The Use of SMS and Other Mobile Phone-based Messaging to Support Education at Scale: A Synthesis of Recent Evidence

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ABSTRACT

Higher levels of device ownership and lower connectivity requirements are key reasons why mobile learning may have potential to support education at scale in low-income contexts. Interest in the use of mobile phones as an educational medium - particularly through the use of SMS or messaging apps - has been renewed recently, as a result of school closures prompted by the Covid-19 pandemic. As a result, the evidence base for educational interventions using SMS at scale has recently expanded. In this work-in-progress synthesis paper, we review recent research studies which have used SMS for education at scale, with findings published since the onset of the Covid-19 pandemic in 2020. We find that there has been a notable increase in studies which have used SMS to promote and support education at a large scale. In addition to its use as a medium for directly supporting learners, it has also been applied to promoting parental engagement and encouraging participation in formal schooling. The efficacy of interventions has been mixed, which highlights the need for nuance and further research as the field looks to understand which benefits of mobile learning could be beneficial to retain post-pandemic.

CCS CONCEPTS

• **Applied computing → Distance learning**.

KEYWORDS

educational technology, international development, low- and middle income countries, mobile learning, SMS

1 INTRODUCTION

Mobile learning (m-learning) is broadly defined as "any educational provision where the sole or dominant technologies are handheld or palmtop devices" ([27], p.62). In the context of Low- and Middle-Income Countries (LMICs), the potential for m-learning to reach a wider range of learners has been viewed as a particular advantage, given that levels of device ownership are often higher compared to computers, and with lower demands in terms of electricity, data and internet connectivity [25, 30].

While m-learning is not new, the use of mobile phones for educational purposes has received considerable renewed interest in recent years, due in part to the Covid-19 pandemic. Mobile-phone based messaging - including SMS and apps such as WhatsApp and Telegram - were frequently used in strategies to support and promote education at a distance, as part of responses to school closures [29]. In order to provide evidence-based guidance at the onset of the pandemic, we undertook a rapid scoping review of existing literature on the use of messaging for education in LMICs [14, 15]. The review noted a lack of evaluation at scale, with the majority of studies showing some potential for messaging but remaining largely untested beyond small-scale studies. A gap in relation to rigorous large-scale evaluation of mobile phone-based initiatives was also noted in a recent review of learning outcomes for girls in a range of educational technology programmes in LMICs [16]. However, as a result of the intense interest in messaging during the pandemic, the research evidence base has recently expanded and this gap can now be addressed. A number of at scale, rigourous evaluations of interventions using SMS to support education in LMICs have been undertaken and published since early 2020. The objective of the present study was to identify this literature, and understand what this new evidence demonstrates.

Although the acute crises related to school closures have passed, interest in the use of messaging to support education, particularly in low-income contexts, looks likely to continue following the success of initiatives undertaken during the pandemic. In this work-in-progress paper, we present a synthesis of evidence from studies with findings published since the original scoping review [15], focusing on recent studies which have sought to apply SMS for education at scale. The objective of the study is to bring together findings from recent studies, in order to identify trends and present a synthesis of findings. This will address a gap in the literature, and provide up-to-date insights for research in the field post-pandemic.

2 METHODS

To address the research objective, a literature review was undertaken with a particular focus since the start of the Covid-19 pandemic. Specifically, the time period was defined to include articles published since the searches for the previous scoping review had been undertaken, in August 2020 [15]. Similar to the original review, we utilise a scoping study approach to the review [2], in which the goal is to map the recent literature through examining "the extent, range and nature of research activity" ([2], p.21).

The search strategy combined three approaches. First, literature searches similar to the original search string (SMS and other phone-based messaging, aimed at supporting primary- or secondary-school learners, or their teachers) were repeated [15]. Inclusion criteria for countries followed the World Bank classifications for LMICs [4]. Second, targeted grey literature searches were carried out focusing on specific organisations which funded educational technology-focused research studies in LMICs during the pandemic (e.g. [12, 26]). Note that only grey literature articles which included empirical findings and substantial detail and rigour on a par with academic papers, such as final reports, were included (blog posts or background documents were excluded, for example). Third, recommendations were sought from colleagues with research interests in the field. In instances where multiple sources were found reporting similar results from the same study (e.g. conference presentations and working papers), the most comprehensive source was selected.

