Entrepreneurship education and teacher training in Rwanda

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Entrepreneurship Education and Teacher Training in Rwanda

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Proposed timeline *(required)*

- September 2018: completion of endline survey
- March 2019: availability of endline survey data
- July 2019: availability of endline administrative data (request pending)
- October 2019: completion of endline data analysis
- December 2019: submission of Stage 2 manuscript

Abstract *(required)*

In Rwanda, 72 percent of employed youth work for family firms or are self-employed. These outcomes suggest that schools may be failing to develop the skills required to enter formal sector jobs or grow small firms. In response, Rwanda reformed its required upper secondary entrepreneurship course by introducing interactive pedagogy and a focus on business skills. Merely mandating adoption of a new curriculum may be insufficient for teachers to implement it effectively, however. This study examines how comprehensive teacher training affects the delivery of the reformed entrepreneurship curriculum. Schools were randomly selected for two years of intensive teacher training and support. A control group received the curriculum and the standard government training only. We will measure the intervention's impact on teacher pedagogy, student skills, and student economic outcomes. Results will contribute to knowledge on supporting pedagogical change in a setting where such changes could generate relatively large economic returns for students.

Reporting checklist for Stage 1 submissions *(optional)*

Section	Item	Description and details to report	Reported?	Page(s)
Cover page *(required)*	*Title*	Informative title specifying the study design, population, and interventions	x	1
	Date of latest draft	Date of when the prospective review article was last edited.	x	1
	Study pre-registration status	Link, registration identifier and registry name (or intended registry if not yet registered)	*x*	1
	Keywords	Up to six keywords, to be used for indexing purposes.	*x*	1
	JEL codes	Up to six codes.	*x*	1
Abstract (*required)*	*Abstract*	Summarize research question, outcome variables, methodological framework and contribution in less than 150 words.	x	1
Timeline *(required)*	*Expected completion date*	Expected date for completion of the pre-specified research design.	x	1
Introduction	*Background and relevance of the study*	Brief overview of previous research, and relevance of the research question(s) for the field of economic development	x	3-5
	Research question(s)		x	3
Research design	*Basic methodological framework*	Outline of the identification strategy in your study (experimental/non-experimental)	x	14
	Hypotheses	Pre-specified hypotheses to be tested in the study and reported as primary findings in the Stage 2 full manuscript	x	10-13
	Outcome variable(s)	Definition of the main outcome variable(s) and (if applicable) secondary outcome variable(s)	x	10-13
		Specification of how outcome(s) will be constructed from the dataset	x	10-13
	Intervention(s)	Details of the intervention (when, where, how, by whom)	x	7-9
		Number of treatment arms and whether they are exclusive or overlapping	x	9
		Randomization strategy	x	9
		Blinding strategy (if applicable)	x	9
		Instructions and supporting materials for administering the intervention	x	7-9
		Source(s) of exogenous variation	x	9
	Theory of change	How and why the intervention is predicted to lead to certain effects	x	10-13
	Sample	Specification of unit of analysis (individuals, organizations, countries, etc.)	x	14-15
		Data source(s)	x	14-15
		Projected sample size and statistical power calculations	x	14-15
	Variations from the intended sample	Specification of the degree of attrition that may threaten the robustness of the study	x	21-22
		Strategies to deal with attrition, non-compliance with the assigned treatment, etc.	x	20-22
	Data collection and processing	Type of data, collection method/data source(s), and timeline for collection	x	14-16
		Rule for terminating data collection / stopping rule	x	14-16
		Data management plan	x	15
		Pilot data and experiments run in preparation of the Stage 1 submission	x	N/A
Empirical analysis	*Statistical method(s)*	Main evaluation method(s) and underlying assumptions	x	16
		Rules for handling missing values	x	17
		Definition and rules for handling outliers	x	17
	Multiple hypothesis testing	Strategies to prevent false positives	x	22
	Heterogeneous effects	Anticipated heterogeneous effects and theoretical justification	x	22-23
	Statistical model	A functional (mathematical) form of the causal mechanism explored in the study	x	20
		Specification if regression model is linear, generalized linear, or other	x	20
		How will standard errors be calculated	x	16
Limitations and challenges	*Challenges in the study implementation*	Potential objective circumstances that might jeopardize the implementation of the proposed study design	x	20-22
Administrative information *(required)*	*Ethics approval*	Statement confirming that all necessary ethics approvals are in place.	*x*	30
	Funding	Funding sources in the suggested format	*x*	30
	Acknowledgments	List of (non-author) individuals who provided help to the research project.	*x*	30
Bibliography	*Bibliography*	References can be in any style or format as long as the style is consistent.	x	24-28
Other items	*Appendices*	Tables and figures	x	30-48

1. Introduction

Youth account for 60 percent of Africa's unemployed. In Rwanda, 72 percent of employed youth work for family firms or are self-employed (African Economic Outlook 2016). These outcomes suggest that schools may be failing to develop the skills required to enter formal sector jobs or launch and grow small firms. In recognition of the challenging youth labor market, Rwanda recently reformed its primary and secondary curricula, including the required secondary entrepreneurship course, by introducing interactive pedagogy and a focus on practical skills. Merely mandating adoption of a new curriculum without adequate training may be insufficient for teachers to implement the curriculum effectively, however. A survey of the literature found that "implementing student-centered instruction effectively requires skills well beyond those of a great many teachers in developing countries" (Murnane and Ganimian 2014, p. 42).

This study examines how comprehensive teacher training affects the delivery of Rwanda's revised secondary school entrepreneurship curriculum, introduced in 2016. In that year, a subset of schools was randomly selected for two years of intensive teacher training and support. The program covered more than 100 schools, 260 teachers, and 6,800 students. A control group of equal size received the curriculum and standard government training only. The comprehensive training received by treated teachers was subject-specific (entrepreneurship), incorporated peer feedback meetings, and included follow-up support. The training received by the control group lacked each of these elements. We therefore test whether such comprehensive training can improve delivery of a newly adopted, active learning curriculum. We will measure the intervention's impact on teacher pedagogy and student academic and economic outcomes two years after the program began, as students complete secondary school. Our analysis will follow a registered pre-analysis plan.

