What is it about Growth Mindset?

Pre-analysis Plan

Recent evidence documents that low-cost interventions aimed at giving adolescents a growth mindset have very sizable and positive effects on their test scores and probability of dropping out of school. However, such interventions are yet to be tested in poorer settings, where resources such as computers and internet are often not available. In partnership with the São Paulo State Secretariat of Education (SEDUC-SP), in Brazil, this project adapts and evaluates the previously evaluated Growth Mindset intervention from its computer-based original format to an SMS-based format, which could be scaled in both developed and developing countries. Above and beyond comparing the computer-based and SMS-based intervention, the project investigates the mechanisms behind the impacts of the growth mindset intervention. To unbundle its message, we randomize students within the SMS intervention into treatment arms that target specifically (i) beliefs about high returns to effort, or (ii) beliefs about low costs of effort, or (iii) salience of school activities, or (iv) risk-taking, or (v) future-orientation. 866,666 students from 6th to 12th grade will participate in the study. We evaluate impacts of the different treatment arms on participation in distance learning activities during the school shutdown caused by the COVID-19 pandemic, and on school attendance, grades and student dropouts when regular classes resume.

I. Introduction

Recent evidence documents that low-cost interventions aimed at giving teenagers a growth mindset (versions of the message "your brain is like a muscle") have very sizable and positive effects on their test scores and on high school drop-out rates. In particular, the Growth Mindset intervention developed for and described in Yeager et al. (2016) has been shown to be effective in promoting a growth mindset for 9th grade students both in the US (Yeager et al., 2019) and Norway (Bettinger et al., 2018). However, this intervention requires the use of computers and internet, resources that are not so widely available in many developing countries. On the other hand, mobile phone(s) can be found in almost every kind of household. Specifically, in Brazil it is estimated that more than 90% of the households have at least one mobile phone (IBGE, 2018). This investigation is particularly relevant for the COVID-19 pandemic period, as public school students can no longer attend school in person and have limited access to homeschooling resources.

For this study, we partnered with São Paulo State's Secretary of Education (SEDUC-SP), in Brazil. SEDUC-SP provides access to 1,415,290 mobile phone contacts either from students themselves (grades 10 to 12) or a students' parent or legal guardian (grades 6 to 9) to evaluate different forms of the growth mindset intervention.

We translated and adapted the computer-based growth mindset intervention from English to Portuguese, following the methodology in Bettinger et al. (2018), that translated this intervention from English to Norwegian. Due to limitations on school operations during the COVID-19 pandemic, we deliver the computer-based intervention remotely to each student by means of a text message link, instead of the original in-person delivery at the school. To access this content, students will need a smartphone, tablet or computer with internet access. We also adapted this content to be delivered exclusively through text messages, making it more accessible to vulnerable populations and scalable in both developed and developing countries. This adaptation process considered the methodology for SMS interventions used in Bettinger et al. (2020) that developed a parent engagement SMS intervention called EDUQ+, namely a platform powered by Movva, a Brazilian social impact startup, which allows schools to send messages to parents with information about children's attendance and grades, and which nudges them with motivating facts and suggested activities to engage them in their children's school life. The SMS-based version of EDUQ+ has been shown to be effective in Brazil, where communication with parents had large impacts on attendance, test scores and promotion rates (Bettinger et al., 2020). We will evaluate the effectiveness of this intervention in Brazil in its computer- and SMS-based versions separately on outcomes such as likelihood of dropping out, engagement with the remote schooling app provided by SEDUC-SP, and test scores.

Moreover, rather than just comparing average treatment effects of computer vs. SMS messages, this paper investigates why the growth mindset interventions works, unbundling mindsets into its underlying mechanisms. We do so by randomly assigning 800,000 Brazilian students from grades 6 to 12 to different versions of the mindset intervention, varying whether students are exposed to specific components of the mindset message: (i) whether or not messages make school activities salient (without conveying any message related to mindsets), whether or not messages emphasize (ii) high returns to effort or (iii) low costs of effort, and whether or not messages highlight (iv) the value of risk-taking (risk preferences) or (v) that of assigning higher weights to future outcomes (time preferences).

