# A Web-Based Public Health Intervention for Addressing Vaccine Misinformation: Analysis of Learner Engagement and Shift in Hesitancy to Vaccinate

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**Abstract.** Web-based public health interventions can be a useful tool for disseminating evidence-based information to the public. However, completion rates are traditionally low, and misinformation often travels at a faster pace than evidence-based sources. This study describes the design of a web-based public health intervention to address COVID-19 vaccine hesitancy. A quasi-experimental approach was used in which a validated instrument, the Adult Vaccine Hesitancy Survey, was given to learners both pre and post intervention to observe any change in attitude towards vaccination. Our pilot observed a small positive shift in vaccine hesitancy and experienced higher than average completion rates. By integrating motivational learning design into public health interventions we increase the likelihood that learners finish the entire intervention, creating greater chance for positive behavior change.

**Keywords.** Health communication, health intervention, learning analytics, vaccine hesitancy, public health, COVID-19

## 1. Introduction

Public health education interventions (HEIs) are those which aim to improve both access and delivery of information to address social determinants of health by empowering behavior change [1]. HEIs are a means of promoting health communication, raising awareness about public health concerns, correcting misinformation, and promoting behavior change [2]. Previous studies have shown that HEIs have aided in the prevention and control of communicable diseases, such as SARS (severe acute respiratory syndrome) [3] and MERS (Middle East respiratory syndrome) [4]. Unsurprisingly, web-

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based HEIs have become more prevalent, owing to their ability to overcome physical barriers and reach broader populations online.

Misinformation about the safety of COVID-19 vaccines spread virally online [5]. Health misinformation has been defined as "a health-related claim that is based on anecdotal evidence, false, or misleading owing to the lack of existing scientific knowledge" [6,7]. Vaccine misinformation led to a rise in vaccine hesitancy, "a delay in acceptance or refusal of vaccination despite the availability of vaccination services" [8]. Web-based HEIs may have a positive impact on vaccine hesitancy, reaching the public online where the misinformation is being spread.

Web-based HEIs, such as massive open online courses (MOOCs), come with many challenges, including a wide variability in results, effectiveness, completion rates, and attrition rates. Reasons for this variability may include a lack of attention in design for learner motivation and interactivity [9]. Designing HEIs with motivational learning design strategies is a way of engaging learners to achieve learning objectives [10].

## 2. Objectives

This study explores the development and engagement in a web-based, HEI designed to influence attitudinal change towards COVID-19 vaccine hesitancy. This study explored two research questions: 1) What kinds of learner engagement did we observe in the intervention? 2) What changes are observed in a participant's vaccine hesitancy status as a result of the intervention, as determined by a pre-post validated survey tool?

## 3. Methods

The released version of our HEI is titled, Level Up! Fight the COVID-19 Misinformation Pandemic. Level Up (LU) is a self-paced HEI distributed for free on our platform MBRU Learn, an online rapid course development platform. LU consists of three stages of learning with associated learning objectives (Table 1) and takes no longer than 30 minutes to complete.

**Table 1.** Topics and Learning Objectives for the pilot release of Level Up

| Stage | Topic | Learning Objectives |
| --- | --- | --- |
| 1 | Understanding and counteracting misinformation | Describe the negative impact that misinformation has on the pandemic. Evaluate information to avoid misinformation traps |
| 2 | COVID-19 transmission and prevention | Apply strategies to reduce the risk of contracting and spreading COVID-19 |
| 3 | The science of vaccinations | Recognize the science behind vaccinations and how they work to protect public health. |

LU uses the design an 8-bit, video-game like experience in which the learner follows an avatar as he grows in strength and abilities in each stage. Gamification principles were integrated into the design in which learners' complete knowledge checks to collect objects (Figure 1), grow in skills and rank, and work towards mastery to 'Beat the Boss'

(Figure 2) and achieve the final rank of Legend. Learners have unlimited attempts to pass knowledge checks and must achieve 100% to progress. Throughout each stage a variety of media and interactive content is used to engage the learners, including animated videos, motion graphics, HTML5 games, audio and text.



**Figure 1.** Screenshot from Level Up—collection of objects.



**Figure 2.** Screenshot from Level Up— Beat the Boss challenge.

The aim of LU is to address misinformation related to COVID-19 vaccines and measure whether a change in vaccine hesitancy occurred. This study used a quasi-experimental design in which the Adult Vaccine Hesitancy Scale (aVHS), a validated instrument, was given to learners both pre and post intervention. The aVHS contains 10-items scored on a Likert scale. All scores and cutoffs were adopted by following the methodology of the research team developing the scale [11]. Statistical analysis software was used for analysis . Analytics data was exported from MBRU Learn and cleaned to enable an exploratory analysis of learner engagement and retention, two of the most common measurements used to understand and improve web-based HEIs [12].

