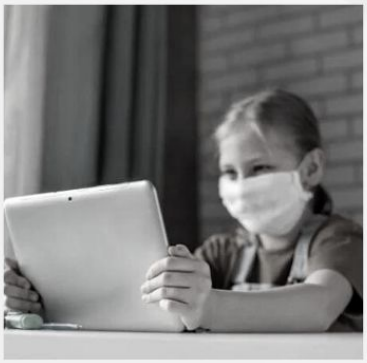
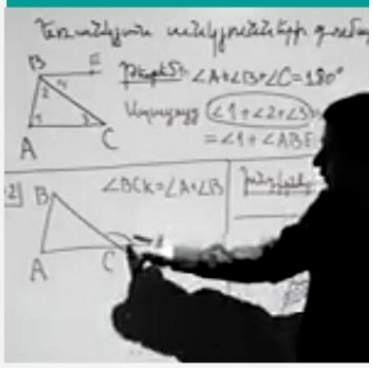
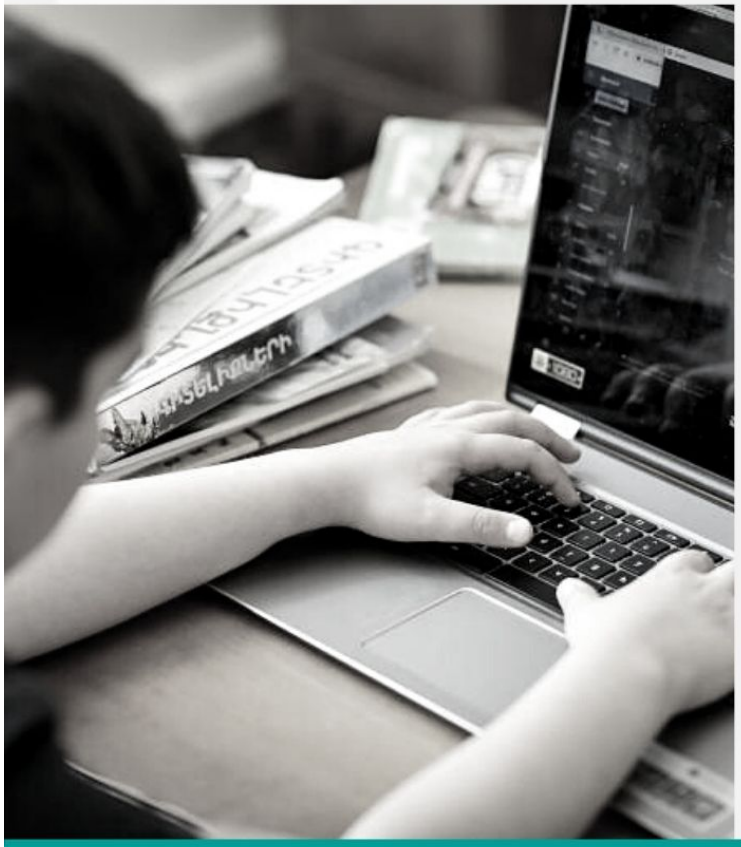
Central Bank of Armenia

Can Teachers Learn Online?

Evidence from Armenia during the COVID-19 Pandemic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Can Teachers Learn Online? – Evidence from Armenia during the COVID-19 Pandemic

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Abstract

The COVID-19 pandemic has forced a shift from traditional face-to-face instruction to online learning. We analyze how this shift has affected learning outcomes: using granular data from financial literacy - training of schoolteachers in Armenia. Our findings reveal that online training worked well for relatively simple skills (acquiring theoretical financial knowledge) but less well than in-person training for more complex tasks (i.e., learning how to teach financial literacy to students). We also found that the deterioration of training success in the online cohort is quite concentrated in some demographic groups such as older teachers, women, and social studies teachers. In addition, we show that teachers with lower initial knowledge benefit more from training.

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1 Introduction

The COVID-19 pandemic has led to a massive shutdown of in-person education across the world in an attempt to contain the spread of the virus. According to UNESCO, about 1.6 billion students in over 194 countries were affected by the pandemic at its peak in April 2020, accounting for more than 94 percent of enrolled learners globally. Much of their instruction that was originally planned for in-person delivery was being delivered online.

The sudden closure of schools reshaped the commonly held views on education settings, forcing teachers and students in various countries to adapt quickly to a new normal of online learning. To provide at least some instruction, online classes have been an important tool for sustaining education during the crisis. Nevertheless, there are well-founded concerns that remote learning has been a somewhat inadequate substitute for its conventional counterpart, especially because of the lack of social contact, and because teachers and students were not adequately prepared for the new demands.

In Armenia, the pandemic hit in the midst of the introduction of a new financial literacy program to the school curriculum as a part of the Financial Education Program. An integral component of the program is the training of teachers, which aims to equip teachers with basic financial knowledge and skills so that they can integrate the new material into the existing courses. Before each school year from 2018 to 2021, a quarter of the teachers that teaches math, and social sciences in Armenia were trained in financial literacy, as well as how to teach this knowledge to their students. We have a rich dataset, including both teachers' pre- and post-training knowledge from 2020, when the training was carried out in an online format because of the COVID-19 pandemic, and 2021, when it was switched back to a traditional in-person mode.

