo, Latvia, Lithuania, Romania, Saudi Arabia, United Arab Emirates). However, there is variation, as some countries experienced larger declines under the online administration mode than others. There were even several countries that did not experience large drops in response rates after switching to the online mode (e.g., Bahrain, Georgia, Kazakhstan, Türkiye). Similar plots for the teacher and school questionnaires are available in [Figure A2](#) and [Figure A3](#). Differences in response rates by survey mode on the teacher and school questionnaires are less obvious.

Estimated average mode effects [Table 2](#) presents the estimates of mode effects on questionnaire response rates from a difference-in-difference model (β from [Equation 1](#)). We use two ways of operationalizing survey administration mode. In the first two results columns, mode can take one of two values: paper or online. Here, countries using the mixed mode are recoded into paper or online based on the survey mode to which the majority of participants responded. In the last two results columns, mode can take one of three values: paper, online, or mixed. Models with and without student background control variables are shown.

In panel (a) of [Table 2](#), the estimated survey mode effects for the home questionnaire are presented. In the models where mode can take only two values (paper or online), estimates indicate that the online mode is associated with significant drops in home questionnaire response rates (17-percentage point decline). When countries using mixed modes are treated as a separate category, estimates reveal that the countries using only digital surveys experienced a 20-percentage point decline. Countries using a combination of survey administration modes (paper and online) also experienced a significant decline in home questionnaire response rates, however, not to the extent of countries using only online surveys (9-percentage point decline). Control variables did not substantially change the effect estimates.

Table 2. Estimated survey mode effects on context questionnaire response rates

	Mode $\in \{\text{Paper, Online}\}$		Mode $\in \{\text{Paper, Online, Mixed}\}$	
	No Controls	Controls	No Controls	Controls
<i>(a) Home Questionnaire</i>				
N = 2,194,609; N Countries = 79; N Cycles = 9				
Online	-0.167*** (0.026)	-0.168*** (0.026)	-0.204*** (0.037)	-0.203*** (0.037)
Mixed			-0.089** (0.030)	-0.086** (0.030)
<i>(b) Teacher Questionnaire</i>				
N = 163,873; N Countries = 86; N Cycles = 11				
Online	-0.038** (0.012)	-0.033** (0.011)	-0.043*** (0.012)	-0.038*** (0.011)
Mixed			-0.041** (0.012)	-0.037** (0.012)
<i>(c) School Questionnaire</i>				
N = 95,000; N Countries = 85; N Cycles = 11				
Online	-0.026** (0.009)	-0.024** (0.008)	-0.031** (0.010)	-0.028** (0.010)
Mixed			-0.031* (0.015)	-0.029 (0.015)

Note. Results are from a difference-in-difference model with country and cycle (year) fixed effects (see Equation 1). Standard errors have been clustered at the country-level and appear in parentheses below the estimates. Control variables include student age and gender along with student-reported number of books in the home and whether a PC was available in the home. Missing values in covariates have been treated as a separate category. All country-cycles have been weighted so that they contribute equally to the estimates.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Panels (b) and (c) of Table 2 show the estimated survey mode effects on response rates to the teacher and school questionnaires. These results show quite a different pattern compared to the home questionnaire. The online survey mode still appears to be significantly associated with declines in survey response for both teachers and principals, however, those declines are much smaller compared to those observed with the home questionnaire. In the model where paper and online modes are compared (i.e., no mixed mode), estimates indicate that the online mode is associated with a 2-4 percentage point decline in survey response. When the mixed mode is treated as a different category, declines associated with

the fully online survey mode range from 3-4 percentage points with the countries using mixed mode experiencing a similar pattern.

Estimated heterogeneity in mode effects Table 3 shows estimates of how the survey mode effects on response rates vary by student characteristics. Three student characteristics are examined: achievement, gender, and number of books in the home. The “Paper” and “Online” columns show the difference in response rate for the comparison shown in the “Contrast” column under the paper and online survey modes, respectively (e.g., for the home questionnaire, the gender row shows the response rate on the home questionnaire for parents of girls minus the response rate on the home questionnaire for parents of boys). The last column shows whether there are differences by mode (“Paper” column minus “Online” column). Note that the models presented here use the definition of survey mode that can only take one of two values: paper or online.

Panel (a) of Table 3 shows the results of the analysis for the home questionnaire. The estimates point to evidence of small biases in the returned home questionnaires. Specifically, students who score higher on the TIMSS/PIRLS assessments, girls, and those with more books in the home are significantly more likely to have their home questionnaire returned. These differences were similar across survey modes. The results for the teacher and school questionnaire (panels (b) and (c), respectively) show different patterns. Overall, the response to these surveys does not appear to be significantly related to classroom- and school-level aggregates of student characteristics. One significant estimate is found indicating that teachers of higher achieving classes are more likely to return a paper survey. Furthermore, similar patterns are observed across survey modes with no significant difference observed (i.e., survey mode does not lead to the emergence of any bias in the respondents based on classroom- or school-level aggregates of student characteristics).

