PLOS Water

RESEARCH ARTICLE

Assessing the effect of a Massive Open Online Course (MOOC) on school water, sanitation, and hygiene improvements in the Philippines

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Citation: Rahaman KS, Bick S, Marquez M, Galban D, Benzian H, Monse B, et al. (2025) Assessing the effect of a massive open online course (MOOC) on school water, sanitation, and hygiene improvements in the Philippines. PLOS Water 4(5): e0000287. https://doi.org/10.1371/journal.pwat.0000287

Editor: Dani J Barrington, The University of Western Australia, AUSTRALIA

Received: August 6, 2024

Accepted: April 28, 2025

Published: May 27, 2025

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Data availability statement: Data for this manuscript were provided by the Department of Education (DepEd), Government of Philippines. Researchers who wish to access this data are required to request data direct from the Department of Education and receive

Abstract

Improving water, sanitation, and hygiene (WASH) services in low-resources settings is a challenge. The Department of Education (DepEd) of the Philippines, supported by GIZ and UNICEF, runs the national WASH in Schools (WinS) program which promotes a stepwise approach to reach national WinS standards and foster the institutionalisation of WASH in the education sector. This includes national-level annual monitoring on WASH service levels in schools, information used to set targets and allocate resources. Since 2019, the programme has also included a Massive Open Online Course (MOOC) for school staff. This platform provides uniform implementation guidance on WinS in schools across the country. In this analysis, we use annual WASH monitoring data from 2017/2018 (baseline) and 2021/2022 (endline) and compare this against school-level information on MOOC enrolment and completion. We used logistic regression models to assess the relationship between school staff participation in the MOOC and changes in select WinS indicators as well as composite measures used to define national progress. Complete baseline and endline data were available for 27,795 schools. Of those, 5,939 schools had at least 1 teacher enrolled in the MOOC. Overall, MOOC participation was associated with improvements in school infrastructure, maintenance of existing facilities, and promotion of hygiene programmes. The MOOC is a promising key component of the national WASH strategy complementing the annual monitoring process and warrants further investigation in the school management sector.

Introduction

Adequate provision of water, sanitation, and hygiene (WASH) infrastructure and services together with improvements in WASH behaviours among school-going children

appropriate approvals. To request access to data, please contact the Assistant Secretary of Operations, Department of Education at oasops@deped.gov.ph.

Funding: Funding for this work was provided the UK Foreign and Commonwealth Development Office (FCDO) as part of the Hygiene Futures grant to LSHTM (Grant number 301186 to RD, with salary support for KSR and SB). The views expressed are those of the authors and do not necessarily reflect those of FCDO or the UK Government. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Competing interests: The authors have declared that no competing interests exist.

are associated with a range of health and educational benefits [1]. Inadequate school WASH is associated with a range of infectious diseases that affect children's overall health and can lead to reduced school attendance, reduced educational attainment, and a lower quality of life [2,3]. In contrast, evidence suggests that enhanced WASH services in schools can decrease student absence, reduce disease, and improve student well-being [1,4–6].

Many schools, particularly in low-resource settings, lack WASH facilities that meet standards of basic services as defined by the WHO/UNICEF Joint Monitoring Programme (JMP) [7]. Coverage of basic water, sanitation, and hygiene services remains low in lower-middle income countries like the Philippines, with recent global estimates suggesting 1 in every 4 schools lacks access to basic water and basic sanitation services and almost half lack access to basic hygiene services [7]. Sustained delivery, operation, and maintenance of WASH services in schools is also a challenge. Schools often lack the capacity to clean and maintain facilities and have inadequate budgets and resources. Irregular monitoring, lack of effective information-sharing systems, and weak accountability mechanisms contribute to limited service provision and poor sustainability [8–11].