This pre-analysis plan summarizes the design of a phone-based experiment designed to test the following hypotheses:

1. Can the growth mindset intervention improve academic and behavioral learning outcomes in Brazil?

- Hypothesis: The mindset intervention increases the likelihood of self-reported growth mindset, improves performance in Math, increases engagement with content while homeschooling, improves grades and promotion rates, and decreases dropout rates.
    - In Brazil, different from the US and Norway, public schools provide education mostly to students from low-income families. Thus, it is not clear that children's learning outcomes will improve with this intervention, as the resources for developing a growth mindset may be scarcer.

2. To what extent can an SMS-based intervention replicate the impacts of the computer-based intervention?
    - Hypothesis: The effect of the SMS mindset intervention is the same as that of the computer-based intervention delivered remotely.

3. Are the effects of the mindset intervention primarily driven by inference about lower costs of effort, inference about higher returns to effort, inference about risk attitudes, or inference about future-orientation?
    - Hypothesis: Emphasizing low costs of effort, high returns to effort, risk-taking or future-orientation leads to differential impacts of the SMS intervention on student outcomes.

4. Are the effects of the intervention at least partly driven by its salience effects?
    - Hypothesis: Making school activities salient, even in the absence of the mindset message, impacts student outcomes.

5. Are the effects of the intervention persistent?
    - Hypothesis: The intervention affects student outcomes such as their mindset and school attendance even in the months after communication has taken place.

6. Do additional rounds of the intervention induce larger impacts?
    - Hypothesis: Extending the SMS intervention for additional months increases its impacts on student outcomes.

7. Does the intensity of the mindset intervention's effect differ by grade?
    - Hypothesis: The mindset intervention has an inverted U-shaped effect across grades 6 to 12, with its peak effect happening during the transition from middle to high school (from grade 9 to 10 in Brazil).

8. Does a combination of computer-based and text-message intervention yield larger effects?
    - Hypothesis: The computer-based and text message delivery formats have complementary features that increase the impact of the mindset treatment on students' outcomes.

II. Intervention – Experimental Design

The intervention will be evaluated through a phone-based randomized control trial with 866,666 students from grades 6 to 12 of São Paulo's state schools. Students will be randomly assigned to either a pure control group (who will not receive any kind of growth mindset content), to an SMS-based content only treatment group, or to the computer-based content treatment group.

We undertake 3 experiments to answer the research questions of interest.

Experiment 1 evaluates the impact of the computer-based intervention, adapted to the Brazilian context, to test hypothesis 1. In September, 400,000 students will receive a text message with a link to access the online content typically used in the computer-based intervention, made available through an online platform (Qualtrics). Upon accessing the link, students will be randomized on the spot to one out of 2 different groups, with equal probability:

1- A placebo group, which will receive an online intervention about the brain; or
2- A treatment group, which will receive an online growth mindset intervention.

The placebo intervention will instruct students in this group about the brain's features and functionalities but will not provide any information about mindset. The treatment intervention will instruct students in the treatment group about growth mindset and how to develop it. Both treatments are based on text, illustrated with a few images (keeping fidelity to prior studies, but adapting to local context). Audio recording of the texts are also made available for students who prefer that option (in case they have enough airtime credit and bandwidth to access it).

Table 1: Research Design of Experiment 1: Effects of the computer-based intervention

Online Placebo Group	**Online Treatment Group**
50% of those who access link	50% of those who access link

Based on other studies with similar settings, we expect 2%-12% of the target sample to access the online content. We would be able assign and observe outcomes immediately after the intervention only for that sub-sample. We estimate a conservative minimum detectable effect (MDE) of 6.3% standard deviation for comparing the treatment group to the placebo group considering a 2% take-up rate of the total sample for this experiment, and reaching 2.6% of a standard deviation at a take-up rate of 12%.

Additionally, we will observe administrative outcomes (attendance, grades, and access to the distance learning platform) for all students, which will allow us to estimate selection into Experiment 1, and estimate treatment effects re-weighting observations by the inverse of the selection probability.