A total of 25 articles were found and screened for potential inclusion. In keeping with the previous review, the inclusion criteria were set to include studies undertaken in any LMIC context, and to focus on school-level education settings and teachers. Further, higher and vocational education contexts were excluded (which accounted for a large proportion of papers). An additional criterion was applied to reflect the particular focus on large-scale evaluation; based on the distribution of sample sizes across the studies, those with n<150 were excluded.

Thirteen studies, ranging in sample size from 838 to over 19,000, were included in the synthesis. Through the screening process and application of the inclusion criteria presented above, a total of thirteen studies were selected for inclusion in the review. An overview of the thirteen studies selected for inclusion in the review is provided in Table 1. Categories for studies within the sample were not defined a priori, but instead were identified through clusters of studies that emerged through the first readings of the paper. As a result, three main themes were identified, relating to the purpose for which mobile phone-based messages were used, including: as nudges to participation in school and re-enrollment; to promote parental engagement in supporting learning at home; and the direct use of messaging to engage with learners.

3 FINDINGS AND DISCUSSION

The discussion is arranged according to three main themes identified across the sample. We report the nature of the use of SMS in each intervention, scale and reach, and major findings (including impact upon learning outcomes, where reported).

3.1 Theme 1 - Nudges to participation in school and re-enrollment

Four of the studies within the sample aligned with the first theme, of using SMS-based informational nudges in order to promote participation in school, and re-enrollment. The issue of whether students would all return to school following Covid-19 closures was raised during the pandemic, with particular concerns about equity and that girls may be less likely to re-enrol, for example [17, 28].

Of the four studies within this theme, two were undertaken prior to the pandemic. Bettinger et al. [6] report an intervention carried out with a large-scale sample (19,253) of ninth-grade learners in Brazil, undertaken prior to the pandemic (in 2016). Caregivers were assigned to one of two treatments, in which information was communicated via SMS. In one group, the messages included specific information relating to their child, while the other group received non-child specific information. Both treatments had similar positive impacts upon learning outcomes, but only the child-specific messages improved caregivers' awareness of school attendance levels. In Indonesia, Cerdan-Infantes et al. [8] tested the effect of delivering information about a school-based management program to parents, either via printed materials, SMS or a meeting. Printed materials were not effective, while meetings gave participants a general awareness of the program, and SMS was effective for conveying specific information.

The two other studies within this theme were undertaken as part of Covid-19 responses. Crawfurd et al. [9] present findings from a randomised controlled trial (RCT) undertaken in Sierra Leone, to test the impacts of SMS reminders to take-up remote instruction via radio broadcasts. A group which received SMS reminders alone formed the control, alongside two treatment groups which received the SMS plus either phone tutorials from government school teachers, or phone tutorials from public school teachers. While the lack of a non-SMS control group prevented isolation of SMS impacts, re-enrollment rates were high across all groups (>99 percent) [9].

Geven et al. [10] report midline findings from an RCT in Pakistan which tested the impacts of SMS-based informational nudges to encourage re-enrollment in schools, over a period of four months. One treatment group received messages designed to promote support for girls' education, while others received gender-neutral messages. In comparison with control households, those receiving the treatment were more likely to re-enrol on average, but the difference was not statistically significant. Households in the treatment groups reported more time spent on remote learning, and greater expectations for girls' time spent in education. There were no reported differences between the gender neutral and girl-focused messages.

There is a fifth study related to this topic, although it is primarily discussed under the third theme of direct use by learners. Ome and Menendez report on a telementoring programme for learners; while the main purpose was instructional, they reported no differences in terms of re-enrollment between groups [23]. This may suggest that whether messages are best directed at caregivers, or learners themselves, is an area for future research.

Table 1: Summary characteristics of the thirteen studies included in the review

Study	Location	Sample size and context
Angrist et al. (2022) [1]	Botswana	4,500 households
Aurino et al. (2022) [3]	Ghana	2,628 households
Beam et al. (2022) [5]	Bangladesh	7,576 households
Bettinger et al. (2021) [6]	Brazil	19,253 high school students
Cerdan-Infantes et al. (2022) [8]	Indonesia	1,822 parents
Crawfurd et al. (2021) [9]	Sierra Leone	4,399 primary school students
Geven et al. (2021) [10]	Pakistan	4,079 households
Hassan et al. (2021) [11]	Bangladesh	838 households
Islam et al. (2022) [13]	Bangladesh	1,763 primary school students and their caregivers
Kizilcec et al. (2021) [18]	Kenya	1,326,748 primary and high school students
Lichand et al. (2022) [20]	Brazil	18,256 high school students
Ome and Menendez (2021) [23]	Zambia	2,091 primary school students
Schueler and Rodriguez-Segura (2021) [24]	Kenya	8,319 primary school students