Improving WinS at the national level will require training and building capacity of teachers and school officials to effectively plan, manage, and monitor school services. Individual and institutional capacity for managing WinS services has largely been under-explored in interventional studies [12] and published intervention trials typically focus on the direct provision of hard copy materials to schools to facilitate planning and monitoring of school infrastructure. More comprehensive approaches to training and building capacity of school employees to support the improvement of WinS services that can also be delivered at the national level are needed.

Massive Open Online Courses (MOOCs) may be one potential tool for delivering this training and capacity development to large numbers of learners in a low-cost, flexible manner. MOOCs are cited as a potential tool for providing consistent and unified education messaging and capacity development to a large number of learners, particularly learners who may not have time or resources to access traditional forms of education and training. In low- and middle-income countries, MOOCs are a possible approach to filling critical human resource gaps necessary for continued professional education and capacity building, particularly among health professionals [13]. Published analyses of MOOCs specific to the WASH sector are limited [14,15], with available studies focusing on reach, learner retention, and learner satisfaction. To our knowledge, there have been no studies evaluating the association between MOOCs or other large-scale digital capacity development interventions and WASH service outcomes in domestic or institutional contexts.

As part of a large, national WinS strategy, the Department of Education in the Philippines (DepEd) together with development partners has offered a MOOC targeted at teachers and school staff to help individuals plan, manage, and maintain WinS services at their associated schools (see methods for further details). Combining information on MOOC enrolment and participation with a national database of school-level WASH services and practices provides a unique opportunity to explore

the association between MOOC participation and WinS service outcomes. The objective of our current analysis was to explore the relationship between WinS services outcomes at two-time points – the 2017/2018 academic year and the 2021/2022 academic year – and school-level information on MOOC participation in the Philippines. As a secondary objective, we explore if service delivery outcomes differ by level of MOOC engagement.

Methods

Ethics statement

Ethical approval for this secondary analysis was provided by the London School of Hygiene and Tropical Medicine ethics committee (Ethics ref no. 28381). Data on individual MOOC participation were fully anonymised before being shared with the research team; individual records were linkable only through the school-specific ID. Informed consent for this analysis was not possible and not deemed a requirement by ethical review.

The SEMEO-Innotech GIZ MOOC

The Fit for School Programme, a partnership between the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), the Southeast Asian Ministers of Education Organization (SEAMEO) and the Department of Education (DepEd) in the Philippines [16,17] has supported the design and implementation of a national WinS programme in the Philippines since 2011. This programme, based on the GIZ/UNICEF "Three Star Approach for WASH in Schools" [18], promotes a stepwise approach to reach national WinS standards and foster the institutionalisation of WASH in the education sector [19]. The programme is monitored through annual WASH surveys to be completed in the same format as DepEd's annual data collection for the Education Management Information System (EMIS). While submission of data for the EMIS is mandatory for all schools, the WinS data collection is voluntary. More information on national monitoring is provided in the Data Sources below.

To support capacity for technical management and planning of WASH services at the school level and provide uniform implementation guidance on national standards, DepEd, the GIZ Regional Fit for School programme and SEAMEO Innotech developed and launched a MOOC [20] targeting the education sector's teaching and managing workforce. The MOOC focuses on multiple aspects of WinS services, including but not limited to: requesting and accessing DepEd funding for infrastructure improvements, developing action plans for facility improvement and construction, planning for the management and on-going maintenance of WinS services, and ensuring on-going behaviour change routines aligned with DepEd standards. This digital learning platform is self-paced and caters to thousands of learners in batches. Integration of different activities (e.g., Facebook challenges, discussion forums, peer review etc.) encourages interaction among participants to share best practices and to motivate each other. Videos available throughout the course allow participants to use materials again with colleagues in their respective schools and divisions. As an incentive for participation, completing the MOOC counts towards the continuing education requirements of school staff.