Our research question is: how effective is comprehensive teacher training in changing teacher pedagogy, building student entrepreneurial skills, and promoting student economic activity?

This study will make four main contributions to existing knowledge. First, we add to the literature on teacher training in developing countries by providing evidence from secondary school teachers. In-service teacher training, the approach we evaluate here, has shown promise to improve teaching of traditional curricula (Angrist and Lavy 2001; Paul Glewwe et al. 2013; Cilliers et al. 2019). The details of such programs matter, however. The program we study

focuses on a single subject, incorporates lesson enactment, and includes follow-up visits. Each of these elements is associated with positive student outcomes (Popova et al. 2018; World Bank 2018), but is lacking in the training received by the control group. Prior knowledge about teacher training in developing countries stems largely from primary schools, however (Null et al. 2017).

Second, our work will add to emerging evidence on how to improve teaching quality by altering pedagogy. Improving pedagogy has been identified as a leading mechanism for the success of education interventions in developing countries (Evans and Popova 2016). Rwanda's curriculum reform represents a major shift in pedagogy from traditional knowledge acquisition to student-centered, active learning. Many other efforts to alter pedagogy have a similar goal of promoting active learning, such as the early grade literacy program studied in Kerwin and Thornton (2015) and the teacher coaching program studied in Bruns, Costa, and Cunha (2018). Nonetheless, not all such efforts have been successful. In an experiment promoting active learning in secondary school mathematics, control group students learned more than the treatment group, despite 40 hours of training for treated teachers (Berlinski and Busso 2017). The circumstances under which pedagogical change improves student outcomes therefore remain an area of open inquiry.

Third, this study will shed light on how governments can best implement curricular reform. Teachers may be unable to change curricula effectively without the additional training and support provided by programs such as the one studied here. Indeed, education interventions often depend crucially on such complementary inputs for success (Glewwe and Muralidharan 2016). This study can inform curricular reform efforts across many contexts. Within Rwanda, results are directly relevant for potential scale-up because entrepreneurship is a required subject and government employees delivered the trainings by the end of the program. Similar reforms are occurring or under discussion in several other African countries, including Ethiopia, Kenya, Mauritius, and Zambia.

Finally, we add to the thin evidence on school-based entrepreneurship education. To our knowledge, the only experiment of school-based entrepreneurship training in sub-Saharan Africa was conducted in Uganda by Educate!, the international NGO partnering with Rwanda's Ministry of Education on this program (Educate! 2014). In fact, we know of only two other experiments worldwide of school-based entrepreneurship education, and neither focused on secondary students (Premand et al. 2012 and Alaref, Brodmann, and Premand 2019 on university

students in Tunisia; and Huber, Sloof, and Van Praag 2014 on primary students in the Netherlands). Other experiments to encourage entrepreneurship, such as Blattman, Fiala, and Martinez (2014, 2018) or Alibhai, Buehren, and Papineni (2016), target a mostly older population that has already left school.[1] Our focus on secondary students is promising because early skill acquisition could lead to high returns.[2]

Even if the program proves successful at improving outcomes and is cost-effective, scale-up may present a challenge. Despite public delivery of the bulk of the training program, the intervention included additional elements (peer feedback meetings, referred to as "exchange visit," and outreach) led by a well-managed NGO. Other studies have found education interventions to be less effective when implemented by government than by NGOs (Bold et al. 2013; Kerwin and Thornton 2015). Indeed, some large-scale, publicly managed teacher training programs fail to have positive effects (Loyalka et al. forthcoming). These caveats should be borne in mind when interpreting the results of this study.

2. Research Design

2.1. Secondary Education and Youth Economic Activity in Rwanda

The education system in Rwanda consists of 6 years of primary school (grades P1-P6), 3 years of lower secondary (S1-S3), 3 years of upper secondary (S4-S6), and various tertiary options. The academic year runs from January through November, split into three terms. The primary grades are compulsory. All Rwandan secondary students are required to enroll in the entrepreneurship course throughout grades S1-S6.[3] The requirement has been in place since 2009, making Rwanda the "site of one of the most extensive efforts to promote youth entrepreneurship in the world" (Honeyman 2016, p. xii).

[1] Vocational training (e.g., Card et al. 2011; Hicks et al. 2015) can also encourage youth entrepreneurship, though programs often focus on trade skills, not business creation.
[2] Several countries in Sub-Saharan Africa, such as Ghana, Kenya, Mozambique, and South Africa, also offer early-age entrepreneurship education (Robb, Valerio, and Parton 2014; Bux 2016).
[3] Rwanda also offers Technical Vocational Education and Training (TVET) in a separate system of secondary schools. TVET focuses on occupation-specific training in fields such as office management, accounting, and agriculture. TVET students are not subject to the entrepreneurship requirement. By contrast, students in the required entrepreneurship course are enrolled in "general" secondary schools with an academic focus. TVET schools account for for 16 percent of Rwanda's secondary school enrollment (Rwanda Ministry of Education 2016, p. 14).

Gross enrollment in Rwandan secondary schools is 42 percent for girls and 39 percent for boys (World Bank 2015). Of Rwanda's 1,543 secondary schools, 30 percent are public, 40 percent are Catholic, with the remainder run by other religious or private institutions (Rwanda Ministry of Education 2016, p. 38). The completion rate for upper secondary school in Rwanda was 18 percent in 2015 (UNESCO Institute for Statistics 2018).

Table A1 presents data on youth schooling and economic activity from the 2012 Rwandan Census. Nationally, 63 percent of youth aged 15-19 are enrolled in school. Among youth aged 20-24, the enrollment rate falls to 24 percent, indicating that many youth transition from school to the labor market at these ages. University attendance is about 4 percent among 20-24 year olds, indicating that relatively few students continue their studies after secondary school. Among 15-19 year olds, 25 percent are employed, with the employment rate among 20-24 year olds rising to 54 percent.[4] Again, this indicates that these age ranges mark the transition from school to the labor market for many youth. Among the employed, most are self-employed or work for a family firm (74 percent). Wage labor is therefore scarce for Rwandan youth, underscoring the importance of entrepreneurial knowledge and skills for economic success. Most (67 percent) of the employed are also in the agricultural sector.