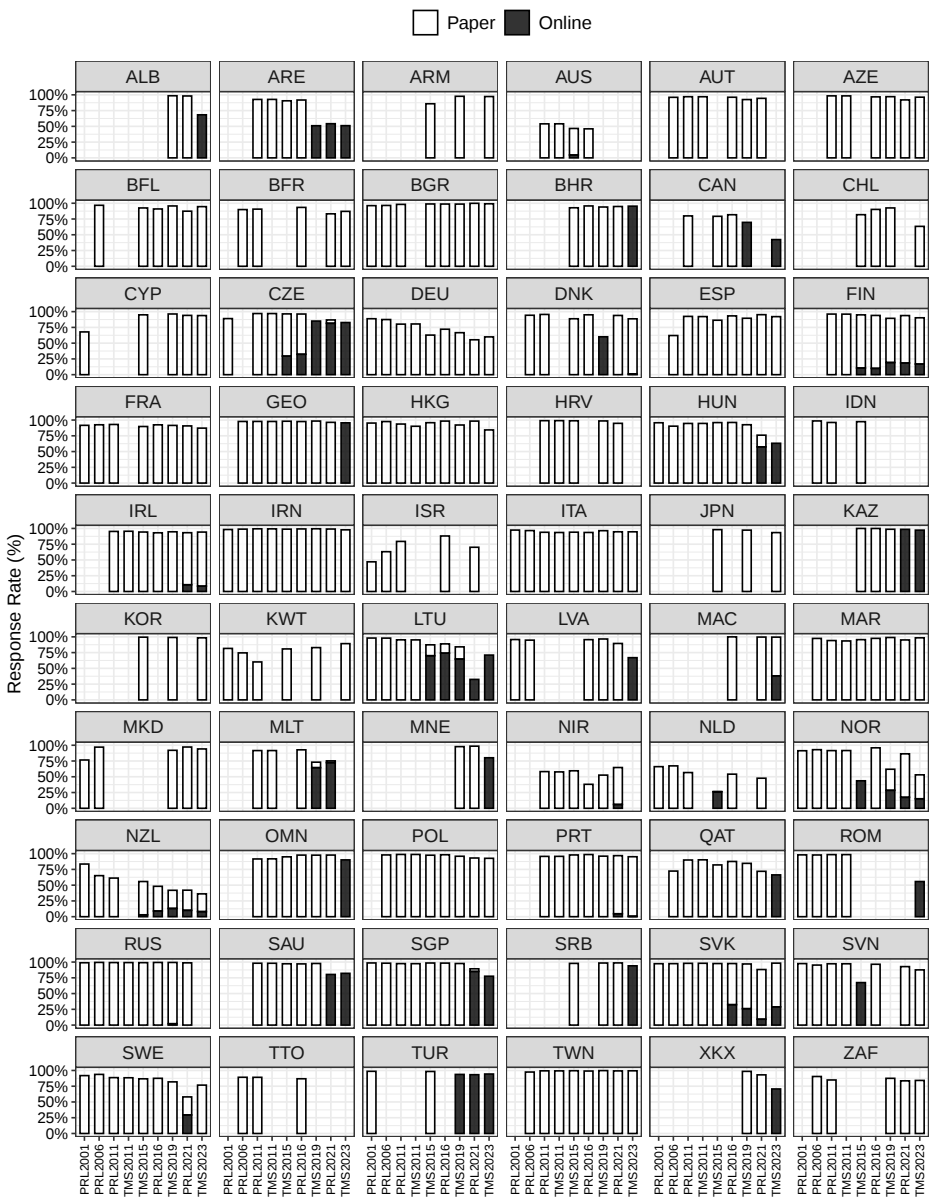
Table 3. Estimated heterogeneity in survey mode effects on context questionnaire response rates by student characteristics

Student Characteristic	Contrast	Paper	Online	Difference (Paper - Online)
<i>(a) Home Questionnaire</i>				
N = 2,194,609; N Paper = 1,906,193; N Online = 288,416; N Countries = 79; N Cycles = 9				
Achievement	+75 pts	0.026*** (0.004)	0.036*** (0.009)	-0.010 (0.009)
Gender	Girl - Boy	0.021*** (0.002)	0.017** (0.006)	0.004 (0.006)
Books in the home	26 or more - <26 books	0.022*** (0.006)	0.041** (0.014)	-0.019 (0.014)
<i>(b) Teacher Questionnaire</i>				
N = 163,873; N Paper = 111,512; N Online = 52,361; N Countries = 86; N Cycles = 11				
Average Achievement	+75 pts	0.007* (0.003)	0.006 (0.006)	0.001 (0.007)
% Female	+25%	0.041 (0.063)	-0.048 (0.213)	0.089 (0.230)
% >26 books in home	+25%	-0.099 (0.171)	-0.093 (0.267)	-0.005 (0.353)
<i>(c) School Questionnaire</i>				
N = 95,000; N Paper = 67,647; N Online = 27,353; N Countries = 85; N Cycles = 11				
Average Achievement	+75 pts	0.004 (0.003)	0.002 (0.006)	0.002 (0.007)
% Female	+25%	0.174 (0.111)	0.132 (0.261)	0.042 (0.265)
% >26 books in home	+25%	-0.061 (0.227)	-0.113 (0.375)	0.053 (0.517)

Note. Results are from a difference-in-difference model with country and cycle (year) fixed effects (see Equation 2). Standard errors have been clustered at the country-level and appear in parentheses below the estimates. The column “Paper” and “Online” show the estimated difference in response rate described by the contrast under the paper and online survey modes, respectively. The “Difference” column is the “Paper” column minus the “Online” column. Inconsistencies may appear due to rounding. Missing values in student characteristics have been treated as a separate category. All country-cycles have been weighted so that they contribute equally to the estimates.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$

Figure 1. Trends in home questionnaire response rates by country and survey administration mode



Note. Only countries that participated in at least one cycle since TIMSS 2015 (first cycle online option was available for home questionnaire) plus had data on at least three cycles were included in the figure. ALB = Albania, ARE = United Arab Emirates, ARM = Armenia, AUS = Australia, AUT = Austria, AZE = Azerbaijan, BFL = Belgium (Flemish), BFR = Belgium (French), BGR = Bulgaria, BHR = Bahrain, CAN = Canada, CHL = Chile, CYP = Cyprus, CZE = Czech Republic, DEU = Germany, DNK = Denmark, ESP = Spain, FIN = Finland, FRA = France, GEO = Georgia, HKG = Hong Kong SAR, HRV = Croatia, HUN = Hungary, IDN = Indonesia, IRL = Ireland, IRN = Iran, Islamic Rep. Of, ISR = Israel, ITA = Italy, JPN = Japan, KAZ = Kazakhstan, KOR = Korea, Rep. Of, KWT = Kuwait, LTU = Lithuania, LVA = Latvia, MAC = Macao SAR, MAR = Morocco, MKD = North Macedonia, MLT = Malta, MNE = Montenegro, NIR = Northern Ireland, NLD = Netherlands, NOR = Norway, NZL = New Zealand, OMN = Oman, POL = Poland, PRT = Portugal, QAT = Qatar, ROM = Romania, RUS = Russian Federation, SAU = Saudi Arabia, SGP = Singapore, SRB = Serbia, SVK = Slovak Republic, SVN = Slovenia, SWE = Sweden, TTO = Trinidad and Tobago, TUR = Türkiye, TWN = Taiwan, XKX = Kosovo, ZAF = South Africa. PRL = PIRLS, TMS = TIMSS.