Data sources

Two primary data sources were used in this analysis: annual school WASH assessments and DepED records on MOOC participation and completion. School WASH information is collected by three key stakeholders per year per school – the school head, a parent representative, and a community representative; the information is then uploaded to the DepEd's EMIS portal. DepEd provided direct access to anonymised data that is only available by request. For the purposes of this analysis, we created 13 binary indicators of WinS services (see Table 2). These 13 indicators covering multiple aspects of school water, sanitation, and hygiene services, are the basis for the school star ranking calculation, the nationally-defined composite measures of school WASH services [19]. For each year of data, schools were given a value of 1 if they met the specific criterion of interest, and a value of zero otherwise. We compare each of these indicators of WinS services from

the 2017/2018 school year – referred to as baseline – with data from the 2021/2022 school year (endline). Analyses using the School Star Ranking are presented in S4 Table, S5 Table, S6 Table and S7 Table.

MOOC data were provided by DepED from an internal database the department maintains of all school staff who enrol in and complete the WinS MOOC. From a total of 4 "batches" or cohorts of learners, it was possible to match MOOC participation data with the school WASH dataset based on school name and school ID.

Data analysis

EMIS data were converted to binary indicators of school-specific WinS services at both baseline and endline. Based on DepEd MOOC enrolment information, we defined two binary indicators. In the first, MOOC participation, we identified all schools where at least one staff member enrolled in the WinS MOOC. Among those schools where at least one staff member had enrolled in the MOOC, a second binary variable was defined based on whether or not at least one staff member completed the WinS MOOC.

Baseline and endline data were converted into separate observations (i.e., a long dataset). Difference-in-difference mixed-effects logistic regression analysis examined the relationship between changes in WinS services at baseline and endline and MOOC participation, with the measures of association estimated by the interaction between data collection round (baseline and endline) and the MOOC participation variable of interest. Associations were modelled separately for MOOC enrolment and MOOC completion, and each of the 13 selected indicators was modelled separately. All measures of association were converted to odds ratios with associated 95% confidence intervals.

All models were adjusted for covariates defined *a priori* with project partners, including type of schools (primary/ secondary), school size (≤440/ 441–840/ 841–1240/ ≥ 1241 learners), and location of the schools (urban/ semi-urban/ rural), and all included a random effect for region. Additional DepEd information on the economic status of the region was available for approximately 2/3 of all schools and fully adjusted models that include the school's economic region have been included in S3 Table.

For the additional analysis, categories for school star ranking (0–3 stars) were defined as specified in S1 Table, change in star ranking between baseline and endline was analysed using mixed-effects linear regression and a binary outcome of any improvement in star ranking between baseline and endline was analysed using mixed-effects logistic regression. All models included a random effect for region and the same covariates as the main analysis.

Results

In the school year 2017/2018, 30,574 schools out of 46,654 invited submitted their WASH monitoring data (66%). In the school year 2021/2022, 45,390 out of 48,533 schools submitted their WASH monitoring data on the digital platform (94%). In total, complete baseline and endline school WASH data were available for 28,779 schools and demographic data available for 27,795 schools, which were included in analysis.

Characteristics of schools

Among schools with complete data, the majority were elementary schools (84%), defined as small schools with 440 learners or fewer (76%) and semi-urban (87%). (Table 1).

Between 2019 and 2021, four batches of MOOC training were delivered; 15,741 school staff completed the course enrolment form with 15,558 school staff providing sufficient information to link their enrolment data with a specific school. After merging, there were 5,939 schools with at least 1 school staff who participated in the MOOC between 2019 and 2021 (21%). Among them, 4,688 schools (17% of total schools) had at least one school staff member who completed the course and received the certificate (Table 1). Adjustments for school type, location and size were made in all regression models.

Table 1. School characteristics at baseline overall and by MOOC participation between 2019 and 2021.

