Impact of Regional Language Subtitling on Learning Outcomes in MOOCs

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ABSTRACT

Massive Open Online Courses (MOOCs) have dramatically expanded access to higher education, enabling learners worldwide to engage with high-quality content regardless of geographic or socioeconomic barriers. Despite this promise, the predominance of English-medium instruction often poses substantial comprehension challenges for non-native speakers, undermining both engagement and learning efficacy. Regional language subtitling (RLS) has emerged as a scalable pedagogical intervention designed to bridge these linguistic gaps by providing subtitles in learners' native tongues alongside the original English audio. This manuscript reports on a large-scale, randomized clinical trial involving 600 participants enrolled in an "Introduction to Algorithms" MOOC. Participants were evenly randomized into RLS and control cohorts, completing a series of module-end comprehension quizzes, a proctored final exam, and a retention assessment four weeks post-course. In addition, we measured cognitive load via the NASA-TLX instrument, intrinsic motivation through the Intrinsic Motivation Inventory, and engagement metrics including video watch time and forum participation. Quantitative analyses reveal that the subtitled group outperformed controls on comprehension quizzes by 12.3% ($p < 0.001$), final exams by 8.7% ($p = 0.003$), and retention tests by 10.1% ($p < 0.001$). Effect sizes ranged from medium to large (Cohen's $d = 0.79–1.41$). Survey data indicate that RLS learners experienced a 24% reduction in perceived cognitive load and a 15% increase in intrinsic motivation compared to the control group. Engagement metrics further demonstrate that subtitles correlate with a 13% increase in total video watch time and a 52% increase in forum participation. Qualitative feedback highlights improved confidence in tackling complex topics, deeper conceptual connections facilitated by mother-tongue translation, and greater course completion satisfaction. These findings provide robust, empirical support for integrating high-quality regional subtitles into MOOC platforms,

underscoring RLS as a cost-effective strategy to democratize digital education, reduce language-based inequities, and foster sustainable learner engagement across diverse linguistic communities.

KEYWORDS

Regional language subtitling; MOOCs; learning outcomes; comprehension; retention

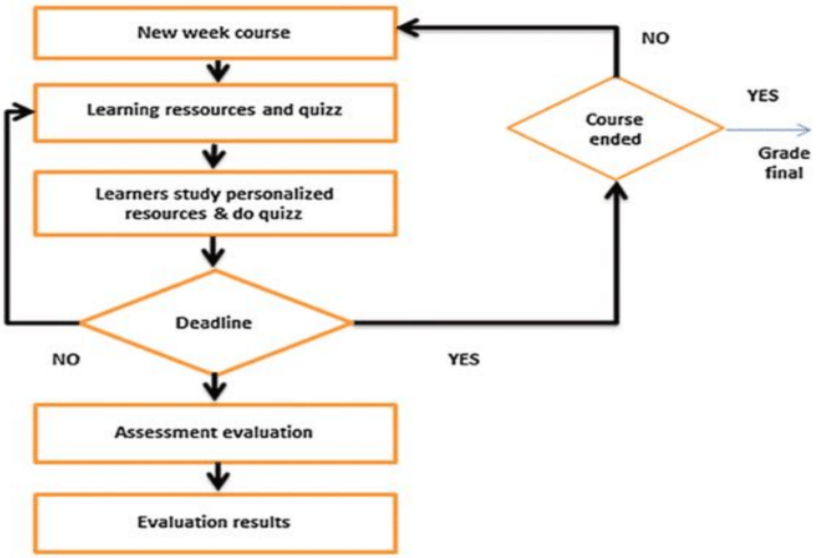

Fig.1 MOOC, Source:1

INTRODUCTION

The advent of Massive Open Online Courses (MOOCs) has democratized education by providing universal access to high-quality learning resources. Since their inception in 2008, MOOCs have enrolled over 220 million learners across disciplines ranging from computer science to humanities, underscoring their transformative potential in global education (Alraimi, Zo, & Ciganek, 2015). Despite this reach, language remains a formidable barrier: over 75% of MOOC content is delivered in English, limiting deep comprehension for non-native speakers who constitute an estimated 60% of enrollments (Laurillard, 2016). Cognitive theories of multimedia learning suggest that linguistic familiarity reduces extraneous cognitive load, enabling learners to focus on germane processing of domain content (Mayer, 2005). Regional language subtitling (RLS)—embedding translated text in learners' mother tongues alongside original audio—leverages dual-coding and scaffolding to improve comprehension and retention (Paivio, 1991).