Follow-up Survey

The follow-up survey, completed by national research coordinators (i.e., those responsible for all study activities in their country), examined experiences in using online survey modes. For simplicity, we will refer to survey respondents as “countries” as they represent the perspective of conducting that study within their respective country. A summary of the findings can be found in [Table A2](#) in the [Appendix](#).

Considerations and challenges in online survey administration

The most frequently mentioned rationale for transitioning to online administration was cost reduction and increased efficiency, a topic raised by 17 of 26 countries. In particular, several countries mentioned that costs necessary for paper surveys (e.g., printing, data entry, data cleaning) were eliminated or substantially reduced in the online mode. Furthermore, some countries noted the benefit of eliminating the need for school-based distribution, which was also seen as reducing the burden on teachers. Half of countries cited improved accessibility and greater convenience as a major factor in choosing the online survey mode.

In slightly less than half of the responding countries, concerns related to data security and compliance with GDPR were mentioned. The same number of countries expressed a broader narrative about modernization of the studies—summed up by one respondent’s remark that: “we need to keep up with the times.” Expected improvement in data quality due to, for example, fewer errors related to data entry, were mentioned by only a few respondents.

The main challenges identified by countries expected to negatively affect response rates could be grouped into three categories. First, half of the countries reported that parents experienced technical issues that were attributed to the online survey system. These included issues such as limited mobile device compatibility and log-in problems that disrupted

access to the survey. Second, half of the responding countries identified technological barriers on the respondent side, such as limited internet access and low levels of digital literacy, particularly in rural areas, as an obstacle. Third, the ability to monitor responses from parents was described as problematic in answers from one third of the countries. When countries are using a paper survey, manuals sent to school coordinators advise that they make a follow-up telephone call or send an email to remind and encourage parents to submit their completed survey if the home questionnaire is not returned within a week. Digital systems offered updated monitoring for countries when digital questionnaires were used but fewer possibilities for targeted follow-up. Legal restrictions, in some countries, on sharing individual response data with schools or teachers meant that they could only send general reminders through schools, directed at both respondents and non-respondents. This is illustrated in the following response:

It became problematic in terms of following the flow of the data gathering and following up on non-participation at the class level, whereas it was the teacher who had the direct contact with parents on the educational management systems, but we could not provide them with concrete insights on who had answered or not due to GDPR, and we could neither contact the parents directly.

This was an issue in countries that used both paper and online survey modes as well, as schools had no insight in online response rates, and the NRC had no information on the number of paper questionnaires received.

Strategies to increase online survey responses Four key strategies aimed at increasing parental response rates were identified. First, almost all countries emphasized the importance of monitoring response rates and using available channels (e.g., through local school coordinators) to issue

targeted reminders based on the most accurate and timely information available about non-response.

Second, from a little more than half of the countries it was recommended that schools actively support parents in completing the survey. This included providing access to devices and technical assistance. Thus, the responses highlighted the value of offering specific time slots for parents to receive help with “internet access, devices, and technical instruction,” a more prominent suggestion in countries where digital access and skills were perceived to vary significantly across different areas.

Third, more than one third of the countries recommended enhancing study legitimacy to encourage participation. Countries suggested that clearer messaging about the relevance and importance of the study could help foster trust and engagement among parents.

Fourth, using multiple survey delivery modes—such as various communication channels or both paper and online options—was viewed as a promising strategy by slightly more than one third of the countries. Sending links via text or school portals or QR codes through paper brochures were some examples used to share access information to the online survey. Mixed modes were seen as particularly useful in contexts with limited digital infrastructure. Countries noted that in cycles in which they used mixed modes, many parents continued to prefer the paper version, which is consistent with the analysis of mode-related drops in response rates, showing a smaller decrease in responses using a mixed mode rather than a fully digital mode.

Comparisons to teacher and school questionnaires Countries identified three key factors that potentially explain why response rates for teacher and school questionnaires experienced substantially smaller drops following the transition to online administration. First, the ability to monitor and communicate directly with school coordinators was stressed as a major advantage in around two-thirds of the countries, enabling

more consistent and direct follow-up and reminders. Second, teachers and principals were perceived as more invested in the study's objectives, as the survey topics were directly relevant to their professional roles. Third, their high level of digital competence was expected to reduce barriers to participation. All differences indicated that the teacher and principal questionnaires did not encounter the same challenges experienced in administering the home questionnaire.

Discussion

Summary of findings

This study provides evidence that survey mode affects response rates. Exploiting within-country changes in administration mode across survey cycles of two large international surveys, we find large declines in parent response to home questionnaires when surveys move online (17 percentage points in paper versus online contrasts; 20 percentage points for online-only when distinguishing mixed modes). In contrast, teacher and principal response rates decline only modestly (3-4 percentage points). The respondent-group asymmetry is central to our findings as it implies that digitization of the survey does not uniformly depress participation, but rather interacts with the social and infrastructural conditions under which different respondent groups are contacted and complete questionnaires. No differences in survey mode effects were found by student background.

These results confirm a broad conclusion from prior empirical research and meta-analyses that online surveys tend to yield lower response rates than paper surveys (e.g., Daikeler et al., 2020, 2022; Manfreda et al., 2008). At the same time, our findings contribute to this literature in several ways. First, the magnitude of the online disadvantage for parents in school-based parent surveys appears larger than average differences reported in general comparisons of online versus paper modes (see

findings from meta-analyses mentioned above). Second, for educators the survey mode effect on response rates is comparatively small, suggesting that mode disadvantages are not universal but depend strongly on respondent role and context, consistent with evidence from the business sector that response patterns differ by population and setting (Anseel et al., 2010).