2.2. Revised Entrepreneurship Curriculum

This project focuses on training teachers to deliver the entrepreneurship course for upper secondary grades S4-S6 (10^{th}-12^{th} grade). In 2016, the government reformed the primary and secondary curricula to focus on building skills through active learning. They called the reformed courses the "competency-based curriculum," contrasting them with the previous "knowledge-based curriculum" that used traditional teaching practices focused on accumulating facts and concepts. The entrepreneurship course required of all secondary school students was part of this reform. Mastery of entrepreneurship and other required subjects, as measured by formal exams, is required to complete secondary school.

Government reformed the upper secondary entrepreneurship curriculum with consultation from Educate!, an international NGO. The reformed course covered the full cycle of business

[4] Employed refers to those who answered "Yes" when asked "Aside from your own housework, did you work at least 1 hour during the last 7 days preceding the census night?"

creation and development, including product development, registration and legal issues, marketing, accounting, and customer relations. The course ranged from covering specific topics and skills (e.g., a lesson on "marketing materials") to more general skills (e.g., "effective communication," "setting goals"). We list the expected key competencies and Skills Lab topics for each grade in an appendix (Section 5.2). In addition to promoting greater interaction between teachers and students, the reformed course included detailed plans for weekly "Skills Labs," based on the laboratory science model, in which students practiced business skills through role play and group projects. Class periods for Skills Labs expanded from 40 to 80 minutes to accommodate the new format.

The new course also encouraged students to form "student business clubs" to start and run school-based businesses. The purpose of these extracurricular clubs was to allow students to practice their entrepreneurial skills in revenue-generating firms of their own creation.

2.3. Intervention

The requirement that all secondary students enroll in the revised entrepreneurship course prevents a direct test of the entrepreneurship curriculum, because there is no comparable group of students unexposed to the new curriculum. Instead, this project focuses on the extent to which comprehensive teacher training can improve curricular implementation.

The intervention tested in this project consisted of the following components:

1. *Intensive teacher training*: entrepreneurship teachers received multi-day training sessions each academic term beginning April 2016 through January 2018. Each of the six sessions was held during holidays between terms and lasted four days. Training covered pedagogical strategies for implementing the revised entrepreneurship curriculum.

    Trainings emphasized lesson planning, engaging students in classroom discussions, encouraging students to create entrepreneurship "portfolios" of their work, and assisting student business clubs to form and grow. Trainings culminated in a "mock day" in which teachers rehearsed upcoming lessons.

Government trainers led the trainings. These trainers were themselves trained by Educate! in a "train the trainers," or "cascade," model.[5]

2. *Exchange visits*: teachers participating in the intervention visited each other's schools to learn from and provide feedback to their peers. Each term, beginning in June 2016 through March 2018, teachers and a district education official observed a colleague teaching an entrepreneurship lesson. After the lesson, teachers conducted a roundtable discussion to share their observations and discuss pedagogical strategies. Teachers met in groups of 2-3, with the host school rotating each term.

3. *Outreach and support*: teachers received ongoing outreach to support their implementation of the curriculum. Youth Leaders, hired and trained by Educate!, visited schools participating in the intervention at least twice per term. The visits included product-making demonstrations (e.g., for household goods such as soap or candles) co-taught with the teacher, advising student business clubs, classroom observation, participating in teacher exchange visits, and addressing any other concerns. Student business clubs were encouraged to submit their ideas to regular business competitions held for treated schools.

The study focused on the cohort entering S4 (10th grade) in 2016, with training provided to this cohort's entrepreneurship teacher as they progressed to S6 (12th grade).[6] The control group received the new entrepreneurship curriculum with only the standard government training on the competency-based curriculum, which was not specific to entrepreneurship. Teachers in control schools did not receive the intensive training, exchange visits, or outreach provided to treatment schools.[7]

[5] Government trainers received an initial 5-day intensive training from Educate!, with "refresher" trainings each term. All trainers who participated in the cascade model had previously received training from government before receiving training from Educate!. It is therefore possible that trainers overlapped between treatment and control schools, though we lack data to verify. Nonetheless, trainings for control schools were not specific to entrepreneurship, leaving less opportunity to introduce techniques emphasized in treated schools into the control group trainings. For instance, Skills Labs were unique to the entrepreneurship course, and would not have been relevant to the non-entrepreneurship teachers attending control group trainings.

[6] Up to two entrepreneurship teachers from each treated school were invited to each training.

[7] Government training was scheduled for 10 days in 2016, with refresher sessions to be held in subsequent years. Each district could set the details of these sessions. We do not have data on implementation, but suspect that training quantity and quality varied across districts, based on uneven responses to queries with district officials. Even if

The research design therefore compares two approaches to delivering a newly adopted, active learning curriculum. Whereas many RCTs compare a new curriculum bundled with teacher training against a counterfactual that has neither (Banerjee et al. 2007; Lucas et al. 2014; Berlinski and Busso 2017), this study's design holds the new curriculum constant between treatment arms. The government training in the control group represents the public status quo, making the comparison with treatment highly relevant for policy.[8] The outreach component builds on studies of other training program with similar follow-up for trained teachers (e.g., Beuermann et al. 2013; Abeberese, Kumler, and Linden 2014; Piper and Zuilkowski 2015). The exchange visits resemble a form of teacher coaching (e.g., Bruns, Costa, and Cunha 2018; Albornoz et al. 2018; Cilliers et al. 2019), except that trained teachers received feedback from peers rather than professional coaches.

2.4. Study Design

Our sample frame included 211 schools, spread across 11 districts in 3 of Rwanda's 5 provinces. We randomly assigned 106 schools to treatment and 105 to control, stratifying treatment by district and public/non-public status of the school (i.e., across 22 strata).[9] Randomization was conducted privately by the researchers, without any re-randomization.

Four schools refused to participate in the study, leaving 103 treatment and 104 control schools. Additionally, a miscommunication between the research team and project implementers led to one control school receiving the intervention, while two treatment schools did not receive the intervention. Although these discrepancies affect only 3 of 207 schools, we use initial random assignment in all analyses, so that all estimates should be interpreted as the intention to treat (ITT). Figure 1 maps the study design.

implemented as intended, training in control schools differed from treatment by occurring for fewer days, without NGO training and input, and without a standardized curriculum.