Experiment 2 aims at testing hypotheses 2, 3 and 4. Also in September, 400,000 students (with no overlap with Experiment 1) will receive 1 SMS, assigned to 1 out of 6 different groups. There is also a control group, of identical size as each of the other cells, assigned to receive no SMS, as follows:

1- Typical growth mindset intervention group ("your brain is like a muscle, ...");
2- Salience group ("we want you to stay in school");
3- High returns to effort group ("if you put more effort in, you can always improve relative to yourself");
4- Low costs of effort group ("studying is actually more fun than you might think");
5- Risk-taking group ("trying is always worth it, failure does not mean anything about your potential");
6- Future-orientation group ("when thinking about your studies, it is important to think about your future!"); or
7- A pure control group, which does not receive any text message.

Table 2: Research Design of Experiment 2: Computer- vs. SMS-based intervention, and mechanism

Typical Growth Mindset Intervention	**Salience Group**	**High Returns to Effort Group**	**Low Costs of Effort Group**	**Risk-Taking Group**	**Future-Orientation Group**	**Pure Control Group**
66,667 students	66,667 students	66,667 students	66,667 students	66,667 students	66,667 students	66,667 students

For this experiment, we estimate an MDE of 1.7% of a standard deviation on outcomes obtained from administrative data when comparing each treatment cell against the pure control group. For a comparison

between computer- and SMS-based interventions, we expect an MDE of 39% of a standard deviation at a 2% take-up rate, and 6.6% of a standard deviation at a 12% take-up rate.

Experiment 3 aims at testing hypotheses 5 and 6. From October through December, the plan is to stick to the assignment for a sub-sample of students, potentially with more messages per student per month. We plan on updating the pre-analysis plan before the end of September to specify the final sample and number of messages. That decision depends on other tests being undertaken by SEDUC together with Movva to determine the optimal trade-off between number of students impacts by the nudges and number of nudges per student per month.

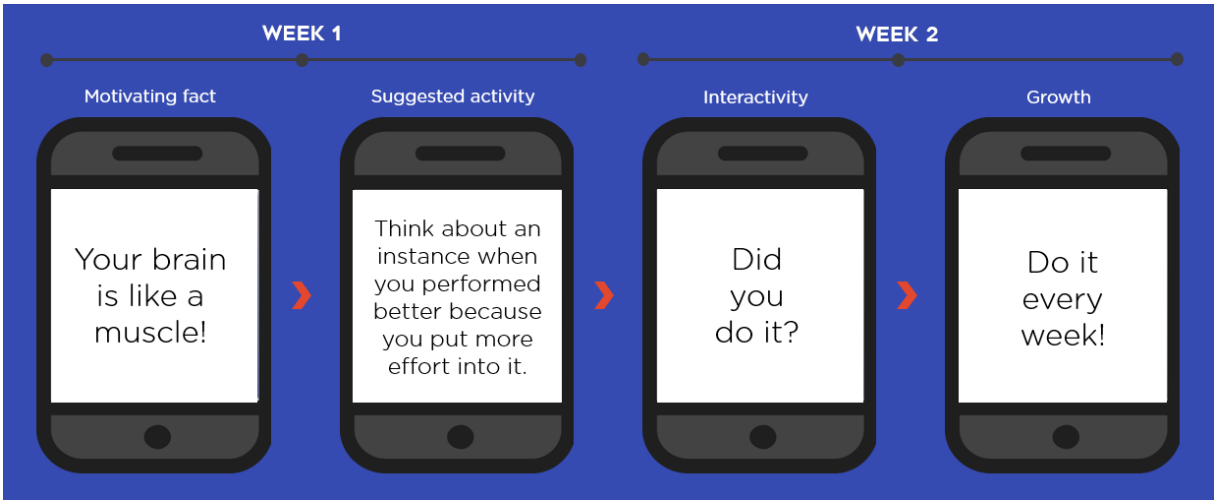
If SEDUC decides to stick to 1 message per month, the plan is to repeat the messages with slight variations in framing but keeping both the assignment and the core concept within each group. Alternatively, if SEDUC decides to go with more than 1 message per month (with a smaller sample size), we will randomly draw users within each treatment arm to receive additional messages. That experiment would allow us to estimate persistence and fade-out of treatment effects, as well as saturation effects (contrasting those assigned to receive additional messages to the ones who received messages only in September, and those to the pure control group).

Table 3: Research Design of Experiment 3: Persistence and saturation effects

Pure Control Group	**1 SMS in Sep Group**	**1 SMS in Sep + additional SMS from Oct-Dec Group**
66,667 students	TBD	TBD

In case Movva sends more than 1 SMS per month, communication will be based on sequences of four messages: a motivating fact, a suggested activity, an interactive message, and a growth message (see an example below).