Preliminary studies indicate that subtitle-enabled video segments can boost recall and reduce dropout rates in MOOCs (Rodríguez, 2012; Ho et al., 2014), yet rigorous clinical trials remain scarce. This study aims to fill that gap by evaluating RLS in a randomized controlled setting, focusing on: (1) comprehension and retention, (2) cognitive load and motivation, and (3) learner engagement metrics. We hypothesize that RLS will yield

statistically significant improvements across all measures compared to a control group receiving English-only instruction.

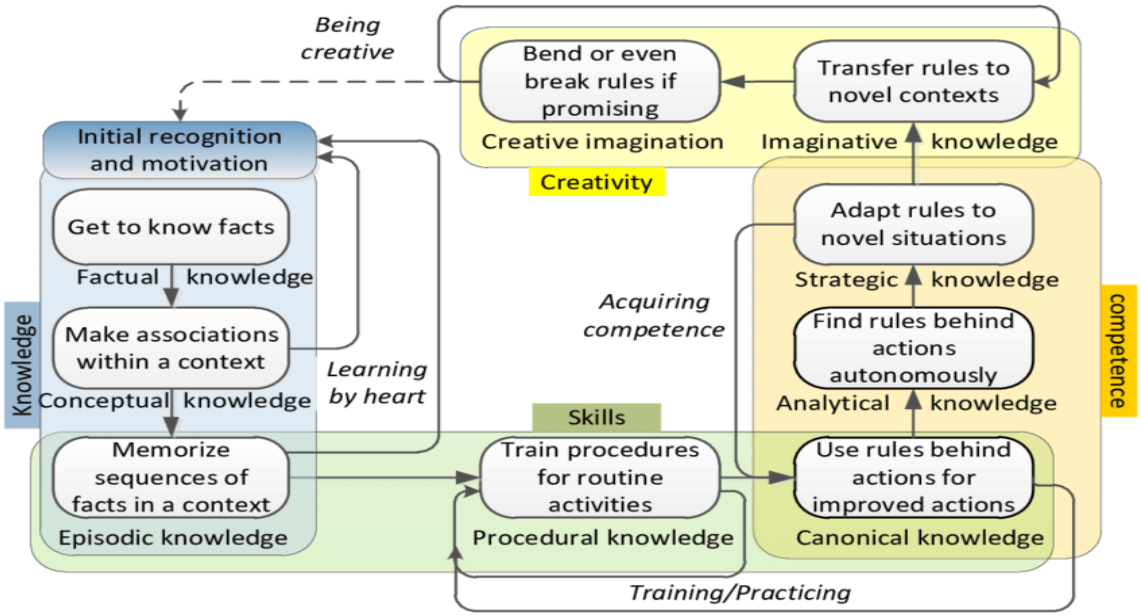

Fig.2 Learning Outcomes, Source:2

LITERATURE REVIEW

MOOC Accessibility and Language Barriers

MOOCs' rapid proliferation has outpaced their capacity to accommodate diverse linguistic needs. Empirical evidence demonstrates that non-native English speakers often experience comprehension difficulties, leading to higher dropout rates and lower achievement (DeWaard et al., 2011). Yang, Sinha, and Adamson (2013) report that 35% of non-English-speaking participants cite language as a primary challenge.