Another unique contribution of this study is that it brings unusually strong external validity and statistical power to the survey mode debate by analyzing data from a very large, cross-national, multi-cycle survey study spanning roughly two decades and covering 86 education systems. Whereas much of the existing evidence comes from non-random samples from single-country studies or specific panels, our design leverages the large-scale institutional setting of TIMSS and PIRLS to strengthen generalizability.

Finally, our study contributes to the literature by exploring the potential mechanisms behind the drop in response rates on online surveys. We use our quantitative findings alongside information provided by national research coordinators, those in charge of overseeing the data collection in their country, to understand the challenges and promises of online survey data collection. We elaborate on some of the potential mechanisms below.

Potential mechanism 1: Social control One possible mechanism emphasizes that mode transitions restructure the social situation of participation. Survey methodology theories stress that participation depends on perceived costs and benefits, legitimacy, and the effectiveness of contact and follow-up (e.g. Dillman, 2020). In school-mediated paper workflows, parent questionnaires are often distributed and collected via teachers and students, which can create local visibility and a sense that returning the questionnaire is socially expected. Different sociological and social-psychological accounts agree that norms, accountability, and the expectation of having to justify actions can shape compliance (Ajzen

& Fishbein, 1980; Coleman, 1990; Hechter, 1987; Lerner & Tetlock, 1999). Under online administration, participation may become less locally observable and sponsorship may feel more distant, potentially reducing the perceived obligation to respond.

Crucially, this social-control account is respondent-group specific in our study, which aligns with our results. For parent questionnaires, both modes typically involve a school-mediated workflow, but paper administration allows teachers to see which students have returned the parent questionnaire, visibility that is absent in the online mode. Teacher and principal questionnaires, by contrast, are usually returned directly as part of professional routines, and neither paper nor online administration requires comparable social monitoring. Such hypotheses were confirmed by country responses to our follow-up survey, highlighting that teachers and principals communicated directly with school coordinators who offer reminders and follow up when surveys (online or paper) have not been returned. This fits the pattern of large mode effects for parents but modest effects for educators.

Furthermore, almost all countries responding to our follow-up survey identified improved follow-up and more direct monitoring as essential strategies for increasing response rates to online home surveys. This strategy is consistent with the social control mechanism as such measures make it possible to track survey completion and to conduct targeted follow-up through trusted sources.

Potential mechanism II: Technological barriers A second explanation relates to the concept of the *digital divide*, which emphasizes that, even in an overall increasingly digital world, there remain individual differences in access to, use of, and skills with digital media (Van Dijk, 2020). Unlike paper surveys, online survey completion requires devices, connectivity, and digital skills, and these prerequisites are likely more unevenly distributed among parents than among educators. Prior research

shows individual prerequisites can affect response behavior and response quality in web surveys (Fan & Yan, 2010). More generally, although societal digitalization is clearly advancing, it remains plausible that not all individuals keep pace with this development to the same extent.

In the international large-scale survey setting, teachers and principals are plausibly better positioned to complete online surveys: they are embedded in professional environments where digital tools are increasingly part of everyday work, and they represent a more educationally selected group. Such observations were made by respondents to our follow-up survey. Parents, in contrast, constitute a socially diverse group with heterogeneous educational backgrounds and potentially greater variance in device access and digital skills. This interpretation is consistent with our empirical asymmetry, large mode effects for parents but modest effects for educators.

A majority of country respondents to our follow-up survey mentioned national and school support in providing access to technology and providing technical assistance as important and proven strategies for improving response rates to online home surveys. School events or hotlines were brought up as examples of this in action in some countries. Such supports directly address the technological barriers that arise in the administration of online surveys.

Limitations and future research

The purpose of this study is to estimate the effect of administration mode on response rates to international large-scale surveys. The evidence supports a robust conclusion: transitions to online administration are associated with response declines for parents and smaller declines for teachers and principals. However, we do not provide direct evidence on the mechanisms generating these effects. While our interpretation is grounded in established theory and supported by our quantitative findings and

follow-up survey, the discussion of potential mechanisms should be read as plausible and hypothesis-generating rather than as tested mediation.

While our design strengthens causal inference relative to purely cross-sectional comparisons, it remains quasi-experimental (Angrist & Pischke, 2009), and we do not directly measure mediators such as device access, digital skills, or perceived accountability. Future work should combine mode transitions with respondent-level indicators, process data, and systematic documentation of implementation practices to test mechanism hypotheses more directly (e.g., device and usability effects, contact strategies, monitoring intensity). In addition, future research may examine whether changes in survey mode affect not only response rates but also data quality. While we try to assess the extent of the effect of survey mode administration on sample bias, we are limited by the characteristics available to us.

Implications for international survey design and survey mode-effect research

For TIMSS and PIRLS (and similar international surveys), the results imply that digitalization is not a simple modernization step with uniform effects. For teacher and principal instruments, online administration appears feasible with limited participation loss, consistent with early documentation of online administration for educator questionnaires in TIMSS/PIRLS (Afana, 2012). For the parent questionnaire, however, online administration presents a substantial risk to response rates, and the mixed mode offers only partial mitigation while adding complexity.

Methodologically, the study underscores the importance of treating respondent group and institutional setting as central moderators of mode effects rather than assuming average effects from general comparisons transfer directly to school-based surveys. Substantively and operationally, the findings suggest that if the goal is high parent participation, online-first

mixed-mode strategies may be insufficient; in many contexts, a paper-only approach may be the more reliable option unless digital administration is redesigned to reduce access barriers and recreate effective contact, sponsorship, and follow-up structures (Dillman, 2020).