	All Schools (n = 27,795)	Schools with at least 1 staff enrolled in the MOOC (n = 5,939)	Schools with at least 1 staff who completed the MOOC (n = 4,688)
	N (%)	N (%)	N (%)
School Type			
Elementary	23,409 (84%)	4,468 (75%)	3,621 (77%)
Secondary	4,386 (16%)	1,471 (25%)	1,067 (23%)
School size			
Small (≤ 440)	20,173 (76%)	3,389 (57%)	2,774 (59%)
Medium (441 – 840)	3,860 (14%)	1,039 (18%)	810 (17%)
Large (841–1240)	1,353 (5%)	463 (8%)	354 (8%)
Very large (≥ 1241)	2,409 (9%)	1,048 (18%)	750 (16%)
School location			
Urban	1,363 (5%)	237 (4%)	195 (4%)
Semi-urban	24,169 (87%)	4,719 (80%)	3,754 (80%)
Rural	2,263 (8%)	983 (17%)	739 (16%)

https://doi.org/10.1371/journal.pwat.0000287.t002

MOOC participation

Water. Among all schools at baseline, 47% reported providing drinking water at all times, 74% provided free drinking water to students, and 46% reported testing water at least once per year. At endline, continuous drinking water provision increased to 62%, free drinking water provision increased to 81%, and reported water testing at least once per year increased to 62% (Table 2).

Table 2. WinS indicators among 27,795 schools at baseline and endline.

	School year 2017/2018 N (%)	School year 2021/2022 N (%)
Water		
School provides drinking water at all times	12,964 (47%)	17,264 (62%)
School provides free drinking water	18,701 (74%)	22,523 (81%)
School tests water at least once per year	12,714 (46%)	17,281 (62%)
Sanitation		
School reports gender segregated toilets	13,623 (49%)	20,375 (73%)
School has a student:latrine ratio < 50	20,688 (74%)	23,575 (85%)
School reports toilets are private, lockable	22,217 (80%)	25,396 (91%)
School reports daily toilet cleaning	24,405 (88%)	24,672 (89%)
School has O&M and repair funding allocated in school budgets	2,297 (8%)	11,058 (40%)
Hygiene		
School reports access to group handwashing facility	9,376 (34%)	22,000 (79%)
School holds daily group supervised handwashing	7,413 (27%)	15,793 (57%)
School provides sanitary pads	16,638 (60%)	24,706 (89%)
School reports hygiene information, education and communication materials in classrooms	24,047 (87%)	27,209 (98%)
School reports menstrual health information, education, and communication (IEC) materials in classrooms	10,310 (37%)	20,508 (74%)

https://doi.org/10.1371/journal.pwat.0000287.t001

Schools where at least one staff member participated in the MOOC demonstrated consistently higher odds of better water services at endline compared to schools with no MOOC participation after adjusting for baseline measures and pre-specified covariates (Fig 1; effect sizes and 95% CIs reported in S2 Table). Schools where at least one staff member enrolled in the MOOC had 58% higher odds of providing continuous drinking water to students at endline compared to schools with no MOOC participation after adjustment for pre-specified covariates and service provision at baseline (adjusted Odds Ratio (aOR): 1.58, 95% Confidence Interval (95% CI): 1.45–1.73). Any MOOC participation was associated with increased odds that a school would provide free drinking water to students (aOR 1.65, 95% CI: 1.49–1.83) and report testing drinking water at least once per year (aOR 1.67, 95% CI: 1.53–1.82).

Sanitation. Among all schools, provision of gender-segregated toilets increased from 49% of schools at baseline to 73% at endline and the proportion of schools with an overall student to latrine ratio below 50 increased from 74% at baseline to 85% at endline (Table 2). Reporting of secure, private toilets with doors and locks increased from 80% at baseline to 91% at endline and reported daily cleaning of toilets increased from 88% at baseline to 89% at endline. At baseline, only 8% of schools reported that regular operations and maintenance was accounted for in school budgets, increasing to 40% at endline.