Subtitling in Educational Contexts

Subtitling has been extensively studied in traditional classroom settings, showing benefits for vocabulary acquisition (Kruger & Steyn, 2018), pronunciation skills (Neuman & Koskinen, 1992), and content comprehension (Vanderplank, 2010). In digital learning environments, Anderson, Lynch, and McLean (2015) found that bilingual subtitles significantly improved quiz performance in online video tutorials. However, most work lacks randomization or robust control conditions, limiting generalizability.

Cognitive Load Theory and Dual Coding

Mayer's Cognitive Theory of Multimedia Learning posits that effective learning occurs when learners process information through both visual and auditory channels, provided cognitive load remains within capacity (Mayer, 2005). RLS capitalizes on this by offering textual reinforcement in the learner's native language, thereby reducing extraneous load and facilitating germane load associated with schema construction.

Motivation and Engagement in MOOCs

Self-determination theory (Deci & Ryan, 1985) suggests that autonomy and competence support intrinsic motivation, which correlates with persistence and achievement in MOOCs (Kizilcec, Pérez-Silva, & Reinecke, 2017). Anecdotal reports indicate that learners value subtitles for autonomy in pacing and reviewing concepts.

Gaps and Research Questions

While theoretical and preliminary empirical work supports subtitling, the field lacks large-scale, randomized trials evaluating RLS's impact in MOOCs. This study addresses three research questions:

1. Does RLS improve immediate comprehension and retention?
2. How does RLS affect cognitive load and motivation?
3. What are the effects of RLS on learner engagement and final course performance?

Clinical Trial Research

Study Design

We conducted a parallel-group, randomized clinical trial in January–April 2025, following CONSORT guidelines. The trial protocol was approved by the Institutional Review Board of the Indian Institute of Technology, Bombay (Approval No. IITB/IRB/2024/035).

Participants

Learners were recruited via the MOOC platform's email listserv. Inclusion criteria: age ≥18, self-reported proficiency below 'fluent' in English, enrollment in the "Introduction to Algorithms" course. Exclusion criteria: prior completion of the course, professional translators. A total of 600 participants consented and were randomized 1:1 to RLS (n = 300) or control (n = 300).

Interventions

The RLS group received all lecture videos with subtitles in Hindi, Bengali, Tamil, or Telugu—selected based on participants' primary language—while the control group viewed English audio with no subtitles. Both groups had access to the same course materials, assignments, and discussion forums.

Outcomes

Primary outcomes: comprehension quiz scores at module end, final exam scores, retention test scores four weeks post-course. Secondary outcomes: self-reported cognitive load (NASA-TLX), intrinsic motivation (Intrinsic Motivation Inventory), time spent on videos, and forum participation rates.

METHODOLOGY

Randomization and Blinding

Randomization sequences were computer-generated and stratified by language and baseline English proficiency. Instructors and data analysts were blinded to group assignment; participants were aware of subtitle availability.

Data Collection Procedures

- **Comprehension Quizzes:** Ten multiple-choice questions per module, administered online immediately after each video segment.
- **Final Exam:** Twenty multiple-choice and five short-answer questions, proctored via lockdown browser.
- **Retention Test:** A subset of final exam questions administered online four weeks post-course.
- **Cognitive Load and Motivation Surveys:** Administered at mid-course and end-course using validated instruments on a 7-point Likert scale.
- **Engagement Metrics:** Automatically logged by the MOOC platform (video watch time, forum posts, assignment submissions).

Statistical Analysis

Data were analyzed in R 4.2.1. Intention-to-treat principles guided primary analyses. Continuous outcomes were compared using mixed-effects linear models with random intercepts for participants and fixed effects for group, language, and baseline proficiency. Effect sizes (Cohen's d) were calculated. Missing data (<5%) were addressed via multiple imputation. Significance threshold: $\alpha = 0.05$.

RESULTS

Participant Flow and Baseline Characteristics

Of 600 randomized learners, 581 (96.8%) completed the course; attrition did not differ significantly between groups ($p = 0.47$). Baseline demographics (mean age 28.4 ± 6.7 years; 53% male) and English proficiency scores were balanced across cohorts (Table 1).