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Appendix

Table A1. Sample sizes and participating cycles by country

CTY	Participating Cycles	Number of Questionnaires		
		Home	Teacher	School
ALB	TMS2019, PRL2021, TMS2023	11,013	554	452
ARE	PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	155,110	10,317	4,049
ARG	PRL2001	3,300	138	138
ARM	TMS2003, TMS2007, TMS2011, TMS2015, TMS2019, TMS2023	15,638	1,931	893
AUS	TMS2003, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	24,670	4,568	2,417
AUT	PRL2006, TMS2007, PRL2011, TMS2011, PRL2016, TMS2019, PRL2021	28,035	2,100	1,173
AZE	PRL2011, TMS2011, PRL2016, TMS2019, PRL2021, TMS2023	32,268	1,841	1,085
BFL	TMS2003, PRL2006, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	29,186	2,578	1,163
BFR	PRL2006, PRL2011, PRL2016, PRL2021, TMS2023	22,056	1,421	758
BGR	PRL2001, PRL2006, PRL2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	33,507	1,799	1,217
BHR	TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	26,031	2,297	1,081
BIH	TMS2019, TMS2023	9,008	570	298
BLZ	PRL2001	2,909	139	120
BRA	PRL2021, TMS2023	27,071	1,435	983
BWA	PRL2011, TMS2011	8,395	359	298
CAN	PRL2011, TMS2015, PRL2016, TMS2019, TMS2023	81,103	5,594	3,841
CHL	TMS2011, TMS2015, PRL2016, TMS2019, TMS2023	17,761	1,140	880
COL	PRL2001, TMS2007, PRL2011	9,097	596	439
CYP	PRL2001, TMS2003, TMS2015, TMS2019, PRL2021, TMS2023	20,606	2,063	907
CZE	PRL2001, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	41,030	2,660	1,498
DEU	PRL2001, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	43,924	3,192	2,353
DNK	PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	29,027	2,523	1,629
DZA	TMS2007		149	149
EGY	PRL2021	7,979	192	192
ENG	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	11,198	2,444	1,548
ESP	PRL2006, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	67,538	3,998	3,079
FIN	PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	36,740	2,585	1,146
FRA	PRL2001, PRL2006, PRL2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	36,284	2,432	1,313
GEO	PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	37,096	2,602	1,492
GRC	PRL2001	2,494	145	145
HKG	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	35,482	2,505	1,509
HND	PRL2011, TMS2011	7,812	360	294
HRV	PRL2011, TMS2011, TMS2015, TMS2019, PRL2021	20,878	1,335	773
HUN	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	43,925	2,695	1,717
IDN	PRL2006, PRL2011, TMS2015	13,590	754	556
IRL	PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	32,030	1,344	1,049
IRN	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	50,677	2,669	2,488
ISL	PRL2001, PRL2006	7,349	483	261
ISR	PRL2001, PRL2006, PRL2011, PRL2016, PRL2021	20,998	828	801
ITA	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	37,419	2,875	1,870
JOR	PRL2021, TMS2023	12,215	643	440
JPN	TMS2003, TMS2007, TMS2011, TMS2015, TMS2019, TMS2023	12,454	1,531	883
KAZ	TMS2007, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	27,949	1,779	1,253
KOR	TMS2011, TMS2015, TMS2019, TMS2023	12,917	867	606
KWT	PRL2001, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, TMS2019, TMS2023	26,963	2,611	1,195
LTU	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	38,347	3,045	1,916
LUX	PRL2006	5,101	363	
LVA	PRL2001, TMS2003, PRL2006, TMS2007, PRL2016, TMS2019, PRL2021, TMS2023	24,487	2,181	1,187
MAC	PRL2016, PRL2021, TMS2023	14,665	971	179
MAR	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	52,038	4,008	2,745
MDA	PRL2001, TMS2003, PRL2006	7,569	505	451
MKD	PRL2001, PRL2006, TMS2019, PRL2021, TMS2023	18,545	1,053	732
MLT	PRL2011, TMS2011, PRL2016, TMS2019, PRL2021	17,512	1,238	463
MNE	TMS2019, PRL2021, TMS2023	13,982	1,055	421
MNG	TMS2007		153	149
NIR	PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021	21,513	1,051	801
NLD	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	25,297	2,225	1,438
NOR	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	36,802	3,139	1,552
NZL	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	41,879	5,578	2,071
OMN	PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	59,347	3,035	1,923
PAK	TMS2019	3,980	249	139
PHL	TMS2003, TMS2019	5,515	432	315
POL	PRL2006, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	37,773	2,832	1,195
PRT	PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	33,087	2,138	1,271
QAT	PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	45,791	3,414	1,772
ROM	PRL2001, PRL2006, PRL2011, TMS2011, TMS2023	20,795	1,285	716
RUS	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021	36,478	2,203	2,071
SAU	PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	33,846	2,249	1,309
SCO	PRL2001, TMS2003, PRL2006, TMS2007	6,492	842	512
SGP	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	58,367	4,749	1,992
SLV	TMS2007		164	148
SRB	TMS2011, TMS2015, TMS2019, PRL2021, TMS2023	16,802	1,059	808
SVK	PRL2001, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	45,533	3,284	1,801
SVN	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, PRL2021, TMS2023	36,093	2,518	1,622
SWE	PRL2001, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	42,669	3,136	1,501
THA	TMS2011		168	168
TTO	PRL2006, PRL2011, PRL2016	12,076	584	447
TUN	TMS2003, TMS2007, TMS2011		754	522
TUR	PRL2001, TMS2011, TMS2015, TMS2019, PRL2021, TMS2023	26,182	1,639	1,166
TWN	TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	36,411	2,912	1,611
UKR	TMS2007		192	144
USA	PRL2001, TMS2003, PRL2006, TMS2007, PRL2011, TMS2011, TMS2015, PRL2016, TMS2019, PRL2021, TMS2023	10,029	5,705	2,616
UZB	PRL2021, TMS2023	10,303	447	346
XKX	TMS2019, PRL2021, TMS2023	13,662	682	447
YEM	TMS2003, TMS2007, TMS2011		934	510
ZAF	PRL2006, PRL2011, TMS2019, PRL2021, TMS2023	52,909	2,061	1,392

Note. PRL = PIRLS, TMS = TIMSS. Home questionnaires were not administered in TMS2003 and TMS2007.

