Design and Evaluation of Automated Interventions to Increase Usage of a Phone-Based Literacy Technology in Rural Africa

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Motivation

Despite an overall rise in global literacy rates, formal education in many low-resource contexts may be insufficient to foster early literacy. Educational technologies may help provide accessible, out-of-school literacy instruction, but children may not persist in voluntarily using such systems to learn. Prior research has developed methods for predicting learner dropout from formal courses and Massive Open Online Courses, often for adults, but not for children's voluntary EdTech usage. Similarly, research in healthcare has shown that automated reminders are positively correlated with voluntary medical adherence, but there is a gap in EdTech literature regarding the effect of such interventions on system usage. Recently, a **phone based literacy intervention technology** developed at Carnegie Mellon University, ***Allô Alphabet***, was deployed on low-cost mobile phones for two longitudinal studies in Côte d'Ivoire. We use call log data to investigate different machine learning models to predict temporary dropout in system usage, and evaluate the efficacy of rule-based, targeted text reminders on increasing system usage. We then contribute insights and design implications for (1) predicting learners' voluntary usage, (2) implementing pre-emptive interventions, and (3) the effect of automated reminders on system usage of out-of-school mobile learning applications in rural contexts.

Research Questions

- *How well can we predict gaps in children's system usage of a mobile-based EdTech application in rural, agricultural contexts?*
- *Which features are most important?*
- *How does the usage gap prediction model perform for a replication of the same study?*
- *How are rule-based, targeted reminders correlated with children's system usage?*
- *Are reminders sent to parents and children more effective than those sent to children alone?*

System Architecture & Usage

Figure 1 : System Architecture for Allô Alphabet

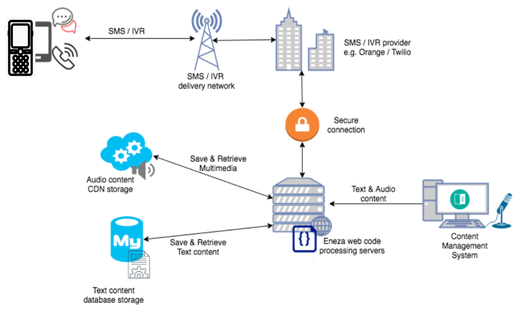

Figure 2: Patterns of calls for one village, for 15 weeks

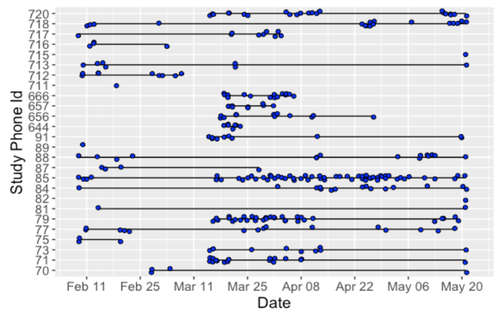

Figure 3: Parent and child using IVR system

Figure 4: Feature phones being used for lessons

Methods

Study Design: The system provides instructions, questions, and feedback via voice messages and text. It was deployed with 750 families across 8 villages in in Côte d'Ivoire in two longitudinal studies since 2019, one of which is ongoing. We collected call log data from system usage records and text intervention data from the network provider.

Data Preparation : We define a gap in usage as the lack of interactions for a week. We created a dataset with each record identified by a *user-week* for both studies, aggregated features for each week, and had a binary classification of whether the user did **not** call the next week *(N_1=2475, N_2=2856)*. We used Population-Informed Week-Forward Chaining for analyses and ran RF, SVM, and XGBoost models. For RQ 4-5, we joined text intervention data (post the onset of COVID-19 since usage patterns were different pre and post March, 2020) with the call log data, and created binary variables for children and adults receiving the reminders, and a pseudo-continuous variable for the success of the reminders on system usage. We used Point-biserial correlation for analysis.

Findings

Figure 5: Difference in usage pattern before and after onset of COVID-19

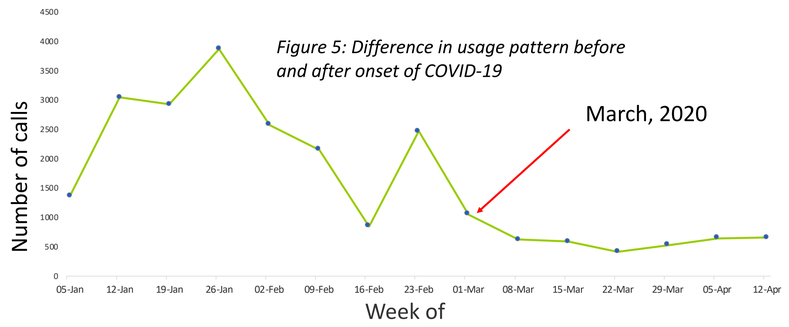

Table 1 : Model performance for Study 1 (RQ1)

Model	Recall	Precision	Accuracy	AUC
XGBoost	**0.93**	0.78	0.75	0.68
SVM	0.92	0.78	0.75	0.65
RF	0.90	0.78	0.74	0.60

Figure 6: XGBoost feature importance for Study 2 (RQ2)

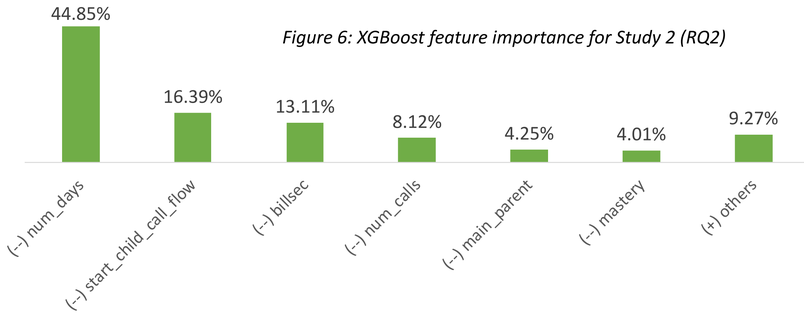

Table 2 : Point-biserial correlation with intervention score (RQ4-5)

Feature	Correlation coefficient	p-value
did_child_receive_reminder	0.26	< 0.001
did_adult_receive_reminder	0.61	< 0.001

Selected Implications

- Call consistency is important rather than just total calls
- Mastery is positively associated with system usage, perhaps because learners feel a sense of achievement (ARCS model)
- Parental involvement is positively correlated with child's system usage in rural, agricultural contexts

Future Work

- Exploring the importance of qualitative and time-invariant features on temporary gaps in usage
- Exploring causal relationships between reminders and children's system usage of EdTech systems

Associated Publication: Chatterjee, R., Madaio, M. A., & Ogan, A. (in press). Predicting Gaps in Usage in a Phone-Based Literacy Intervention System. *Proceedings of the International Conference of Artificial Intelligence in Education.*

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