3.2 Theme 2 - Parental engagement in supporting learning at home

The second theme comprises four studies with a shared focus upon the use of SMS in order to promote parental and caregiver engagement in supporting and facilitating their childs' learning and education at home. Similar to the first theme, this is an issue that became particularly prominent during the Covid-19 pandemic response [7]. In the original review undertaken at the start of the pandemic, few studies were found that focused on parents and caregivers in LMICs [15, 21]. All four studies included in this theme were undertaken as part of Covid-19 responses.

Aurino et al. [3] report findings from an RCT undertaken in Ghana during the pandemic, as part of the broader Parental Nudges Project. The study tested whether the messages impacted upon the rate of return to school, caregivers' beliefs about the value of education, and children's learning outcomes. The study also tested whether the duration of messages (12 or 24 weeks) played a role. The findings present a mixed picture, with some positive impacts but also negative effects, particularly for households where parents have lower education levels; "For caregivers with no education (65 percent of the sample), the intervention only increased caregiver expectations on reaching the desired level of education, especially among girls, but reduced educational engagement and some measures of children's school enrollment and attendance." ([3] p.2).

Hassan et al. [11] present an RCT implementing and evaluating a telementoring programme with households in Bangladesh. Over the course of 13 weeks, caregivers were provided with SMS messages and phone call support. Substantial impacts were observed in terms of parental engagement and childrens' learning gains, with greater benefit to lower socioeconomic status (SES) households. The team also report on an interactive radio instruction (IRI) intervention in Bangladesh [13]. SMS were used as a means to 'nudge' caregivers into supporting their children in engaging. While the effect of SMS was not controlled for, the intervention was shown to be effective and reminders were regarded as playing an important role in promoting engagement.

Finally, Beam et al. [5] also undertook an RCT in Bangladesh with three treatment arms, to test the impacts of SMS nudges to engage with online learning and educational TV, teacher outreach, and reduction of internet costs. The SMS nudges were found to have positive effects on parental investment in childrens' learning, and learning outcomes, but higher SES households benefitted to a greater extent.

3.3 Theme 3 - Direct use by learners

The final cluster comprises studies in which SMS and mobile messaging were used as a medium for delivering educational content and interacting directly with learners. This was the only theme which continues from the pre-pandemic literature review [15].

Two of the publications report findings from data collected prior to the pandemic. Ome and Menendez [23] present the findings from an evaluation carried out in 2016 in Zambia, where SMS messaging was used to send stories to households with children. Householders were sent stories along with weekly reminders and questions to test reading comprehension, and parents were invited to attend monthly meetings to address issues and encourage home-based reading. The results illustrated a positive impact on reading skills, and indications of cost-effectiveness evidenced that scaling up the programme nationally would cost USD 20-22 per child [23]. Kizilcec at el. [18] analyzed data from Shupavu291 - a mobile phone-based educational platform, which provides learners with curriculum-linked educational materials, quizzes, and allows users to submit questions to teachers, via SMS [19] - in Kenya during previous school closures in 2017, relating to political unrest. The data showed an increase in use of the platform during periods of disruption, and an emphasis on accessing different forms of content (e.g. greater demand for course content, rather than quizzes, which are frequently a focus in the run up to exams) [18].

Two studies present empirical evidence collected as part of Covid-19 responses. Angrist et al. [1] assigned households in Botswana to either a control group, or one of two treatment arms; the first group received numeracy 'problems of the week' by SMS messages, while the second received the messages and additional support via phone calls from teachers. While SMS showed initial promise, the gains overall were limited; the SMS and phone call arm showed substantial improvement, and the targeting of messages to the students'

level was also associated with increased learning gains. However, Schueler and Rodriguez-Segura [24] strike a cautionary note, reporting on a similar intervention (also based on SMS assignments and teacher phone calls, in Kenya). They report positive short-term numeracy gains, particularly for children who did not return to school. However, in the months following the intervention, the benefits were not maintained for children who returned. They conclude that in the context of school - rather than as emergency remote learning - this mode may not represent the best use of school resources. The intervention was also found to not affect the likelihood of returning to school (see also Theme 1).