Figure 1: Example of an SMS sequence for the Typical Growth Mindset Intervention Group



Across the different treatment arms, each message tries to stick closely to the concept within that arm. In particular, the distinction between high returns to effort and low costs of effort will be done by appealing the concept of willpower in the Low Costs of Effort Group (Job, Dweck and Walton, 2010).

Additionally, we intend to embed a 4th experiment into experiment 3 to evaluate hypothesis 8, or how the computer-based intervention format interacts with the text message format. To do so, we will select a random subsample of subjects in Experiment 3, to be determined and updated here after September, to receive a text message containing the link to the computer-based treatment. If the two formats yield the same results, we should not expect different or improved outcomes from their combination. However, if there are complementarities between the two formats (e.g., the computer-based treatment is better at engaging students, and the text message treatment's salience allows to fixate the concepts over time), we might find outcomes to improve with respect to each intervention separately.

III. Outcomes

We will assess how the different versions of the Mindset intervention impact learning efforts and outcomes for students enrolled in grades 6 to 12 (ranging 10-18 years old students). To do so, we will use administrative records to evaluate treatment effects on

- Daily access to the distance learning platform;
- Daily time online on the distance learning platform;
- Weekly attendance (by school subject) when the time regular classes resume;
- Quarterly grades (by school subject) when regular classes resume;
- Student dropouts.

We will measure baseline levels of growth mindset, motivation to return to school when regular classes resume, students' experiences with distance learning, and feelings of isolation during the pandemic (school-grade averages, as of early September, before the intervention starts). We will do so by assigning each student one of four questions randomly, i.e., 25% of students in a given grade-school pair will receive one text message with one of the following questions:

Q1 – On a scale from 1 to 6, how much do you disagree (0) or agree (6) with the following: Your intelligence is something about you that you can't change very much.

Q2 – Do you plan on going back to school once in-person classes resume?

Q3 – Tell us about your experience of studying from home during this period without in-person classes.

Q4 – Share with us how you've been feeling during the past few months without seeing your teachers and classmates.

These questions will be rephrased accordingly when the message recipient is the student's caregiver and not the student.

In addition, we also have information on various other baseline variables: the history of access to the distance learning platform since May; attendance and grades for the first quarter of the year, provided by administrative records; predicted risk of dropouts at the student-level, on a 0-100 scale.

We are interested in estimating heterogeneous treatment effects of the interventions according to those baseline measures.

Additionally, between September and December, students who take-up the computer-based intervention and rotating subsamples of 1,000 students within each SMS treatment arm and the pure control group (total 7,000 students per week) will be drawn to receive a question via SMS, to capture treatment effects on mindset. Questions are variations of Q1 above, following Bettinger et al. (2018).

For experiment 1, we expect to send the SMS question to all students who take-up the computer-based intervention up to a 4.75% of the total sample. As a conservative estimate with a take-up rate of 2% and 2% of response rate to SMS questions, we estimate an MDEs of 44% within a single week, and as low as 11% when accumulated over 15 weeks. At a 4.75% take-up rate and 2% response rate for the SMS question, we estimate the MDEs for a single week to be 28%, and as low as 7.4% when accumulated.

For experiment 2, at a weekly response rate of 2%, we estimate an MDEs of 88% within a single week, and as low as 22% accumulated over 15 weeks. At a weekly response rate of 12%, we estimate an MDEs of 36% within a single week, and as low as 5.8% accumulated over 15 weeks.

IV. Estimation

We will document the effects of the treatments on the following outcome categories for the 6th to 12th graders in our sample (aged ~11 and ~18 years old respectively):

1. Students' outcomes:
    - Students' self-reported mindset (growth or fixed), weekly;
    - Student-level access to the distance learning platform, measured by the daily access and the daily time on the platform;
    - When actual classes return: school attendance, grades, grade retention and dropout rates, measured by administrative records.

Whenever we have access to multiple outcome variables mapped into a single outcome category (e.g. grades for several school subjects), we will build summary measures: following Kling, Liebman and Katz (2007), we will normalize all outcomes to z-scores, and run seemingly unrelated regressions (SUR) to compute effect sizes for each outcome category.

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