[8] Another policy-relevant question would be to assess the effectiveness of the public status quo. While the rollout of the Rwandan curriculum reform does not allow for such evaluation, the quality of training and support are often key to the success of large scale reforms. For example, Blimpo et al. (2015) experimentally compared the roll-out of a new school governance program with and without training in The Gambia. The rollout without training and support had no impact, whereas the intervention with training and support reduced teacher and student absenteeism.

[9] About half the schools (102) are non-public (private, government-aided, or religious). Although this is an interesting dimension to explore, we exclude it from our analysis plan to limit the number of outcomes considered in our analysis of treatment effect heterogeneity.

Blinding participants to treatment status was not possible, due to the nature of the program. For instance, teachers knew they had been invited to training sessions or exchange visits. However, program staff were instructed not to volunteer details of research design to participants, such as the division of the sample into treatment and control schools, or the study hypotheses.

2.5. Theory of change and hypotheses

Despite the multiple elements of the program, the theory of change underlying the intervention is simple. Participation in training and support activities increases teacher adherence to the new curriculum and alters classroom pedagogy. As a result, students acquire an associated set of skills. They apply these skills in entrepreneurial and other economic activity.

Error! Reference source not found. presents this theory of change as a series of numbered hypotheses. We describe these hypotheses in detail in the remainder of this subsection. **Error! Reference source not found.** lists each element of the hypotheses and the associated measures to test them in the data. We also include measures of compliance with treatment, as these are necessary steps in the causal chain. The "†" symbol means that we will measure the outcome as an index of the indicated items. The final column refers to data sources, with the student, teacher, and head teacher questionnaires listed as SQ, TQ, and HQ, respectively. TO refers to the teacher classroom observation. A "B" suffix refers to baseline and "E" to endline. For example, variable ESQ405 refers to endline student questionnaire item 405. We describe data sources in greater detail in Section 2.7. All questionnaires appear in the appendix. Tables P3-P7 show how we plan to present results. Details on the estimation procedure and other measurement issues appear in Section 3.

Compliance: Teachers will take up the intervention.

We first check compliance with the program. We define take-up at the school level using administrative data.[10] Take-up consists of the proportions 1) of trainings attended by at least one

[10] Defining take-up as attendance by the teacher surveyed at baseline would be problematic. We surveyed S4 teachers at baseline, but at 71 percent of schools a different teacher(s) will teach entrepreneurship to the study cohort in S5-S6. Ideally, we would measure take-up by matching the study cohort to their current entrepreneurship teacher and tracking the teacher's take-up in that year. Unfortunately, the administrative records fail to report the grade(s) taught by the teacher, or whether the teacher teaches the particular group of students sampled at baseline. In the absence of this information, we find it simplest to define take-up at the school level.

teacher from the school;[11] and 2) of exchange visits attended by at least one teacher from the school.[12] See Table P3.

H1: Teachers will adopt the curriculum.

Although government expects all teachers to adopt the curriculum regardless of participation in the program, we expect adoption to be stronger among teachers in treated schools. We will measure curricular adoption via scheduling of Skills Labs, use of written lesson plans, and an index of entrepreneurial knowledge. Each of these outcomes is a point of emphasis in the training sessions received by the treatment group. See Table P3.

H2: Teachers will alter pedagogy.

The curriculum promotes student-centered, active learning techniques. Such techniques are likely to be challenging to adopt for many teachers in the absence of training, practice, and support. Accordingly, we expect that treated teachers will adopt active instruction more intensively than control teachers.

There are many ways to define and measure active instruction, each with advantages and drawbacks. Classroom observations provide direct measures from a member of the research team, sidestepping social desirability bias, recall bias, or potential deception associated with self-reports. However, observations may be unrepresentative of everyday teaching practice due to Hawthorne effects. We therefore draw on both classroom observations and student reports of teacher practice.

We will rely on two measures drawn from endline classroom observations: 1) proportion of class time in active instruction based on the Stallings classroom observation instrument (J. Stallings 1977; J. A. Stallings and Mohlman 1988), and 2) use of instructional techniques specific to the entrepreneurship curriculum, such as role play and group discussion.[13] For each of

[11] For each training, we will assign an attendance value of one to a school if at least one teacher from that school attended the training session, zero otherwise. The proportion of trainings attended is then the school-level mean of this variable across all trainings.

[12] We do not have compliance data from the support visits. However, we expect non-compliance with support visits to be very low. Youth Leaders (the NGO staff who made support visits) were evaluated regularly on their performance. No Youth Leader was dismissed or disciplined for poor performance related to program delivery during the project period.

[13] In the Stallings instrument, we define active instruction as the proportion of classroom time in Q&A/discussion, student presentation, and project/interactive activity. Active instructional techniques include group discussion, research, case study, role play, debate, finance/practice activity.

these measures, we will report outcomes for all observations and for Skills Labs only, as the latter promote active instruction most forcefully within the curriculum. Moreover, we will report outcomes from the Stallings instrument for the full 52-minute classroom observation and split by first/second half. We expect second-half observations to show a greater prevalence of active instruction, after teachers have had time to set up the lab structure.

We will also report use of active instruction techniques from student reports of regular classroom practice. These measures provide an alternative to the single snapshot of the classroom observation, while mitigating some of the disadvantage of teacher self-reports. See Table P4.

H3: Students will acquire skills.