The odds that a school with any staff participation in the MOOC would provide gender segregated sanitation facilities compared to schools without any MOOC participation were 2.36 times higher at endline in our adjusted models (95% CI: 2.11–3.03). Any MOOC participation was associated with increased odds that a school reports student:latrine ratio below 50 (aOR 1.19, 95% CI: 1.07–1.34), daily toilet cleaning (aOR: 1.31, 95% CI: 1.13–1.52), secure toilets with doors and locks (aOR 1.29, 95% CI: 1.12–1.50), and budgeting for O&M and repairs in school budgets (aOR 1.46, 95% CI: 1.31–1.64) (Fig 1).

Hygiene. Access to a group handwashing facility increased from 34% at baseline to 79% at endline and schools reporting daily group handwashing activities increased from 27% to 57% (Table 2). At baseline, 60% of schools reported providing students with sanitary pads, increasing to 89% at endline. At baseline, 87% of schools reported hygiene-related

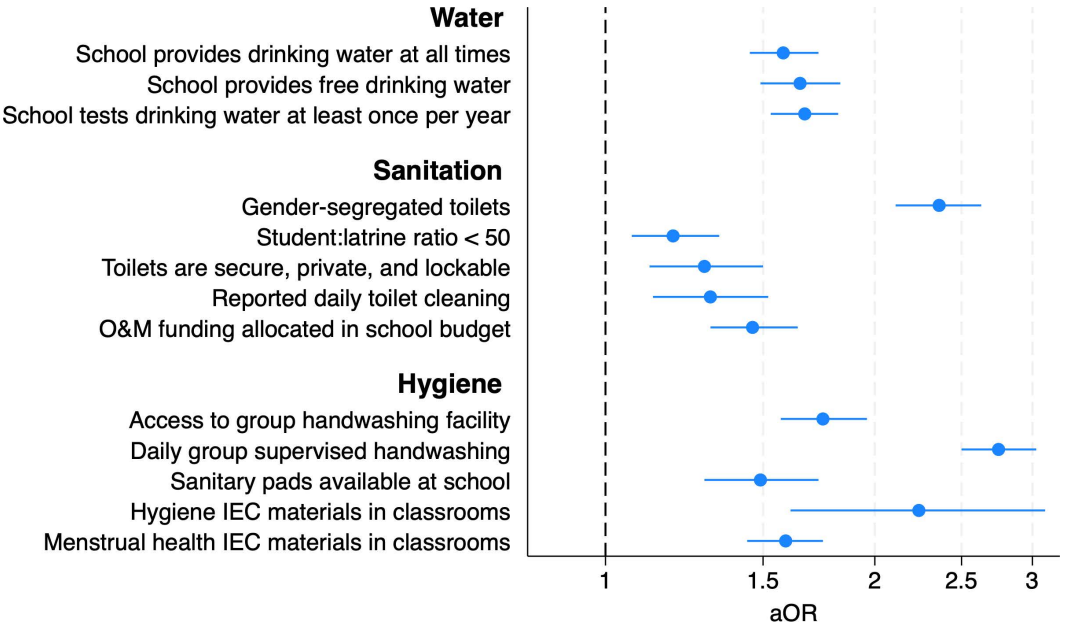

Fig 1. Associations between any MOOC participation and changes in 13 WinS service indicators between baseline and endline. Adjusted ORs and 95% CI (horizontal bars) estimated from mixed-effects logistic regression adjusting for school type, size and location, and a regional random effect.

https://doi.org/10.1371/journal.pwat.0000287.g001

IEC materials and 37% reported menstrual health-related IEC materials in classrooms or other student-facing areas, increasing to 98% and 74% at endline.