This natural experiment enables us to compare the effectiveness of online instruction relative to traditional face-to-face teaching, as well as test for heterogeneous treatment effects among training participants and discuss the role of baseline knowledge and confidence in the post-training performance of teachers. Our main research questions are:

(1) Did online instruction affect the learning outcomes of teachers? Note that, while many studies have analyzed the effectiveness of online instruction for student learning, to our knowledge, none have focused on how well teachers can learn new skills online.

(2) Does the effectiveness of remote training depend on the complexity of the material? The pre- and post-tests of the teachers contain sections covering both basic financial knowledge, as well as teaching techniques in order to convey this knowledge to students, with the latter arguably being more complex material.

(3) Which individual characteristics and environmental factors determine the degree to which online teaching is a successful substitute for in-person teaching? We have a large array of demographic data for all teachers.

(4) How do the gains of training correlate with the baseline performance of teachers? That is, do teachers who were already knowledgeable before the training benefit more or less than those who were less experienced?

Our empirical analysis proceeds in the following stages. First, we look at the overall effectiveness of the online training, utilizing granular data on teachers' characteristics and performance that we have collected before the training and afterward. Having rigorous evidence on the effectiveness of remote instruction is important because of its possible implications for designing and implementing tailored policies in the fields of academic and practice education. This is especially true in the post-pandemic world, when remote instruction is often cheaper to administer, while a higher level of inclusion and flexibility can be achieved when compared to traditional in-person instruction.

We find empirical support for the hypothesis that virtual training was less effective than conventional in-person training, with the overall estimated training effect decreased by about a third in the online year, relative to the in-person training. Interestingly, the effect varied substantially for different complex tasks. Specifically, remote training was essentially as effective for acquiring theoretical financial knowledge as face-to-face training. However, the effect of the training on implementation skills (that is, the ability to teach the material to students) was reduced by one-half among online learners compared to the control group of in-person learners. These results indicate that more complex competencies are more difficult to learn in an online environment.

From a policy standpoint, an interesting question is how the training effects compare among different subgroups. For instance, are there ex-ante identifiable groups for which online training is as effective as in-person training, and other groups that are much better off if they receive traditional in-person training? This can help combine the right content and technological solutions to make online learning an efficient tool for expanding access to quality education. In addition, the existence of heterogeneous effects might inform policymakers about the potential problems that particular groups face in online instruction, allowing them to design and deploy adequate measures in a timely and convenient manner.

To this end, in the second step of our analysis, we use the experiment to test for the presence of heterogeneous effects in the transition to online learning. For instance, we find that male teachers and math teachers do essentially as well in an online course as in the in-person course, while female and social studies teachers do significantly worse in the online course than in the in-person course, in particular as far as the improvement of teaching skills is concerned. While we have no causal evidence for how these differences are mediated, we interpret our results as suggestive that learners with different learning styles (e.g., abstract learners, vs. those who prefer learning with concrete scenarios and human interaction) are affected differentially by a transition to online teaching.

Third, we analyze how the initial level of teachers' financial knowledge or implementation skills affects their training success (i.e., the degree to which their performance increased after the training). This can provide valuable insights into the reasons for different gains among the training participants and allow for the administration of more targeted teaching approaches for individuals with unequal cognitive abilities. We provide evidence that teachers with poor baseline performance have benefited more from the training than those with higher

baseline scores, catching up and compensating for initial differences in their abilities. A plausible interpretation of this result is that the most efficient teachers at pretest already perform close to their ceiling and have limited room to improve. Yet, we also find that math teachers, a group with significantly higher pre-scores than other teachers, learn about as much as other teachers and so maintain their advantage over other teachers post-training.

The remainder of the paper is structured as follows. Section II presents a brief review of related literature. Section III describes the financial literacy program and data. Section IV provides information on balance tests for baseline covariate differences. Section V presents the empirical approach and key findings. Section VI concludes.

2 Literature Review

Although the pandemic has led to a substantial increase in remote instruction across the world, little is known about whether using online teaching can achieve the same learning effectiveness as traditional in-person education. This is true not only for students of educational institutions but also for adult learners.

A large number of studies agree that remote learning has been an important tool to sustain skills development during the pandemic to avoid the alternative of no schooling (Burgess, 2020; Hanushek and Woessmann, 2020; Fuchs-Schündeln et al., 2020; Clark et al., 2020; Subedi et al., 2020). Online learning was helpful, in particular, for reaching a larger number of learners with a smaller investment in education infrastructure, making it a cost-effective solution in the context of upskilling and reskilling the employees (OECD, 2020). Remote instruction has also played an instrumental role in ensuring the diverse learning needs that have emerged because of the pandemic (UNESCO, 2020). In addition, the adoption of novel technologies has enabled individuals to boost their satisfaction with the learning process through improved inquiries in respective forums, feedback on key concepts, and time management (Kumari et al., 2020).

While several studies suggest that online and traditional face-to-face education are comparable in terms of learning outcomes (Pei and Wu, 2019; Suprianto et al., 2020), remote instruction is generally considered as lacking in interactivity relative to offline education (Bali and Liu, 2018; Ocak, 2020; Poluekhtova et al., 2020). There is rich evidence that online learning suffers from a lack of two-way collaboration with instructors and classroom socialization, which deteriorates the overall performance of learners (Adnan and Anwar, 2020; Baber, 2021; Bahasoan et al., 2020; Baczek et al., 2021; Chun et al., 2021). In the present paper, we contribute to this literature by studying an environment in which there are two types of learning objectives - financial literacy skills, as well as the ability to teach these to students. These skills plausibly represent different levels of complexity, and we show that online teaching works much better for the less complex task of learning facts than for the more complex one of developing implementation skills.