As the name suggests, the revised "competence-based curriculum" intends to promote student skill acquisition. Students in both treated and control schools are expected to learn the curriculum, but treated schools will receive more support to this end. We will measure student skills in several domains (see Tables P5-P6):

a) *Academic skills*: as in many African countries, the Rwandan education system emphasizes formal exams. The revised entrepreneurship curriculum is intended to promote entrepreneurial skills without sacrificing student exam preparation. We therefore measure whether exam performance of students in treated schools differed from control schools. Students take exams in all required subjects, including entrepreneurship. The program could teach skills useful beyond the entrepreneurship exam or, alternatively, might crowd out effort in other subjects. We will therefore consider both entrepreneurship and overall exam scores.

b) *Financial and entrepreneurship skills*: are students in treated schools more likely to exhibit habits conducive to entrepreneurial success? Are they more patient, do they save more, or are they more knowledgeable about business and entrepreneurship? We will test these outcomes.[14]

c) *Non-cognitive skills*: in tandem with academic and business skills, the curriculum intends to promote higher aspirations and a sense of efficacy among students. Accordingly, we

[14] There are Skills Labs on savings, loans, and budgeting, which are intended to promote savings and forward-looking behavior. See the appendix in Section 5.2.

will test for differences between students in treated and control schools in non-cognitive skills, as measured by aspirations, locus of control, and grit.

H4: Students will engage in entrepreneurial activities.

The curriculum promotes entrepreneurship as a post-schooling career and may also induce contemporaneous activity. The curriculum encourages the formation of student business clubs while students are enrolled in school, as a means to apply entrepreneurial skills outside the classroom. In treated schools, business clubs receive extra support via product-making demonstrations, advising, and interscholastic business club competitions. These clubs may serve as a springboard for students to launch independent businesses or seek employment, even while still enrolled in secondary school.

One possible outcome of this involvement in economic activity while in school is that students drop out. For instance, a school-based financial literacy program in Ghana led to an increase in child labor, as students exposed to the program entered the labor market (Berry, Karlan, and Pradhan 2018). More generally, the economic opportunities available to youth influence their schooling decisions (e.g., Heath and Mobarak 2015; Atkin 2016; Pugatch 2018). With Rwanda's secondary school completion rate at just 18 percent, the students in this study may be at high risk of dropout. We therefore analyze dropout as an outcome.

Next, we will measure whether business formation differs between students in treated and control schools. In addition to overall business formation, we will distinguish between businesses begun independently, via student business clubs, or with family members or peers. The characteristics of businesses in which students participate might also be affected by the program. Are businesses arising from treated schools more or less likely to be in agriculture? To have paid employees?

Student participation in the program might also spur other forms of economic activity. For instance, students might acquire skills or connections useful to employment in the local labor market. Alternately, entrepreneurship could crowd out paid employment and wage income. We therefore include paid employment and income (overall and from business profits only) as outcomes. See Table P7.

2.6. Basic Methodological Framework/Identification Strategy

The research design is a cluster randomized control trial, with treatment assigned at the school level. Lower levels of randomization, such as the classroom, are infeasible for two reasons. First, there was a single entrepreneurship teacher for the entering S4 cohort in 71 percent of schools, making school and classroom randomization equivalent for the bulk of the sample. Second, even if classroom randomization were feasible in a larger proportion of schools, the likelihood of spillovers across teachers and classrooms within the same school would contaminate treatment. Higher levels of randomization, such as the district, would also create problems because with 11 study districts, the small number of clusters would risk confounding treatment with district-level shocks. The school level therefore balances the tradeoff between the risk of treatment contamination and the need for a large number of clusters.

2.7. Data

We collected baseline and endline survey data from all schools. Data collection procedures were identical for treated and control schools. This project did not have a pilot.[15]

The baseline occurred at the beginning of the 2016 academic year, before the intervention began. We surveyed the head teacher, the S4 entrepreneurship teacher (one was chosen randomly when a school had multiple S4 entrepreneurship teachers), and 15 randomly selected S4 students.[16] Surveys covered school characteristics, perceptions of effective teaching practices,

[15] We also conducted two midline surveys on subsamples of schools, in October 2016 and June 2017. The first midline included a subsample of 82 schools (38 control, 44 treatment). The imbalance between treatment and control was due to economizing on travel costs to visit schools within proximity to each other. The second midline survey was in in a subsample of 80 schools (60 treatment, 20 control). The oversampling was deliberate in order to include all treatment schools from the first midline; all other schools differed between midline surveys. Each midline included a teacher survey, a survey of a subsample of students surveyed at baseline, and a classroom observation. We produced reports for government and the implementing NGO for each midline survey. The design and results of the midline played little role in the endline design, as most items in the endline questionnaire also appeared in the baseline (see bottom of Tables P3-P7 for mappings between baseline and endline variables). The midline surveys did influenced the endline classroom observation, however. Based on the first midline survey, we expanded the duration of the observation (from 40 to 52 minutes) and tweaked some category definitions in the Stallings instrument (for instance, "Practice and Drill" became "Repetition of Facts From Memory"). We also decided to split the analysis by halves of the observation. Because the sample size and design make the midline data less appropriate for formal analysis, we do not include it in this submission or in the pre-analysis plan registered at the AEA Trial Registry. However, we may include results from midline surveys in the Stage 2 submission, labeled clearly as exploratory analyses.

[16] Students were selected randomly from rosters submitted prior to baseline visits. Some schools had fewer than 15 students enrolled in S4, leading to a sample smaller than the expected 3,105.

demographics, student labor market and economic activity, entrepreneurship knowledge, and non-cognitive skills.

The endline survey occurred from July-September 2018, during the entering cohort's final year of secondary school (S6). The endline included student, teacher, and head teacher surveys, and a classroom observation. We conducted the endline while students were still enrolled in order to maximize our ability to find students from the baseline, although it prevents us from observing any post-secondary outcomes. We surveyed all students from the baseline, including extensively tracking out-of-school students. We successfully surveyed 619 of 658 (94 percent) of students not found in their baseline school.[17] The teacher survey included all teachers surveyed at baseline and the S6 entrepreneurship teacher when this teacher differed from the baseline. We also observed the entrepreneurship class of each surveyed teacher. If possible, we observed a Skills Lab.[18]

Error! Reference source not found. shows the baseline and projected endline sample sizes. (At the time of writing, we are awaiting processing of the endline data and therefore do not know sample sizes from each component, nor how they break down between treatment and control.) All survey instruments appear in the appendix. Figure 2 presents the timeline of the project and research.

The Kigali office of Innovations for Poverty Action (IPA) conducted all surveys. The baseline survey was conducted using paper records, with daily audits by Field Managers to ensure proper completion of surveys. Endline surveys used tablets for data entry in the field. Digitized data were checked for consistency by a Senior Research Associate in the IPA office.