Country abbreviations are based on ISO 3166-1 alpha-3 codes: <https://www.iban.com/country-codes>.

Figure A1. Follow-up national research coordinator survey (page 1)

About the survey

The questions below pertain to the PIRLS and TIMSS studies in your country, specifically for the home (parent) questionnaire. The survey does not ask for personal data about you as an individual. Please answer the questions in the following questions without providing any personal information.

Survey Content

Since PIRLS 2016, an online home (parent) questionnaire survey-option has been used in PIRLS (2016, 2021) and TIMSS (2019, 2023). On average, transitioning from paper to digital survey administration was associated with an approximately 20% drop in response rates to the home (parent) questionnaire (Authors, 2025).

In your country, the response rate was <response rate in online/mixed cycle> in <cycle w/ online mixed mode> using the <online/mixed> survey administration mode compared to <response rate for country in most recent paper round> in the most recent paper round.

What were **the reasons** for your country’s switch from paper to digital surveys in the home (parent) questionnaire?

Were GDPR considerations part of the decision?

Regarding the home (parent) questionnaire, what were some **problems or challenges** experienced in the switch from paper to digital surveys?

Based on your country’s experiences, can you recommend **successful strategies** that you used to ensure high response rates to the home (parent) questionnaire?

Figure A1. Follow-up national research coordinator survey (page 2)

Did your country use any **follow-up strategies** to ensure high response rates to the home (parent) questionnaire? If yes, which?

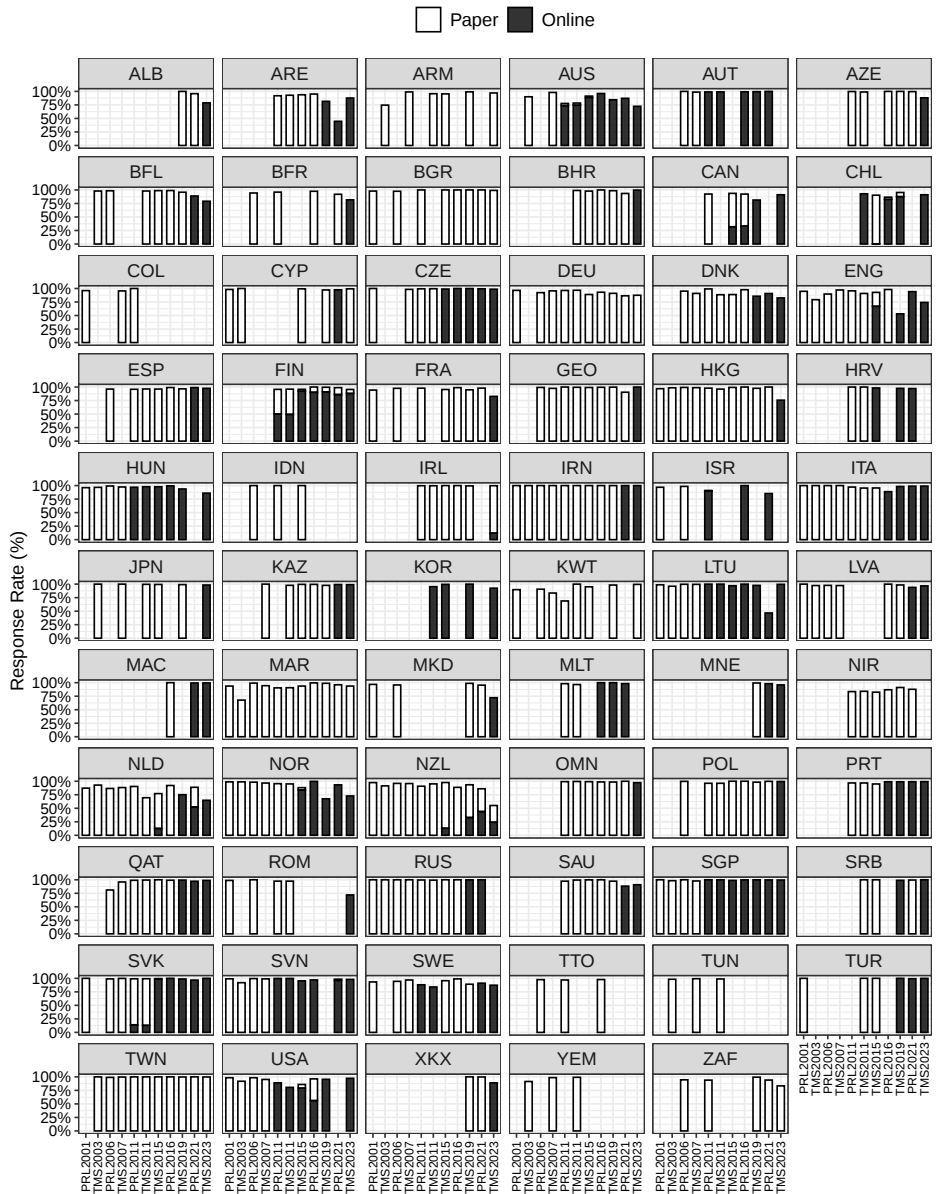
Your country used a **mixed survey format**, i.e. you administered the home (parent) questionnaire both on paper and digital surveys. Please explain your process in distributing both paper and digital home (parent) questionnaires to respondents.

The **teacher and school questionnaires** have also changed to a digital format with a smaller decline in response rates than in the home (parent) questionnaire. What could be the explanation for this in your country?