The effects of online learning on different demographic groups also remain unclear. Although distance-learning arrangements seem an effective means to substitute for in-person learning in emergencies, not all learners benefit to the same degree (Tomasik et al., 2020). A general challenge faced in many developing countries is the lack of equipment and internet access (e.g., adult learners from vulnerable socio-economic backgrounds often do not own the required devices, or have to share them with other household members), which produces unequal learning opportunities (Muñoz-Najar, 2021).
Balancing training with working and caring responsibilities is also a major challenge for adult learners because they have to cope with additional problems such as the sudden shift to home-schooling for children, deteriorated learning environments, and increased distress in addition to their daily tasks (Saavedra et al., 2020). Lastly, learners lacking digital skills are often not able to successfully adapt to online learning environments (European Commission, 2020). Our data allow us to test for heterogeneous treatment effects in different demographic groups. For example, we find that men and math teachers do relatively well in online courses, while women and social studies teachers do considerably worse.
Our paper contributes to the existing literature by bringing new evidence on the effectiveness of online training for adult learners, which is yet to be investigated. It also provides valuable insights on key individual and environmental factors that affect the performance of learners and their ability to adapt. In addition, it discusses the role of teachers' baseline knowledge in their post-training scores, which can be used for evidence-based decisions and tailored policies in the fields of academic and practice education.

3 Financial Literacy Training Program and Data Description

In 2018, Armenian schools started introducing a new financial education program, covering basic financial knowledge and skills, such as proper budgeting, debt management, and long-term planning - integrated into the existing mathematics and social studies courses. The introduction to new financial education program was staggered such that every year until 2021, a quarter of Armenia's schools introduced this curriculum. Before the start of each academic year, teachers from the approximately 350 schools in the new cohort – joining the program that year - participated in a training; which had two main objectives. Foremost, the teachers had to acquire the financial knowledge and skills that they were then supposed to instruct their students, including topics such as compound interest rates, inflation, and risk diversification. Secondly, teachers had to learn methods to properly integrate the new material into their existing courses, plan lectures on different concepts and techniques to evaluate students' understanding of the financial literacy material.
To measure the success of the training in both objectives, participating teachers

received the same test, both before the training (in order to establish a baseline of their knowledge), and three months after the end of the training. The factual knowledge part of the test consists of the "Big Three Questions" from Lusardi and Mitchel (2011) that cover the concepts of compound interest, inflation, and risk diversification. We call the number of these three questions answered correctly the Financial Literacy Score (FLS). The implementation skills part of the test consists of four questions on integration, lecture planning, concept selection, and grading concepts. We call the number of questions answered correctly in this section the Teaching and Management Score (TMS). Lastly, we add up each teacher's FLS and TMS and use the term Total Score (TS) for this indicator to get an overview of the general performance of teachers in online training.

In addition to teacher performance, we also have data on an array of demographic information about each teacher, specifically gender, age, marital status, household size, family income, the percentage of family income earned by the teacher, and whether they are a math teacher. In the 2021 questionnaire, we also asked teachers to indicate the main constraints they had faced during the virtual training, such as technical problems with computer usage and internet uptake, as well as concerns regarding additional distress, household worries, working environment, and lack of social contact.

In 2018, 2019, and 2021, the training was carried out in a traditional in-person setting, while in 2020 it was switched to an online format because of the COVID-19 pandemic. Data from the before and after tests are only available for 2020 and 2021 and form the basis of this study. As we are interested in the effects of online teaching, we call the 2020 cohort the treatment group and 2021 the control group.

4 Empirical Findings

4.1 Testing for Baseline Differences

Since school participation in different cohorts was randomly assigned, we expect to observe similar covariates of participants for both years. Figure 1 uses the survey data to compare the major demographic and socio-economic characteristics of the treatment and control groups. It is evident that the distributions of most variables - gender, number of household members, marital status, household income, and share of personal contribution - are fairly similar for the two groups. A Pearson chi-square test on categorical variables and a t-test on the number of household members (see Appendix A1 for details) confirm that there is no statistically significant difference between these covariates of the 2020 (i.e., online) and 2021 (i.e., in-person) classes.

The age distributions of the two groups differ slightly, with the average age of the 2021 group exceeding the average age of the 2020 group by about 1.9 years. However, since teachers of different ages perform very similarly before the training in both years, this difference in the age distribution does not give rise to a

significant expected difference in the performance of the two groups before the training.

Figure 1: Baseline Covariates of Treatment (Online Learners) and Control (In-Person Learners) Groups. Notes: The figures display the distributions of teachers by their demographic characteristics in the years 2020 and 2021, including gender, age, marital status, size of household, monthly household income, and teachers' share in their household income.

Figure 2 compares the histograms of FLS, TMS, and TS for the pre-surveys in 2020 and 2021. It is apparent that the shapes of distributions are very similar, which suggests that participants of both years have identical baseline

knowledge. In particular, the average overall scores before the training stand at 3.24 (in 2020) and 3.18 (in 2021) out of 7, respectively. Of this, the FLS pre-scores are 1.86 (in 2020) and 1.83 (in 2021), out of 3, and the TMS scores are 1.38 and 1.35, respectively, out of 4 (see Appendix A2 for formal tests). Thus, the two groups resemble each other not only in most of their covariate distributions but also in their performance before the training.