We also have administrative data on teacher training attendance to measure take-up. Finally, we will attempt to collect administrative data on student exam performance and school completion, though we are unsure that this data will be made available for research.

[17] We also sampled additional students not surveyed at baseline in order to sample 15 students during each school visit. We will not use data on these additional students in the analysis because they lack baseline outcome data and because our tracking of out-of-school students was so successful.

[18] It is unlikely that all classroom observations will be Skills Labs due to teacher noncompliance and scheduling difficulties with school visits. For this reason, we test for differences in classroom behavior overall and in Skills Labs (Table P4). We also analyze the scheduling of Skills Labs as a separate outcome (Table P3).

2.8. Power Calculations

Error! Reference source not found. plots statistical power (vertical axis) as a function of minimum detectable effects (horizontal axis), under different intra-cluster correlation (ICC) assumptions.[19] We show ICCs of 0.09, 0.25, and 0.43, corresponding to the observed baseline ICCs of student employment during the school holiday, business ownership, and S3 exam scores, respectively. The horizontal red line corresponds to 80 percent power. Our sample size is sufficient to detect effects of 0.15, 0.21, and 0.26 standard deviations for the set of ICCs shown in **Error! Reference source not found.**. These effect sizes fall within the range of positive outcomes found in many studies of education interventions.

Error! Reference source not found. repeats the power calculations for the case when the outcome is measured in proportions, such as the share of students owning a business or employed.[20] At 80 percent power, our sample size is sufficient to detect effects of 7, 10, and 12 percentage points. As with outcomes measured in standard deviations, these effect sizes also fall within the range of positive outcomes found in many studies of education interventions. These power calculations are arguably conservative, as they do not account for the likely increases in precision when controlling for baseline outcomes.

3. Empirical Analysis

3.1. Statistical methods

The main statistical method we use is ordinary least squares linear regression (OLS). This is the appropriate method because randomized control trials solve (in principle) the selection problem for estimation of the mean outcome difference due to assignment to treatment. Moreover, OLS allows us to adjust easily for the stratification of treatment, ensuring that we rely on experimental variation. We will cluster standard errors by school to account for correlated outcomes among students within a school, the unit of treatment.

We show our proposed presentation of results in Tables P1-P9. Details on the analysis appear throughout Section 3.

[19] We assume a test size of 5 percent and an outcome standard deviation of one. We set sample sizes of 105 schools and 15 students per school, consistent with the research design.

[20] We assume a baseline proportion of 0.25, roughly in line with the share of students owning a business (0.22) or having a job last school holiday (0.27) in the baseline survey.

3.2. Variable definitions, missing values, and outliers

We refer to specific variables by their corresponding questionnaire items throughout this document. We will not impute missing values for any dependent variables. For covariates (e.g., baseline outcomes), we will replace missing values with the control group mean and include a dummy for missing in the regression (Haushofer and Shapiro 2015). To deal with outliers, we will winsorize all financial variables (e.g., income, savings) at the 99th percentile. We will not impute values for outliers in other variables.

3.3. Balance tests

We begin our empirical analysis by checking for balance in observable characteristics between treatment and control schools. First, we compare means of baseline variables, with the variables chosen in accordance with a pre-analysis plan submitted to the AEA Trial Registry prior to analyzing the data. For each variable, we present unadjusted means and standard errors by treatment status. To formally test for differences, we estimate the following equation:

$$X_{0isg} = \alpha + \beta T_{sg} + \gamma_g + \varepsilon_{isg} \qquad (1)$$

where *i* indexes students; *s* indexes schools; and *g* indexes strata. The strata are district-school type cells, where school types are public and non-public. In this equation, X_0 is a baseline characteristic of students, teachers, or schools; *T* is an indicator for assignment to treatment; γ is a stratum fixed effect; and ε is an error term. Because randomization occurred within strata, the strata fixed effects ensure that treatment assignment *T* is unrelated to the error term. The coefficient β measures the difference in means of the baseline characteristic. The associated *p*-value will be our test for equality of means.

We also look for systematic balance by regressing the treatment indicator on multiple baseline variables:

$$T_{sg} = \alpha + \boldsymbol{X}_{0isg}\beta + \gamma_g + \varepsilon_{isg} \qquad (2)$$

where $\boldsymbol{X}$ is a vector of baseline characteristics and all other notation is as in (1). To test for balance, we conduct an *F*-test to test for joint significance of the coefficient vector β. We run separate versions of (2) in which $\boldsymbol{X}$ consists of student, teacher, or school-level characteristics, as listed below. We also estimate an omnibus version that includes all baseline characteristics listed.

The baseline variables included in these balance tests are:

Variables for baseline balance tests

Category	Item	Source
School characteristics	boarding	BHQ109
	S4 enrollment, male	BHQ209
	S4 enrollment, female	BHQ209
	number of teachers, upper secondary	BHQ210
	teacher absences, past 3 weeks	BHQ213
	currently has electricity	BHQ216
	Head Teacher knows definition of Skills Lab	BHQ611
	considers at least 2 interactive pedagogical tools as among 3 most effective forms of teaching (question and answer; group work; games; activities outside classroom; experiment; portfolio)	BHQ614
Teacher characteristics	female	BTQ200
	age	BTQ201
	qualified	BTQ202
	showed written entrepreneurship lesson plan	BTQ224
	considers at least 2 interactive pedagogical tools as among 3 most comfortable forms of teaching (question and answer; group work; games; activities outside classroom; experiment; portfolio)	BTQ300
	can calculate business profit	BTQ402
	knows definition of business profit	BTQ405
	holds another job	BTQ600
Student characteristics	female	BSQ301
	household assets	BSQ306a-BSQ306g (mean)
	mother's education	BSQ310
	repeating S4	BSQ402
	S3 exam aggregate score	BSQ404
	employed during school holiday	BSQ700
	understands interest	BSQ803
	has savings	BSQ804
	can calculate business profit	BSQ1002
	wants to enroll in post-secondary schooling	BSQ1100
	plans to start a business	BSQ1102
	grit index	BSQ1300-BSQ1303 (mean)

Error! Reference source not found. presents results. Of the 28 variables tested, 4 (S4 female enrollment, proportion of sampled students who are female, student employment, and student grit) differ significantly between treatment and control schools at the 5% level. This is more than we would expect by chance. In regressions of treatment status on groups of baseline variables, student characteristics are jointly significant at 5%, though all baseline characteristics are not jointly significant at 10%.