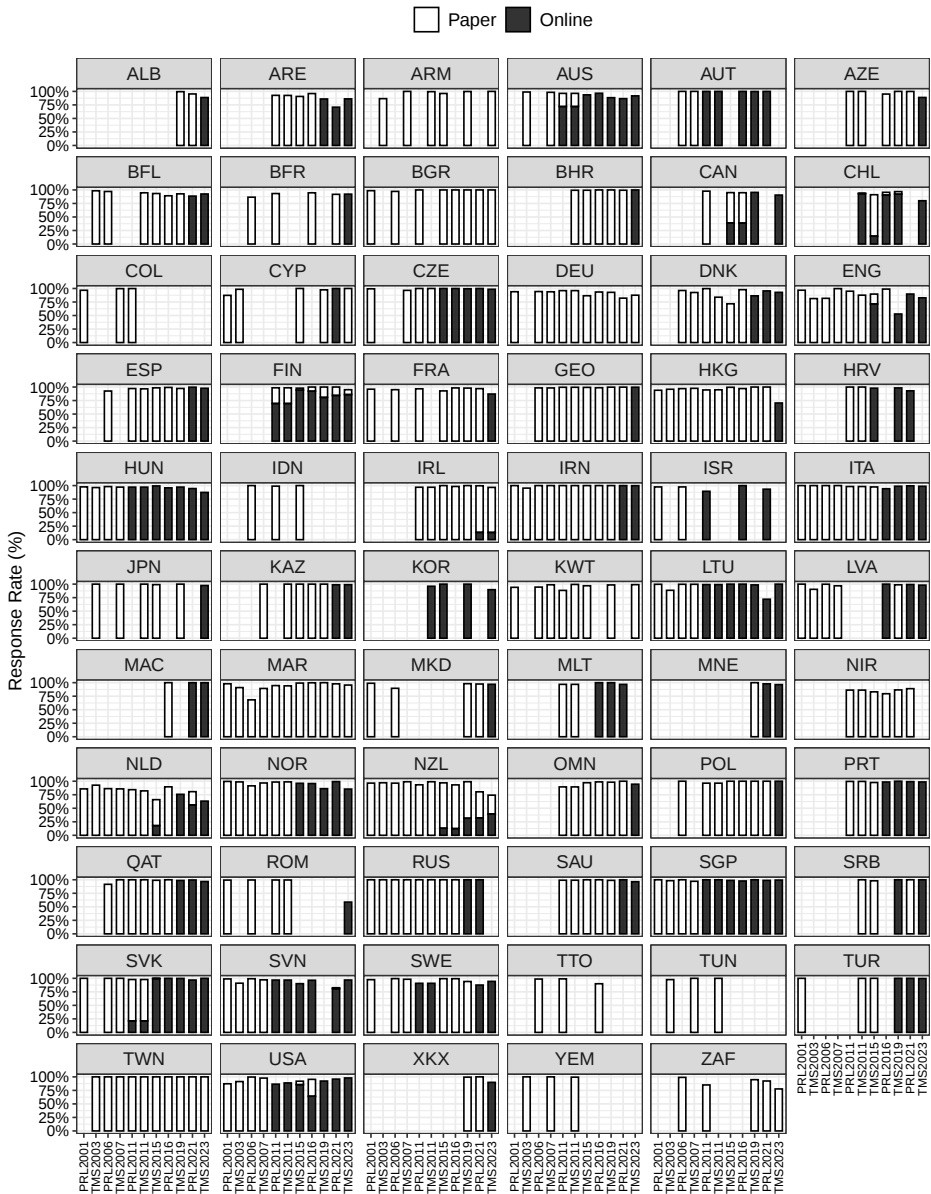
Thank you for your answers.

Your responses will be helpful in understanding the differences in response rates between paper and digital surveys, as well as understanding how to improve the use of digital or mixed survey administration formats to achieve high response rates to ILSA context questionnaires.

Figure A2. Trends in teacher questionnaire response rates by country and survey administration mode



Note. Only countries that participated in at least one cycle since PIRLS/TIMSS 2011 (first cycle online option was available for teacher questionnaire) plus had data on at least three cycles were included in the figure. ALB = Albania, ARE = United Arab Emirates, ARM = Armenia, AUS = Australia, AUT = Austria, AZE = Azerbaijan, BFL = Belgium (Flemish), BFR = Belgium (French), BGR = Bulgaria, BHR = Bahrain, CAN = Canada, CHL = Chile, CYP = Cyprus, CZE = Czech Republic, DEU = Germany, DNK = Denmark, ENG = England, ESP = Spain, FIN = Finland, FRA = France, GEO = Georgia, HKG = Hong Kong SAR, HRV = Croatia, HUN = Hungary, IDN = Indonesia, IRL = Ireland, IRN = Iran, Islamic Rep. Of, ISR = Israel, ITA = Italy, JPN = Japan, KAZ = Kazakhstan, KOR = Korea, Rep. of, KWT = Kuwait, LTU = Lithuania, LVA = Latvia, MAC = Macao SAR, MAR = Morocco, MKD = North Macedonia, MLT = Malta, MNE = Montenegro, NIR = Northern Ireland, NLD = Netherlands, NOR = Norway, NZL = New Zealand, OMN = Oman, POL = Poland, PRT = Portugal, QAT = Qatar, ROM = Romania, RUS = Russian Federation, SAU = Saudi Arabia, SGP = Singapore, SRB = Serbia, SVK = Slovak Republic, SVN = Slovenia, SWE = Sweden, TTO = Trinidad and Tobago, TUR = Türkiye, TWN = Taiwan, USA = United States, XKX = Kosovo, ZAF = South Africa. PRL = PIRLS, TMS = TIMSS.