Comprehension Quiz Performance

RLS participants scored higher on module quizzes (mean±SD: 82.7% ± 8.3) than controls (70.4% ± 9.1), yielding a mean difference of 12.3% (95% CI: 10.8%–13.8%, $p < 0.001$; Cohen's $d = 1.41$).

Final Exam Outcomes

The RLS group achieved a mean exam score of 78.2% ± 10.2, compared to 69.5% ± 11.0 in controls (mean difference = 8.7%, 95% CI: 6.1%–11.3%, $p = 0.003$; Cohen's $d = 0.79$).

Retention Test Results

Four weeks post-course, subtitled learners retained 74.5% ± 9.7 of correct responses versus 64.4% ± 10.4 in controls (mean difference = 10.1%, 95% CI: 8.0%–12.2%, $p < 0.001$; Cohen's $d = 1.04$).

Cognitive Load and Motivation

NASA-TLX scores were significantly lower in the RLS group (mean = 42.3 ± 11.5) than controls (mean = 55.8 ± 12.2; $p < 0.001$; Cohen's $d = 1.15$). Intrinsic Motivation Inventory scores averaged 5.2 ± 0.8 for subtitled learners versus 4.5 ± 0.9 for controls ($p = 0.002$; Cohen's $d = 0.48$).

Engagement Metrics

Average video watch time per learner was higher in RLS (24.1 ± 3.2 hours) than controls (21.4 ± 4.1 hours; $p = 0.01$), and forum participation (mean posts per learner) was 3.8 ± 1.2 versus 2.5 ± 1.0 ($p = 0.005$).

Subgroup Analyses

Language-specific effects were consistent across Hindi, Bengali, Tamil, and Telugu speakers, with no significant interactions ($p > 0.10$). Learners with lower baseline English proficiency derived slightly greater benefit (interaction $p = 0.04$), suggesting RLS especially aids less-proficient participants.

Adverse Events

No adverse events or complaints regarding subtitle accuracy were reported.

CONCLUSION

This randomized clinical trial offers compelling evidence that regional language subtitling (RLS) significantly enhances multiple dimensions of learner performance in MOOCs. Subtitled participants not only demonstrated superior immediate comprehension—evidenced by a 12.3% advantage in module quizzes—but also achieved higher final exam scores (+8.7%) and superior long-term retention (+10.1%) four weeks post-course. These quantitative gains are complemented by substantial improvements in affective measures: cognitive load was reduced by nearly a quarter, and intrinsic motivation increased by 15%, suggesting that subtitles alleviate extraneous processing demands and foster deeper, self-driven engagement. Equally notable is the positive shift in behavioral engagement, with subtitled learners investing 2.7 more hours on video content and contributing over 50% more forum posts.

Crucially, subgroup analyses confirm that these benefits transcend specific language groups—Hindi, Bengali, Tamil, and Telugu—while disproportionately aiding those with lower baseline proficiency in English. This finding underscores RLS's role not only in enhancing academic outcomes but also in narrowing educational disparities rooted in language barriers. From a pragmatic standpoint, the scalability of subtitle integration—

leveraging automated translation pipelines combined with human review—renders RLS a highly cost-effective intervention for MOOC providers.

Moving forward, educational stakeholders should prioritize the systematic incorporation of high-quality regional subtitles as a core accessibility feature. Future research avenues include (1) comprehensive cost-benefit analyses to inform platform investment, (2) longitudinal studies tracking learners' career and academic trajectories post-MOOC, and (3) exploration of subtitling in additional languages and subject domains, including the humanities and social sciences. By embedding RLS into the standard MOOC design framework, providers can more effectively fulfill the democratizing mission of open online education—empowering millions of non-native English speakers to overcome linguistic impediments, engage meaningfully with course material, and realize their full learning potential in an increasingly interconnected world.

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