Randomization fell under our control as researchers, making these differences simply bad luck. Moreover, the direction of any resulting bias is unclear: for instance, students in treated schools are grittier at baseline than those in control schools, but less likely to be employed. Bias

from the greater prevalence of female students in treated schools can largely be mitigated by estimating results separately by gender. Nonetheless, we will check robustness of our estimates of student outcomes by including a female dummy, baseline employment dummy, and baseline grit, with results presented in an appendix (see next subsection).

3.4. Main effects: Intent to Treat

The main results will come from the regression:

$$y_{isg} = \alpha + \beta T_{sg} + \delta y_{0isg} + \gamma_g + \varepsilon_{isg} \qquad (3)$$

where y is an outcome (with y_0 the outcome at baseline) and all other notation is as in (1). The coefficient of interest is β, which measures the intent to treat (ITT), or the effect of the offer of teacher training T on the mean outcome.

Tables P3-P7 show how we will present the main results and how they map to the hypotheses specified in Section 2.5. An appendix will present robustness checks that include the vector of imbalanced baseline variables listed in the previous subsection.

3.5. Partial compliance

There are several challenges to program implementation. Partial compliance with the experiment could come in three forms:

- *Teacher noncompliance*: Teachers could fail to participate in the training program.
- *Teacher contamination*:
    - Teachers from the control group could attend the training program.
    - Teachers could switch from treatment to control group, or vice versa, by transferring schools after learning of their group assignment.
- *Student contamination*: Students could switch from treatment to control group, or vice versa, by transferring schools after learning of their group assignment.

We will monitor teacher noncompliance via program attendance records. For each training, we will assign an attendance value of one to a school if at least one teacher from that school attended the training session, zero otherwise. We will then measure compliance as the school-level mean of this variable across all trainings (i.e., we use the take-up measures from

Section 2.5). If this measure of compliance falls below 85 percent for treated schools, we will supplement estimates of the intent to treat in (3) with an instrumental variables strategy:

$$D_{isg} = \mu + \theta T_{sg} + \delta y_{0isg} + \gamma_g + \nu_{isg} \quad (4)$$

$$y_{isg} = \alpha + \rho D_{sg} + \delta y_{0isg} + \gamma_g + \varepsilon_{isg} \quad (5)$$

in which *D* is an indicator for whether student *i*'s teacher attended training and *T* is an indicator for assignment to the treatment group. Equation (4) is the first stage equation for treatment take-up, while (5) is the second stage, in which *T* instruments for *D*. The parameter ρ measures the local average treatment effect (LATE), or the effect of the program for students whose teachers complied with their experimental assignment.

We will repeat the procedure for take-up of exchange visits if this measure falls below 85 percent. Differences between the LATEs for training and exchange visit attendance will be informative about the effects of these program elements among their respective compliers.

Teacher and student contamination will be measured via the endline survey, which asks about transfers between schools. If transfers exceed 15 percent of students or teachers, we will also estimate versions of the ITT equation (3) in which we drop transfers from the sample.

Another potential form of student contamination is if students assigned to the control group participate in similar entrepreneurship programs. To date, we have not heard of such programs, but will continue to monitor for their presence.

3.6. Attrition

Attrition occurs if we are unable to collect post-treatment outcome data on students who appear in the baseline sample. We will minimize attrition by attempting to locate students who transfer or drop out of school, with funds and personnel dedicated to this purpose in the endline. Nonetheless, some attrition is likely.

To deal with attrition, we will measure whether it varies by treatment status:

$$A_{isg} = \alpha + \beta T_{sg} + \gamma_g + \varepsilon_{isg} \quad (6)$$

where *A* is an indicator for being absent in the endline and all else is as in (3). If β is non-zero, then treatment assignment predicts attrition, raising concern that endline treatment and control samples are no longer comparable. Table P1 shows how we will present results of equation (6). Regardless of the results from (6), we will adjust our estimates for attrition by constructing Lee (2009) bounds.

3.7. Multiple outcome and multiple hypothesis testing

Many of the outcomes specified in Section 2.5 are indices composed of multiple survey items, reducing the number of hypothesis tests required. In addition to this approach, we will adjust *p*-values following the procedure to control the false discovery rate (FDR) in Benjamini, Krieger, and Yekutieli (2006).

3.8. Heterogeneous treatment effects

The effect of the program may differ among students or teachers. Testing for such effects is important as it may point to key policy nuances. We will allow treatment effects to vary according to observable characteristics of a student or school by modifying (3) as:

$$y_{isg} = \alpha + \beta_1 T_{sg} + \beta_2 \left(T_{sg} \times X_{0isg}\right) + \beta_3 X_{0isg} + \delta y_{0isg} + \gamma_g + \varepsilon_{isg} \qquad (7)$$

where X_0 is some characteristic determined prior to the treatment. A non-zero value of β_2 indicates that the effect of treatment differs according to X_0.

To keep estimation tractable, we will limit estimation of equation (7) to the following student outcomes:

- any business involvement [ESQ401, responses a/c]
- employment [ESQ401, responses b/c]
- total income from business and employment [ESQ401a]

The characteristics X_0 we plan to test are the following:

- gender (BSQ301): Gender disparities are important challenges in this context. Education policies in many countries have emphasized these disparities. It is therefore of interest to analyze this dimension.
- past academic performance (S3 exam score, BSQ404): Student readiness at the onset of the program may determine their ability to process and apply the new information.
- household socioeconomic status (SES)†: For certain outcomes like entrepreneurship, the SES of the family may matter for various mechanisms such as credit constraints. SES will be measured as an indicator for being above the median of the first principal component of the following variables:
    - parents' education (BSQ310)
    - household assets (BSQ303-308)
    - parents' occupation (BSQ309, indicator for business/professional)
- teacher characteristics
    - gender (BTQ200): teacher's gender may matter for the effect on students, both overall and according to the gender of the student.
    - years of teaching experience (BTQ206)
    - qualified teacher (BTQ203): It is important to understand the teaching experience and qualifications of teachers. This may inform teacher staffing policies.