Finally, one study conducted during the pandemic engaged students by SMS but addressed socio-emotional support rather than focusing upon academic content directly [20]. The intervention involved sending SMS to high school students (aged 15 to 18) or their caregivers (as such, this also relates to the second theme, but is distinct in including messages directly to students). Messages "targeted students' socio-emotional skills; in particular, messages tried to motivate students to stay engaged with school activities during remote learning, to support them in regulating negative emotions, to foster a growth mindset, and to develop grit" ([20], p.4-5). Although the intervention did not tackle subject matter directly, it was shown to have statistically significant benefits both in terms of maths and (to a greater extent) Portuegese. This also reflects findings from a previous study on the Shupavu291 platform prior to the pandemic, which found a growth mindset to be associated with higher test scores [19]. The use of SMS to promote socio-emotional skills, and the indirect impact of this upon learning outcomes, is an area which would benefit from further research.

4   CONCLUSIONS

The synthesis of studies presented here confirms that the research literature surrounding the use of SMS and other mobile phone-based literature to support education in LMICs has grown substantially since 2020, as this medium played an important role in Covid-19 responses. By way of comparison, the previous review only identified six studies with a sample size of over 1,000 [14], whereas this study comprises 14 since 2020 alone. The synthesis provides a useful update to the field in two ways. First, in comparison with the evidence review undertaken at the onset of the pandemic, it reveals how the use of SMS to support education has changed. Second, reflections on the findings - and variation between studies - provide insights for future research, and how SMS may be used to support learning as we move away from the acute educational crisis prompted by the pandemic.

Promoting participation in school and re-enrolment: In some cases, information by SMS improved learning outcomes and participation in school, as effectively or more so than other media [6, 8, 9]. However, in some instances the impact of SMS was not significant [10]. There are questions around whether it is useful to target messages; e.g. personalised information may have some benefits for parental awareness [6] but tailoring to promote girls' participation did not have a significant impact [10]. Targeting learners may be less effective than caregivers [24].

Parental engagement: Positive impacts were seen in terms of engagement and learning [3, 5, 11, 13]. However, this is an area

where efficacy seems to be particularly sensitive to context; in some cases gains were greatest for high SES households [5], but greatest for low SES in other [11], or could be negative or positive depending on caregivers' education level [3].

Direct use by learners: Demonstrable learning gains in languages [20] and maths [1, 20], but gains not always measured[18]. Learners can access educational content flexibly according to need and changing circumstances - e.g. school closures, exam preparation [18] - but there are questions about efficacy and costs relative to other forms of EdTech or school reopening [1, 24]. SEL support by SMS may impact learning outcomes more broadly [20].

The availability of the collection of recent studies which met the inclusion criteria confirms that SMS-based educational interventions can be readily carried out with large sample sizes, in many instances here at short notice. This suggests that the medium has the potential to be used to support education at scale in low-income contexts. However, within the studies, there is little discussion about to what extent the samples are self-selecting learners or households who do have access to mobile devices or provision of alternatives for individuals or households who do not. Some studies had a high rate of attrition (up to approximately 50 percent) - often without addressing why, or whether different groups of learners are affected to a greater extent. So although there is potential, there are also core equity questions that need to be examined further.

The three themes identified demonstrate that the use of SMS to support learning in LMICs since 2020 also reflects a shift in terms of roles. In comparison with the original review [15], there has been a much greater emphasis recently on caregivers as gatekeepers or facilitators of learning. This is not surprising given the extent of school closures and the necessary pivot towards remote learning. However, as education returns to 'business as usual', it raises a question of how transferable the findings will be and the role of the teacher.

The findings overall underscore the need for careful consideration of what 'lessons learned' from emergency responses will be applicable post-pandemic. While the body of research generated about SMS and education in LMICs has expanded the evidence base on this topic, and identified areas which have shown positive impacts, the synthesis also reveals variation in effects from seemingly similar interventions in different contexts. The analysis also found instances where different socio-economic groups could have contrasting outcomes in similar interventions. Understanding the effectiveness of educational technology interventions, and adopting a nuanced view of effectiveness to consider not just impacts on learning outcomes but also contextual factors about why or how an intervention has been effective is an ongoing focus for current work-in-progress supported by EdTech Hub. Current projects include several studies addressing the use of SMS and messaging in a range of contexts; through this work, and continued synthesis of the wider field, key contextual factors and transferable design principles may be identified [22].

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