Any MOOC participation was consistently associated with increased odds of improved hygiene service provision compared to schools where no staff participated in the MOOC. Odds that a school would have access to a group handwashing facility were 1.75 times higher at endline among schools with any MOOC participation compared to schools with no staff participating in the MOOC in our adjusted models (95% CI: 1.57–1.96) and the odds that a school reported daily group handwashing activities 2.75 times higher (95% CI: 2.50–3.03). Schools with any MOOC participation had higher odds of providing access to sanitary pads for students (aOR 1.49, 95% CI: 1.29–1.73), display hygiene-related IEC materials (aOR 2.24, 95% CI: 1.61–3.10), and display menstrual health related IEC materials (aOR 1.59, 95% CI: 1.44–1.75) (Fig 1).

MOOC Completion

We found mixed evidence of an effect in our analysis comparing schools with at least one staff member who completed the MOOC compared to schools where staff members participated in but did not complete the MOOC (Fig 2, S2 Table). We found no evidence that MOOC completion was associated with differences in the odds of a school always providing drinking water to students but increased odds that schools would provide free drinking water (aOR 1.38, 95% CI: 1.11–1.72) and report testing drinking water at least once per year (aOR 1.34, 95% CI 1.11–1.63).

Schools with MOOC completion had higher odds of providing gender-segregated sanitation facilities (aOR 2.14, 95% CI: 1.69–2.70) and higher odds of reporting daily toilet cleaning (aOR 1.61, 95% CI: 1.18–2.20) compared to schools with only MOOC participation. We found no evidence that MOOC completion was associated with changes in the odds that a school reported a student:latrine ratio below 50 (aOR 1.21, 95% CI: 0.96–1.52); having secure, private toilet facilities with both a door and a lock (aOR 1.33, 95% CI: 0.98–1.81), or allocating for O&M in school budgets (aOR 0.86, 95% CI: 0.66–1.13).

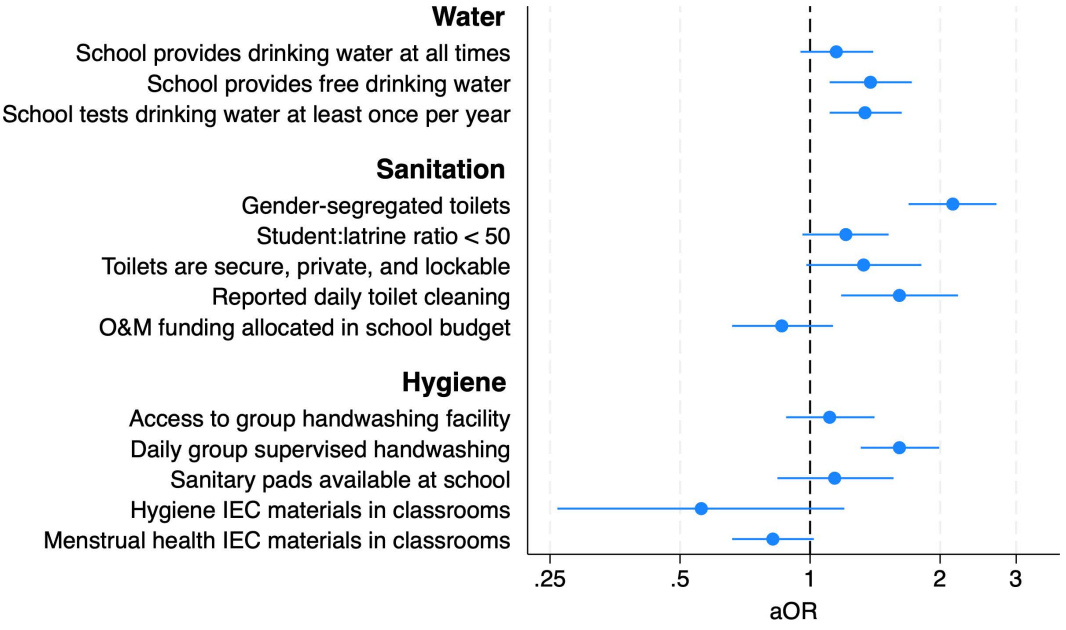

Fig 2. Associations between any MOOC completion and changes in 13 WinS service indicators between baseline and endline, among schools with at least one staff member enrolled in the MOOC. Adjusted ORs and 95% CI (horizontal bars) estimated from mixed-effects logistic regression adjusting for school type, size and location, and a regional random effect.