## 4. Results

A total of 641 learners enrolled in Level Up, with a total of 408 learners completing the entire intervention. 88 learners dropped off immediately after enrollment and did not attempt any content. A detailed breakdown of learners at each stage of Level Up is provided in Table 2. The biggest loss of learners occurred at Stage 1, with 68 learners attempting the stage but not finishing. Analysis revealed that the quiz in Stage 1 was attempted an average of 5.5 times per learner, with question 2 being the question that was most often missed, with 2002 incorrect attempts.

**Table 2.** Breakdown of learners at each stage and section of Level Up (N=641) *cumulative by stage

| | Completed zero content * | Attempted content | Total non-completers * | Exited between stages | Completed whole stage | % completed |
|---|---|---|---|---|---|---|
| Pre survey | 88 | 38 | 126 | NA | 515 | 80.34% |
| Stage 1 | 135 | 68 | 203 | 9 | 438 | 68.33% |
| Stage 2 | 204 | 8 | 212 | 1 | 429 | 66.93% |
| Stage 3 | 212 | 9 | 221 | 0 | 420 | 65.52% |
| Beat the Boss | 221 | 11 | 232 | 0 | 409 | 63.81% |
| Post survey | 232 | 1 | 233 | 0 | 408 | 63.65% |

A total of 300 learners completed both the pre and post aVHS. A total score of the aVHS was calculated for each pre and posttest. Learner shift from vaccine hesitancy pre-post is described in Table 3, with 35 hesitant learners and 265 non-hesitant learners after pre-test. We observed a 5.4% decrease in hesitancy after the post-test, with the proportion of vaccine hesitant learners dropping from 11.7% (n=35) at pre-test to 6.3% (n=19) after the post-test. Only 3 learners, or 1%, of our 265 non-hesitant learners at pre-test shifted from non-hesitant to hesitant. Chi squared ($\chi^2$) showed significant results p<.001. The mean score for the post-test was lower than the pre-test (mean pre-test 18.6, SD=5.21, mean post-test 16.62, SD= 5.21) indicating a reduction in hesitancy. The difference in means was 1.98, 95% CI (1.48-2.48), t=7.8273, p< .0001.

**Table 3.** Hesitancy changes from pre to post test (N=300)

|  |  |  | Hesitant (post) | Not Hesitant (post) |
|---|---|---|---|---|
| Hesitant (pre) | 35 |  |  |  |
|  |  | After post | 16 | 19 |
| Not Hesitant (pre) | 265 |  |  |  |
|  |  | After post | 3 | 263 |

## 5.    Discussion

Level Up was developed to understand if a web-based HEI, developed using motivational learning design, could make an impact on leaners hesitancy to vaccinate. Our pre-post test results showed some impact on vaccine hesitancy with 5.34% of previously hesitant learners shifting into not hesitant status after completing the intervention and post-test. A backward shift was also observed in 3 participants (1%) who went from not hesitant to hesitant. A larger population size is necessary to draw further conclusions. Completion rates for LU (64%) were higher as compared to online web-based interventions, such as MOOCS, which typically experience completion rates from .7% to 52% [13,14], an indicator that our motivational learning design strategies were effective. In their systematic review of papers using gamification for MOOCs, de Freitas and da Silva [12] found greater participation rates from learners when gamification principles were used as reflected by the time spent on MOOC platforms, the number of learners completing end-of-course evaluations, and the number of tasks and lessons completed [12]. Our loss of 68 learners in Stage 1 appears to be a result of a difficult choose-all-that-apply (CATA) question on the Stage 1 quiz. Visual placement of instructions is quite important for CATA questions [15] which is not changeable within MBRU Learn, so future work will see this assessment reworked.

## 6. Limitations

We are limited by our pilot population size and more participants are needed to draw further conclusions the impact on vaccine hesitancy. The majority of our population were also fully vaccinated so we would benefit from a greater diversity of learners. We did not publicly advertise for enrollments so learners in this are those who already follow MBRU Learn and therefore might be more motivated to complete our interventions. We

are also limited by our platform from seeing more granularity when it comes learner activity. The intervention is only available in English and to those who have an Internet connection.

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