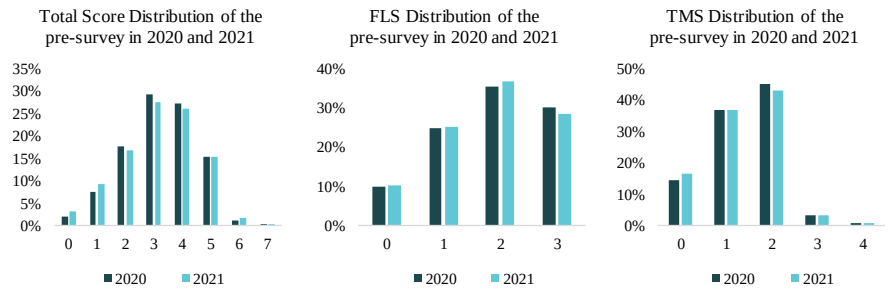

Figure 2: Performance of Online and In-Person Learners at Baseline. Notes: Bars represent the percentage of teachers by their TS, FLS, and TMS that have been recorded during the pre-test assessments in the years 2020 and 2021.

In summary, both the distribution of covariates and the distribution of pre-training scores are very similar in 2020 and 2021. Consequently, the canonical requirement for the application of DiD estimators - namely that, in the absence of the treatment, the average outcomes for the treated and control groups would have been similar (see Abadie, 2015) - is satisfied.

4.2 Main Regression Results

To assess the impact of online instruction on teachers' performance, we apply a simple difference-in-difference (DiD) approach, controlling for a number of observed covariates and a regional fixed effect for the capital city, Yerevan. The basic model estimated is

$$y_{it} = \beta_1 + \beta_2 Online_i + \beta_3 PostTraining_t + \\ + \delta(Online_i x PostTraining_t + \sum_{i=1}^{n} \gamma_i X_{it} + \epsilon_{it}$$

where y_{it} is the standardized score (FLS, TMS, or TS) of teacher i in period t, with a maximum value of 100 and minimum of 0; $Online_i$ is a binary variable that equals 1 if individual i participated in the 2020 online training and 0

otherwise; $PostTraining_t$ is a binary variable that is equal to 0 for the survey taken before the training and is 1 for the survey taken 3 months after the training. The term X_{it} represents a vector of control variables that account for key characteristics of program participants, and ϵ_{it} denotes the time-varying error component, which is assumed to be independently and identically distributed. Our principal parameter of interest is the DiD coefficient δ, which measures how the effect of training (measured by the change in teachers' performance before and after the training) differs between in-person and online trainings.

Table B1 in the appendix summarizes the regression results for TS with and without controlling for training participants' demographic characteristics (age, gender, teaching subject, family size, household income, and a dummy for Yerevan residency). Since δ is negative and statistically significant in all three specifications, we can conclude that online training was substantially less effective than the conventional face-to-face training. To gauge the size of the effect, observe that the overall effect of the training in 2021 is about 12 percentage points, and this is reduced to about 8 percentage points in the online year 2020.

Moreover, the magnitude of the estimate remains roughly the same when we control for various characteristics of teachers and regional fixed effects, implying that the estimated impact is mostly driven by instruction method and no other covariates. In addition, age, teaching subject, and household income are positively associated with the overall performance of training participants, while gender, household size, and Yerevan fixed effect appear to have no significant effect on training outcomes. Next, we separate the estimates of teachers' performance into the components of financial literacy knowledge and implementation skills components. The results in Table B2 of the appendix illustrate that, in any of the specifications, virtual training was essentially as effective for teachers in terms of acquiring substantive financial literacy information as the in-person training.

In contrast, as shown in Table B3 of the appendix, the improvement in the TMS score was significantly lower for teachers of the 2020 online cohort. While teachers in the in-person cohort improved by about 11 percentage points after the training, this improvement was reduced to 5 percentage points for the online cohort.

A plausible interpretation is that the more complex competencies on how to implement the acquired knowledge in practice are more difficult to learn in an online environment where communication between instructors and teachers is naturally limited.

4.3 Heterogeneous Treatment Effects

In order to see whether the effects of online instruction vary significantly depending on teachers' demographic covariates, we now test for the existence of heterogeneous effects for financial knowledge and implementation skills among online and in-person groups. Understanding such a relationship is critical for deciding whether online instruction is likely to work well for a particular group

of individuals. In addition, the existence of heterogeneous effects may provide hints as to the potential causes of problems for learners in online instruction. That is, if we find that a particular demographic group struggles much more than the rest, this information may be helpful for policymakers in designing targeted support for this group. Furthermore, if online instruction is cheaper to implement than in-person training, information about heterogeneous treatment effects may guide decisions about which groups can receive online training without much loss, and which groups should receive in-person training. To assess heterogeneous training effects, we estimate the conditional average treatment effects for specific subgroups, which are defined by a particular covariate of program participants in the pre-training period. An alternative technique could be the application of a triple difference (DDD) type approach and incorporation of additional treatment-by-covariate interaction terms into the equation [1]. However, since the randomization of schools was not stratified for each covariate of interest, it would be problematic to interpret the interaction terms as causal relations due to a lack of power.