Figure A3. Trends in school questionnaire response rates by country and survey administration mode

Note. Only countries that participated in at least one cycle since PIRLS/TIMSS 2011 (first cycle online option was available for school questionnaire) plus had data on at least three cycles were included in the figure. ALB = Albania, ARE = United Arab Emirates, ARM = Armenia, AUS = Australia, AUT = Austria, AZE = Azerbaijan, BFL = Belgium (Flemish), BFR = Belgium (French), BGR = Bulgaria, BHR = Bahrain, CAN = Canada, CHL = Chile, CYP = Cyprus, CZE = Czech Republic, DEU = Germany, DNK = Denmark, ENG = England, ESP = Spain, FIN = Finland, FRA = France, GEO = Georgia, HKG = Hong Kong SAR, HRV = Croatia, HUN = Hungary, IDN = Indonesia, IRL = Ireland, IRN = Iran, ISR = Israel, ITA = Italy, JPN = Japan, KAZ = Kazakhstan, KOR = Korea, Rep. of, KWT = Kuwait, LTU = Lithuania, LVA = Latvia, MAC = Macao SAR, MAR = Morocco, MKD = North Macedonia, MLT = Malta, MNE = Montenegro, NIR = Northern Ireland, NLD = Netherlands, NOR = Norway, NZL = New Zealand, OMN = Oman, POL = Poland, PRT = Portugal, QAT = Qatar, ROM = Romania, RUS = Russian Federation, SAU = Saudi Arabia, SGP = Singapore, SRB = Serbia, SVK = Slovak Republic, SVN = Slovenia, SWE = Sweden, TTO = Trinidad and Tobago, TUR = Türkiye, TWN = Taiwan, USA = United States, XKX = Kosovo, ZAF = South Africa. PRL = PIRLS, TMS = TIMSS.

Table A2. Summary of themes identified from follow-up survey responses

Theme	Description	Representative quotation	# CTY (of 26)
What were the reasons for your country's switch from paper to digital surveys in the home (parent) questionnaire?			
Efficiency and cost-savings	Expected effects on workload and costs in carrying out the study. Includes efficiency in handling the survey (e.g. distribution costs) and processing responses. Efficiency can in this regard also be less workload for NRCs or participating schools.	The paper-based version involved expenses such as printing, data entry, and data cleansing, which are no longer necessary with the digital format.	17
Easier accessibility	Expectations on the respondents' experiences of the shift in terms of ease in accessing the survey and time needed to answer and handle the response.	Parents could more easily complete the questionnaire using their mobile phones or computers, at a time and place that suited them.	13
Data security	Expected increase in data security as part of the transition to an online mode. Includes easier compliance with GDPR regulations as well as more secure handling of data and increased protection of participants anonymity.	The digital format provided a more secure way of handling and storing personal data, in line with data protection requirements.	11
Trends in digitalization	Transition from paper-based to electronic surveys is seen as part of a broader and inescapable societal shift toward digitalization, which is seen in other related surveys and experiences. Moving to online formats is seen as a natural progression of survey-handling, aligning with technological developments and common practices across sectors.	Digital assessment is the trend of the times.	10

Theme	Description	Representative quotation	# CTY (of 26)
Regarding the home (parent) questionnaire, what were some problems or challenges experienced in the switch from paper to digital surveys?			
Technological barriers (lack of access, low digital literacy)	Physical or personal hindrances in filling in the online survey, not directly re-lated to the specific survey. This includes limited internet access or low levels of digital literacy among groups in the population.	Many parents lacked sufficient digital skills or reliable access to the internet and devices, which made participation difficult, with the situation being especially pronounced in rural schools.	15
Technical system issues	Survey-specific issues, that can affect response rates. These include but are not limited to restrictions on device compatibility (e.g. that mobile devices could not be used to fill in the survey) or downtime on the online platform.	Occasional issues with the online platform, such as login problems or lack of mobile-friendly design, caused delays or confusion for some users.	12
Limited monitoring and follow-up capabilities	Changes in the possibilities of monitoring response rates on the home questionnaire. It can relate to either teachers' or school coordinators' ability to monitor responses or both, as well as NRC's ability to do so.	We asked coordinators to remind parents to answer three times during the survey period. Since neither they nor we could see exactly who had answered or not the reminders went out to all parents in a general fashion.	9

Theme	Description	Representative quotation	# CTY (of 26)
Based on your country’s experiences, can you recommend successful strategies that you used to ensure high response rates to the home (parent) questionnaire?			
Follow-up/ Monitoring	Suggestions for how to improve monitoring of responses or compensation for the lack of direct monitoring possibilities.	We regularly emailed School Coordinators the details of their school’s submission status, and they were also able to monitor the submission status through the online survey system monitor, allowing them to promptly follow up with parents.	25
National and school support	Suggests that schools could support parents in completing the survey, including providing access through school equipment and hosting information meetings as well as national contact to support parents (e.g., hotlines, tech support, tech availability).	In some schools in rural areas, parents were invited to a parent-teacher conference and in computer studies classrooms they would fill out their questionnaires with support of school coordinators	16
Promotions/ Campaigns	Suggestions for promoting communication about the study. This relates to in-formation on what the study is about and how it in the long run will affect schooling as well as communication about expected or previous results.	Schools...made campaigns to ensure parents awareness of the important of these surveys and assessments.	10

Theme	Description	Representative quotation	# CTY (of 26)
Multiple delivery methods	Suggestions about how to communicate to respondents on how to participate in the study, including suggestions to offer parents both a paper and online mode, and different ways of sending links for participation.	Sending the link for the survey via paper brochures with a QR code that could be scanned to go to the questionnaire link in addition to sending it to the parents through the school portal. Some schools also used SMS messages or whats app groups to send the survey link.	9
The teacher and school questionnaires have also changed to a digital format with a smaller decline in response rates than in the home (parent) questionnaire. What could be the explanation for this in your country?			
More direct monitoring	Differences in access to the two participation groups, including differences in follow-up possibilities based on response rates.	This could be because teachers complete it during their working hours. The school coordinator communicates directly with teachers, as they meet in person, can remind them, follow up, etc.	16
Technological familiarity and access	Expected differences in relation to digital literacy and online access possibilities between teachers and school principals compared to parents.	Digital Assets are available and provided to all educators in schools centrally, therefore access to digital format is available and promoted.	10

Greater commitment to the study	Teachers and school principals are expected to feel more related to the theme of the survey compared to parents.	Greater engagement and responsibility because teachers and principals are directly involved in the assessment process and understand the importance of the survey.	9
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Note. Only themes that were present in at least 5 country’s responses are included in the summary.