https://doi.org/10.1371/journal.pwat.0000287.g002

Schools with staff who completed the MOOC had 1.61 times higher odds of practicing daily group handwashing compared to schools with staff who participated in but did not complete the MOOC (95% CI: 1.31–1.99). We found no evidence that completion was associated with the odds that a school would have access to a group handwashing facility (aOR 1.11, 95% CI: 0.88–1.41), provide sanitary pads (aOR 1.14, 95% CI: 0.84–1.56), display hygiene-related IEC materials (aOR 0.56, 95% CI: 0.26–1.20), or display menstrual health-related IEC materials (aOR: 0.82, 95% CI: 0.66–1.02).

Robustness analysis

To assess the robustness of our analysis, we re-ran all models with information on the economic status of school locations, resulting in models with only 20,799 records.

In this additional analysis (S3 Table), significance and magnitude of improvements were consistent between models assessing the effect of any MOOC participation with and without this covariate. For models analysing effects of MOOC completion, there were smaller effects and fewer significant outcomes for water outcomes, more mixed effects for sanitation outcomes, and generally larger and more consistent effects for hygiene outcomes. However, results from this analysis should be interpreted with caution due to the large loss of data.

Additional analysis based on changes in school star ranking

Associations between MOOC participation and MOOC completion, and improvements in school star ranking (linear change and any improvement between baseline and endline) are reported in S4 Table, S5 Table, S6 Table and S7 Table. Results mirrored the main analysis, with larger and more consistent effects of MOOC participation and more mixed effects of MOOC completion on improvement in star ranking.

Discussion

We note a general improvement in WinS services over the period of our analysis, a period in which DepEd implemented a large-scale WASH in schools programme. Across all schools, we observed large improvements in both school infrastructure (continuous drinking water provision, gender segregated sanitation facilities, access to group handwashing facilities) as well as the provision of consumables and the management and maintenance of this infrastructure (water testing, provision of sanitary pads, having dedicated budgets for operations and maintenance). Specific WinS services which saw limited improvements over the study period, such as providing free drinking water and daily cleaning of toilets, were already high at baseline. We observed consistently greater improvements on all WinS indicators associated with participation in the DepEd-managed MOOC. Our findings suggest that online digital learning platforms, as part of a comprehensive school WASH programme, can have positive effects at a national scale.

That the MOOC was associated with improvements in infrastructure may seem surprising given that infrastructure improvements require significant financial investments that were explicitly not within the scope of the MOOC. However, the MOOC was intended to support all aspects of school-based management of WinS services and may have helped schools access DepEd funds, design and implement improvement plans, and engage with local stakeholders (local government, private partners, school alumni) to lobby for financial support to access necessary supply and services for infrastructure improvements. Improvement in hygiene facilities, particularly access to group handwashing facilities, were likely enabled by focusing promotion of specific, low-cost handwashing infrastructure such as the WASHALOT [21]. Future iterations of MOOC-style courses should further explore how they can support and facilitate budgetary allocation at the school level.

Sustained provision of WASH services in schools is a necessary component of any school WASH programme and essential for WASH services to achieve their intended impacts on health and education [1,22]. However, findings from experimental studies of service provision models are mixed [23–26]. Based on a review of published barriers and enablers and service delivery intervention, Pu and colleagues propose three necessary conditions for sustainable delivery of school

WASH services: resources (human, financial, physical, etc), timely and credibly information, and accountability mechanisms [12]. The comprehensive school WASH strategy, including the MOOC for school staff, implemented by DepEd in the Philippines with technical support from development partners, serves as a potential model for addressing these three components at a national level. The policy and programmes connect the accountability mechanism of annual reporting with financial rewards and incentives. The MOOC specifically enhance the human and technical capacity of schools to manage WinS services through innovative training models, incentivising school staff to complete these programmes.