For this reason, we only perform a subgroup analysis with predefined cutoffs of age (below 36, 36 - 55 or above 55), gender (male or female), family size (less or more than 3 members), household income (less than 180.000 AMD, 180.000-250.000 AMD or more than 250.000 AMD), the teacher's personal contribution to household income (less than 25%, 25-50% or more than 50%), marital status (married or single) and region (Yerevan or other regions).

Table C1 in the appendix reports the impact estimates of subgroup regressions for financial literacy and implementation skills. Several interesting patterns emerge. Firstly, it can be noticed that the effects of online training on the FLS score do not differ across various categories, implying that all the subgroups performed better when training in-person. Secondly, although the TMS has deteriorated during the online training in terms of transferring complex materials to teachers, the effects are quite heterogeneous. One interesting thing to note is that male teachers scored higher than their female counterparts did. The same was true of math teachers who outperformed the teachers of social sciences under the remote training mode. This might be related to differences in innate qualities of teachers, which is a well-documented fact in the existing empirical literature (Hussain et al., 2017; Ashong & Commander, 2012).

Another notable result is that participants under 36 years essentially perform the same in the online and in-person classes. This could be explained by the phenomenon that young people are more tech savvy than their older counterparts (Pawlowski, 2018; OECD Digital Economy Outlook, 2020; etc.), and are as such less negatively affected by the transition to online classes. This implies that developing basic digital skills for older teachers and supporting them with essential resources will be instrumental to the mainstreaming of online learning. In fact, when we asked teachers what difficulties they had faced during the online instruction, only 11.1 percent of young teachers mentioned technical issues with computer usage, compared to 21.5 percent of the middle-age group and 24.6 percent of senior teachers (see Figure 3 for details). Similarly, around 46.1 percent of young teachers had problems with internet connection, while

the figures for middle-aged and senior teachers stood at 49.5 and 52.2 percent respectively.

For older teachers, the findings are somewhat surprising, as their TMS performance did not deteriorate during the remote training, despite their technical difficulties. However, this group had the lowest level of pandemic-related stress, as well as smaller concerns regarding home worries, working environment, and social contact, which might explain their decent performance. For example, only 40 percent of senior teachers mentioned that they had worsened working conditions during the remote training, which is approximately 10 percentage points lower than the numbers reported by young and middle-aged teachers. Likewise, only 28.8 percent of senior teachers reported having additional stress during the online instruction, compared to 34 percent of the other groups. Finally, only 75 percent of senior teachers had problems due to a lack of social interaction during the remote training, while the figure for middle-aged and young teachers was nearly 82 percent.

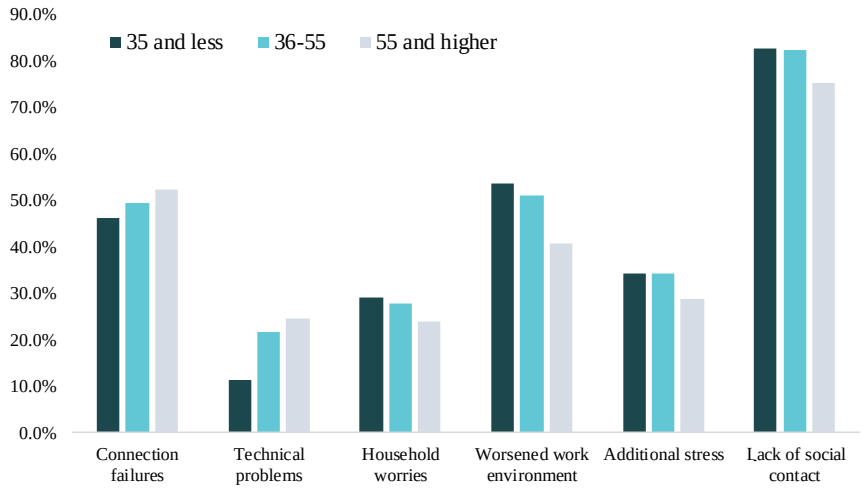

Figure 3: Common Problems Faced in the Period of Remote Instruction. Notes: Bars illustrate the proportions of teachers in each age group who have mentioned any of the six concerns as a major obstacle for online learning. The survey applies only to the 2021 cohort.

These patterns are also confirmed by the finding that unmarried teachers did as well as their counterparts in the offline group, whereas married teachers performed worse in the 2020 online cohort. The picture was much the same for participants from small families whose performance did not suffer from online training, while participants from larger families experienced a significant decline in their TMS scores. Finally, teachers who were the main household

earners scored lower in the online training than teachers who were secondary earners.

Again, these factors plausibly proxy for teachers' learning environment and workspace conditions, which worsened substantially during the pandemic due to competing needs of other household members (e.g., teleworking, homeschooling). For some teachers, balancing professional and personal responsibilities, such as their own caregiving duties and family concerns, might have been a reason for their lower TMS during the online training. They might also be correlated with pandemic-related stress and lack of in-person social contact with trainees, which could have created substantial pressure and anxiety for teachers, affecting their overall performance.

Table 5 provides additional empirical support in favor of these arguments. It shows that, among teachers who were married, had large families, or were the main earners of their household, the proportion of teachers who complained about certain issues was greater than of those teachers that were unmarried, had small families, or were not the main earners of their household.

	Worsened work environment	**Household worries**	**Additional stress**	**Lack of social contact**
Marital status				
Married	50.0	27.9	32.3	80.8
Non-married	43.1	22.5	31.6	79.0
Size of household				
Large	52.1	28.5	33.9	81.0
Small	43.7	25.2	27.9	76.1
Teachers' share in household income				
25% and less	47.7	24.6	30.4	78.7
26-50%	48.9	27.4	31.5	80.1
51% and higher	49.2	28.2	33.5	82.4

Table 1: Problems Faced by Teachers during the Remote Instruction by Marital Status, Size of Household, and Teachers' Share in Household Income (%)

4.4 Performance of Teachers Conditional on their Baseline Scores

A long-standing debate in developmental and non-developmental intelligence research deals with the issue of whether individuals with higher levels of task-

relevant cognitive resources gain more from training. While positive correlations between general ability and gains from instructions have been reported (e.g., Kliegl et al., 1990; Verhaeghen & Marcoen, 1996; Kwon & Lawson, 2000), negative correlations are also common (e.g., Gaultney et al., 1996; Traut et. al., 2021).

Clearly, there are two plausible effects that are working in different directions. On the one hand, learners who are generally smarter (or already have some experience with the subject matter) may have an easier time to implement successful learning strategies and understand the additional material that is taught during the training, than those who are less smart or less experienced. In isolation, this magnification effect leads to a positive correlation between initial score and score increase after the training.

On the other hand, there is a more or less mechanical effect, namely that low performers in the initial test can increase their score by much more than high performers. For example, a learner who answers all questions on the pre-test correctly has, by definition, zero upward potential; in contrast, a learner who answers no pre-test question correctly cannot go anywhere but up. In isolation, this compensation effect leads to a negative correlation between initial score and score increase after the training. Whether the magnification effect or the compensation effect dominate in a particular setting is, of course, an empirical matter.

We now analyze how teachers' initial financial knowledge or implementation skills of teachers affect their performance during the training. Sources of this variability are of great interest as they could provide insights into the reasons for the effectiveness of the teacher training, and allow for administration of more tailored instruction approaches.

Thus, we regress the improvement in TS, FLS, and TMS on the corresponding pre-training scores of participants, controlling for their demographic characteristics, as well as time and fixed effects. The regressions results, which are summarized in Table D1 of the appendix, show that the compensation effect considerably (and statistically significantly) outweighs the magnification effect. In other words, people who were initially behind exhibited much greater growth compared to those who initially performed relatively well.

For example, the average gain from the training was 40.8 percentage points for those who did not answer any questions correctly in the baseline assessment, while the improvement was nearly zero for teachers with five correct answers out of seven (see Figure 4). Similarly, the regression coefficient of -0.74 for the FLS indicates that a 10-point higher score in the pre-test, on average, leads to a 7.4 points lower training increase. In other words, the training closes, in expectation, about 3/4 of the initial financial literacy competency difference between different teachers.

Another interesting result is that math teachers performed better before the training than teachers of social science subjects. In particular, the average total score of math teachers was 9.5 percentage points higher in the pre-training assessment, compared to the total score of their social science counterparts. However, as can be seen in Figure 5, the average training effect (with respect

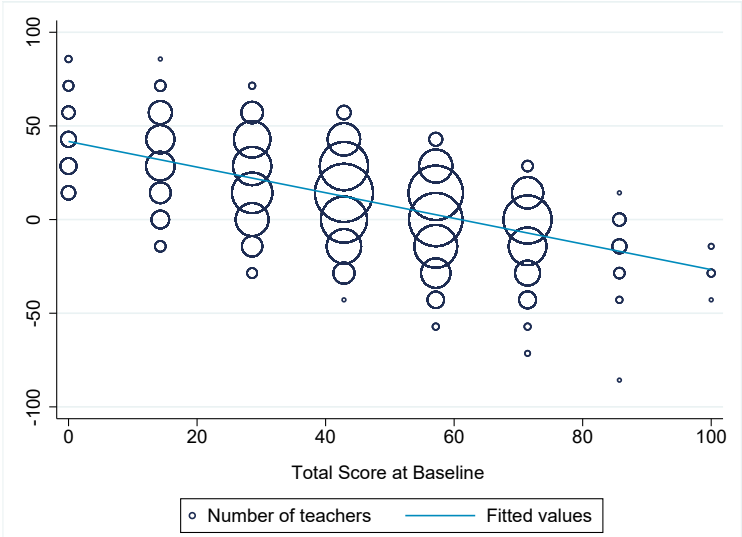

Figure 4: Training Gains Conditional on Baseline Scores (percentage points). Notes: The size of the bubbles shows the number of teachers in each group who benefited similarly during the training.

to TS) was not statistically different between the two groups. Thus, for these groups, the magnification effect and the compensation effect approximately cancel out.

Another interesting result is that math teachers performed better before the training than teachers of social science subjects. In particular, the average total score of math teachers was 9.5 percentage points higher in the pre-training assessment, compared to the total score of their social science counterparts. However, as can be seen in Figure 5, the average training effect (with respect to TS) was not statistically different between the two groups. Thus, for these groups, the magnification effect and the compensation effect approximately cancel out.