Published analyses of MOOCs specific to the WASH sector are limited [14,15], with available studies focusing on reach, learner retention, and learner satisfaction. To our knowledge, this is the first analysis that links MOOC participation with changes in WASH service provision. MOOCs often suffer from low rates of completion [14,15,27,28]. In our dataset, 78% of schools with at least one staff member enrolling in the MOOC also had at least one staff member complete the MOOC. Linking MOOC completion with continuing education credits may have contributed to higher completion rates in the DepEd programme than commonly observed in other studies. We note however, limited evidence of improvements in WinS services associated with MOOC completion compared to MOOC participation, suggesting that even limited engagement with the MOOC may have been sufficient to improve school-based management of WinS services and produce change. Alternatively, staff who were more motivated to engage in school WASH activities may have also been more likely to participate in the MOOC.

The strengths of the study include its national focus, the large sample size, and the ability to compare WASH status before and after the roll out of the MOOC in the same schools over a five-year period. However, we relied on crude measures of MOOC participation and only two data points reflecting school WASH conditions over the observation period. The two time points available in our EMIS data mean we cannot fully determine temporal relationships between service improvement and MOOC participation. The study uses self-reported data on WinS services available in DepEd's EMIS. The EMIS data collection system aims to reduce bias through joint data gathering by 3 members of the school community; the reported WASH data are validated at multiple levels of the DepEd administration as well as through technical support by GIZ and the WHO/UNICEF Joint Monitoring Programme. It is unclear whether a MOOC, successful in the context of the Philippines education sector, would have effects generalisable to other regions and political contexts, particularly given the high rates of mobile phone coverage and internet use in the Philippines. Further randomised trials that include independent observations of facilities and longitudinal follow-up with more frequent measurements could help to assess the trajectory of change in WinS services and attribute effects to such capacity building interventions.

Conclusion

This national-scale study found that a Massive Open Online Course as an educational intervention for school staff was able to support the sustained delivery and improvement of WinS services in schools in the Philippines over a five-year period. At the school level, having any school staff enrolled in the programme was associated with improvements in school WASH status in general; further research is needed to confirm causal links between these improvements and MOOC participation. Findings indicate that a MOOC offers a feasible approach for large-scale capacity development at low-cost and is able to support and complement national WASH in Schools programmes.

Supporting information

S1 Table. DepEd's WASH in Schools Three-Star Approach.
(DOCX)

S2 Table. Associations between a) any MOOC participation and b) any MOOC completion among schools with at least one staff member enrolled in the MOOC, and changes in 13 WinS service indicators between baseline and endline.
(DOCX)

S3 Table. Robustness analysis adjusting for economic region. Associations between a) any MOOC participation and b) any MOOC completion among schools with at least one staff member enrolled in the MOOC, and changes in 13 WinS service indicators between baseline and endline.
(DOCX)

S4 Table. Multivariable linear regression of changes in school star ranking between baseline and endline by any school-level participation in the MOOC.
(DOCX)

S5 Table. Multivariable linear regression of changes in school star ranking between baseline and endline by any school-level MOOC completion, among schools with at least one staff member enrolled in the MOOC.
(DOCX)

S6 Table. Multivariable logistic regression of improvement in school star ranking between baseline and endline by school-level participation in the MOOC.
(DOCX)

S7 Table. Multivariable logistic regression of improvement in school star ranking between baseline and endline by any school-level MOOC completion, among schools with at least one staff member enrolled in the MOOC.
(DOCX)

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Writing – review & editing: Kh. Shafiur Rahaman, Sarah Bick, Marvin Marquez, Dexter Galban, Habib Benzian, Bella Monse, Robert Dreibelbis.

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