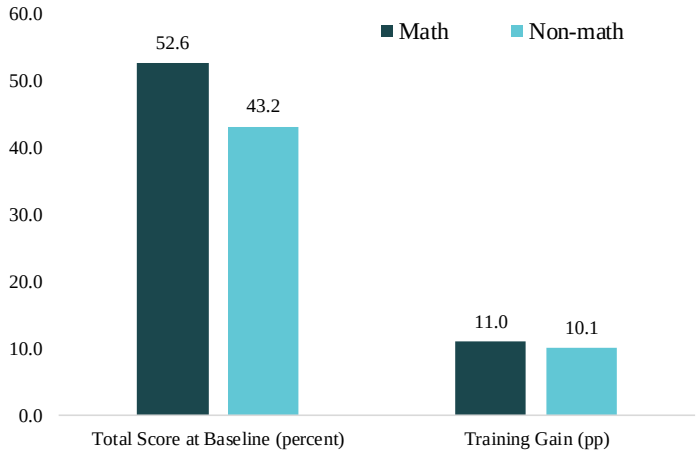

Figure 5: Training Gains for Math and Non-Math Teachers (percentage points). Notes: The baseline difference is statistically significant, while the training effect difference is not.

5 Conclusion

The COVID-19 pandemic has disrupted education in over 194 countries across the world, forcing them to implement some form of remote learning. While this was the best available option for sustaining knowledge attainment and skills development during the crisis, how successful online training is in terms of replicating the outcomes of in-person instruction is still a matter of debate. Furthermore, there is substantial uncertainty as to whether different demographic groups are affected asymmetrically by a transition to online learning. To contribute to this debate, we bring new evidence on the effectiveness of remote instruction on teachers' performance, using data from a financial education program for teachers in Armenia.

We find that, on average, online training is about one-third less effective than traditional in-person teaching. However, this average masks considerable effect heterogeneity, both in terms of the subject matter studied, and between different demographic groups. Overall, online instruction is essentially as good as in-person learning with respect to financial literacy knowledge, while it is much less effective (by about one-half) when it comes to conveying teaching skills. Furthermore, groups often associated with a more abstract learning style (men, math teachers) are significantly less negatively affected by a transition to online learning than women and social studies teachers. Our estimates are important for informing policymakers about the potential problems particular learners face in online learning, and for designing targeted policies to address them constructively.

In future research, it would be interesting to follow up on our results in order to

see whether the differential skills of teachers translate into differential learning success among their students.

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6 Appendix

6.1 Appendix A1. Comparison of Baseline Characteristics of Training Participants

	Online Learners	In-Person Learners	Difference
Gender			
Female	96.2	95.7	– 0.5
Male	3.8	4.3	0.5
			[0.23]
Age	45.3	47.2	1.9
			[0.00]
Marital status			
Married	80.6	80.3	– 0.3
Non-Married	9.6	10.1	0.5
Divorced	2.8	1.9	– 0.9
Widowed	7.1	7.7	0.6
			[0.49]
Size of household	4.55	4.60	0.06
			[0.40]
Household income			
55.000 and below	1.0	2.5	1.5
56.000 - 180.000	35.3	42.4	7.2
181.000 - 250.000	27.9	24.4	– 3.5
251.000 - 400.000	19.2	15.2	– 4.0
400.000 and high	6.8	5.6	– 1.2
N.A.	9.8	9.9	0.1
			[0.00]
Teacher's share in household income			
1-25%	27.6	33.4	5.8
26-50%	40.2	37.3	– 2.9
51-75%	13.4	12.4	– 0.5
76-99%	5.2	4.7	– 0.5
100%	3.5	3.9	0.4
N.A.	10.1	8.2	– 1.9
			[0.04]
Sample	**1,204**	**1,181**	

Parentheses and square brackets represent the p-values of t-tests and chi-square tests.

6.2 Appendix A2. Comparison of Baseline Performance of Training Participants

	Online Learners	In-Person Learners	Difference
FLS			
0	9.9	10.2	0.3
1	24.6	25.1	0.6
2	35.4	36.2	0.8
3	30.1	28.5	– 1.6
			[**0.79**]
TMS			
0	14.6	17.0	2.4
1	36.8	35.7	– 1.1
2	44.9	43.6	– 1.3
3	3.2	3.2	0.0
4	0.6	0.5	-0.1
			[**0.62**]
Total score			
0	1.9	3.4	1.5
1	7.4	9.0	1.6
2	17.7	17.4	– 0.3
3	29.1	26.5	– 2.6
4	27.2	26.1	– 1.1
5	15.3	15.7	0.4
6	1.2	1.7	0.5
7	0.3	0.2	-0.1
			[**0.20**]
Sample	**1,204**	**1,181**	

Square brackets represent the p-values of chi-square test.

6.3 Appendix B1. Regression Results for Overall Performance (Total Score) of Teachers

	Model 1	**Model 2**	**Model 3**
Online	0.92	-0.35	-0.37
	(0.80)	(0.78)	(0.63)
PostTraining	12.28***	12.26***	12.26***
	(0.80)	(0.77)	(0.77)
Online x PostTraining	-4.10***	-4.04***	-4.04***
	(1.13)	(1.09)	(1.09)
Age		-0.10***	-0.10***
		(0.02)	(0.02)
Female		-1.60	-1.49
		(1.37)	(1.37)
Math teacher		9.88***	9.87***
		(0.62)	(0.62)
Size of household		0.01	-0.03
		(0.18)	(0.18)
Household income			
56.000 - 180.000		6.93***	6.95***
		(2.10)	(2.10)
181.000 - 250.000		10.08***	10.18***
		(2.13)	(2.13)
251.000 - 400.000		12.57***	12.80***
		(2.16)	(2.17)
401.000 and higher		13.43***	13.77***
		(2.34)	(2.35)
N.A.		7.68***	7.89***
		(2.24)	(2.24)
Fixed effects for Yerevan			-1.06
			(0.67)
Constant	45.39***	40.09***	40.34***
	(0.57)	(2.87)	(2.87)
Number of observations	**4,757**	**4,744**	**4,744**

*p<0.1; **p<0.05; ***p<0.01

6.4 Appendix B2. Regression Results for Factual Knowledge (FLS) of Teachers

	Model 1	**Model 2**	**Model 3**
Online	0.91	-0.81	-0.82
	(1.23)	(1.20)	(1.20)
PostTraining	13.52***	13.53***	13.53***
	(1.25)	(1.20)	(1.20)
Online x PostTraining	-1.42	-1.35	-1.35
	(1.75)	(1.69)	(1.69)
Age		-0.02	-0.02
		(0.04)	(0.04)
Female		-5.48*	-5.42**
		(2.12)	(2.12)
Math teacher		15.43***	15.42***
		(0.97)	(0.97)
Size of household		-0.35	-0.37
		(0.27)	(0.27)
Household income			
56.000 - 180.000		6.03*	6.04*
		(3.25)	(3.25)
181.000 - 250.000		11.65***	11.71***
		(3.30)	(3.30)
251.000 - 400.000		15.10***	15.23***
		(3.36)	(3.36)
401.000 and higher		17.50***	17.69***
		(3.62)	(3.64)
N.A.		5.73*	5.85*
		(3.47)	(3.48)
Fixed effects for Yerevan			-0.60
			(1.05)
Constant	61.02***	55.38***	55.53***
	(0.88)	(4.45)	(4.45)
Number of observations	**4,770**	**4,744**	**4,744**

*p<0.1; **p<0.05; ***p<0.01

6.5 Appendix B3. Regression Results for Implementation Skills (TMS) of Teachers

	Model 1	**Model 2**	**Model 3**
Online	0.95	-0.01	-0.03
	(0.90)	(0.90)	(0.89)
PostTraining	11.37***	11.31***	11.31***
	(0.90)	(0.89)	(0.89)
Online x PostTraining	-6.13***	-6.06***	-6.06***
	(1.26)	(1.25)	(1.25)
Age		-0.16***	-0.16***
		(0.03)	(0.03)
Female		1.31	1.46
		(1.57)	(1.57)
Math teacher		5.72***	5.71***
		(0.72)	(0.72)
Size of household		0.28	0.23
		(0.20)	(0.20)
Household income			
56.000 - 180.000		7.60**	7.63**
		(2.41)	(2.41)
181.000 - 250.000		8.90***	9.03***
		(2.44)	(2.45)
251.000 - 400.000		10.68***	10.98***
		(2.49)	(2.49)
401.000 and higher		10.38***	10.83***
		(2.69)	(2.70)
N.A.		9.15***	9.42***
		(2.57)	(2.58)
Fixed effects for Yerevan			-1.41
			(0.78)
Constant	33.66***	28.62***	28.95***
	(0.64)	(2.30)	(3.30)
Number of observations	**4,757**	**4,744**	**4,744**

*p<0.1; **p<0.05; ***p<0.01

6.6 Appendix C1. Interaction Term (δ) when Estimated Separately for Different Subgroups

	FLS	TMS
Age		
35 and less	-2.95	-3.94
	(2.83)	(2.78)
35 – 55	-0.42	-7.57***
	(2.33)	(1.73)
55 and higher	-3.13	-5.00**
	(3.15)	(2.29)
Gender		
Male	-0.27	3.96
	(7.55)	(6.36)
Female	-1.45	-6.51***
	(1.73)	(1.27)
Teacher type		
Math	4.24	-2.69
	(2.75)	(2.33)
Non-math	-3.45	-7.62***
	(2.10)	(1.46)
Size of household		
Small	-2.49	-3.11
	(3.56)	(2.67)
Large	1.92	-7.40***
	(2.44)	(1.80)
Teachers' share in household income		
25% and lower	-3.37	-4.34*
	(3.14)	(2.23)
26% - 50%	-4.24	-4.62***
	(2.61)	(2.01)
51% and higher	4.05	-8.91***
	(3.11)	(2.29)
Marital status		
Married	-2.03	-6.61***
	(2.68)	(1.39)
Non-married	1.39	-3.79*
	(3.78)	(2.84)

*p<0.1; **p<0.05; ***p<0.01

6.7 Appendix D1. Performance of Teachers Conditional on their Baseline Scores

	Δ in Total Score (pp)	Δ in FLS (pp)	Δ in TMS (pp)
Baseline score	-0.75***	-0.73***	-0.92***
	(0.02)	(0.02)	(0.02)
Demographic controls	Yes	Yes	Yes
Time effects	Yes	Yes	Yes
Fixed effects for Yerevan	Yes	Yes	Yes
Constant	43.75***	58.59***	35.99***
	(4.10)	(5.66)	(4.98)
Number of observations	2,372	2,372	2,372

*p<0.1; **p<0.05; ***p<0.01