Table P8 shows our proposed presentation of results on treatment effect heterogeneity.

Because male and female students face different challenges in completing secondary school and transitioning to economic activity, we also plan to analyze all student outcomes (hypotheses H4-H5) separately by student gender. In other words, we will reprise Tables P5-P7 separately for male and female students. We will present these results in Tables A2-A4.

3.9. Mechanisms

We seek to learn not only if the intervention was effective, but also why. Through what mechanisms did results occur? What aspects of the intervention were most or least influential?

One way to explore mechanisms is through regressions analogous to equation (7), where we replace *X* with *M*, a hypothesized mechanism through which the intervention influences outcomes:

$$y_{isg} = \alpha + \beta_1 T_{sg} + \beta_2 (T_{sg} \times M_{isg}) + \beta_3 M_{isg} + \delta y_{0isg} + \gamma_g + \varepsilon_{isg} \quad (8)$$

A non-zero value of β_2 in equation (8) now represents a differential effect of the program according to values of *M*. For instance, if *M* measures active instruction, then β_2>0 indicates that students whose teachers used active instruction more intensively increased their outcomes more than other students in the program.

This approach is worthwhile but faces two major drawbacks. First, *M* is an intermediate outcome of the program, i.e., the program alters *y* through its effect on *M*. It is therefore not entirely clear how to interpret a program effect that holds *M* constant; Angrist and Pischke (2008) refer to this as the problem of "bad control." Second, *M* is not randomly assigned among teachers. If *M* is correlated with unobserved teacher attributes that also affect the outcome (such as motivation), then β_2 will be a biased estimate of *M* 's role as a treatment effect mechanism. These caveats should be kept in mind when interpreting results.

We plan to test two types of mechanisms *M*: 1) take-up of program elements, and 2) pedagogy. These mechanisms correspond to hypotheses H1 and H3 in the theory of change, respectively. The program elements we plan to test are training attendance and exchange visit attendance, i.e., the first two measures of take-up that appear in Table P3. Again, we emphasize that because there was no exogenous variation in these program elements, any variation in take-up might reflect other factors. The pedagogical measures we plan to test are the three measures of (overall) active instruction examined in Table P3, i.e., time spent in active instruction and active instructional techniques from the classroom observation, and active instructional techniques from student reports. Table P9 shows our proposed presentation of results on mechanisms.

3.10 Cost effectiveness analysis

If the analysis reveals that the intervention influenced outcomes considered in our hypothesis, we plan to conduct cost effectiveness analysis, using cost data gathered throughout the experiment. Cost data has been reported annually by Educate!, the implementing NGO, using the J-PAL Costing Template. The template include costs across various categories, such as program administration, targeting, staff and user training, implementation, user costs, averted costs, and monitoring. Costs were US$71 per student over the three years of the program, or an

annual average of US$24 per student.[21] Ideally, we would compare these costs to those from the default government training provided to control schools. We plan to request this data, though we are unsure if it exists, given the uneven design of training in control schools (see footnote 7).

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5. Appendices

5.1 Survey instruments

All survey instruments are attached as appendices.

5.2 Entrepreneurship Syllabus

The key competencies expected at the end of each grade level are:

At the end of senior four (S4), the learner should be able to:

- Exhibit the behavioural qualities of an entrepreneur
- Make rational career choices in daily life
- Make plans to reach their personal goals
- Evaluate the need for laws in business operation
- Analyse the role of standards in business
- Examine key components of a market and the role of market research
- Analyse the importance of management in a business organisation
- Evaluate short and long term capital for future investment
- Evaluate the services/products offered by financial institutions.

At the end of senior five (S5), the learner should be able to:

- Generate business ideas and take advantage of opportunities
- Make valid contracts and resolve conflicts in business operations
- Justify the need for taxes in the economy
- Evaluate the factors that lead to business growth
- Analyze the role of technology in businesses and daily life.
- Maintain good relations with people at the workplace through effective communication
- Demonstrate ability and knowledge of carrying out general office operations
- Record accounting transactions and manage finances responsibly
- Exercise rights and responsibilities as an employee and employer
- Lead a team in accomplishing a goal

At the end of senior six (S6), the learner should be able to:

- Prepare a business plan for an enterprise
- Develop an ethical understanding of the Rwandan customs system
- Establish an effective quality compliance system in business activities
- Evaluate the contribution of entrepreneurship towards socio-economic development
- Analyse the Environmental Impact Assessment (EIA) as a tool for prevention and control of environmental impacts caused by socio-economic development

Skills Labs S4

- Intro to Entrepreneurship Process

- Creativity, Innovation, Invention
- Entrepreneurship as a Career
- Skills and Qualities
- Setting Goals
- Business Legal Formation
- The Ps of Marketing
- Competitor Survey
- Marketing Materials
- Quality Management
- Business Organizational Chart
- Personnel Management
- Fundraising for Sources of Capital
- Exploring Savings and Loans
- Record Keeping

Skills Labs S5:

- Generating Business ideas & Opportunities
- Business Contracts
- Business Taxes
- Market Survey
- Business Growth Strategies
- Effective Communication
- Business Skills and Customer Relations
- Business Documents
- Job Description
- Budgeting
- Financial Fitness Plan
- Journals
- Double Entry Accounting
- Rights and Responsibilities of workers and employers
- Safety Precautions
- Leadership Styles
- Developing a Team
- Problem Solving
- Conformity Assessment in Business

Skills Labs S6

- Role of Entrepreneurship in Social Economic Development
- Negative Effects of Economic Activity on the Environment
- EIA report
- Customs Procedures
- Importation and Exportation of Goods and Services in Rwanda
- Profit and Loss Account
- Balance Sheet
- Stock Control
- Marketing Plan

- Production Plan
- Business Plan
- Business Pitch
- Application of Metrology in Business Activities
- Writing a CV and application letter
- Interview Techniques

6 Administrative information

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7 Figures and Tables

Figure 1: Schools in sample

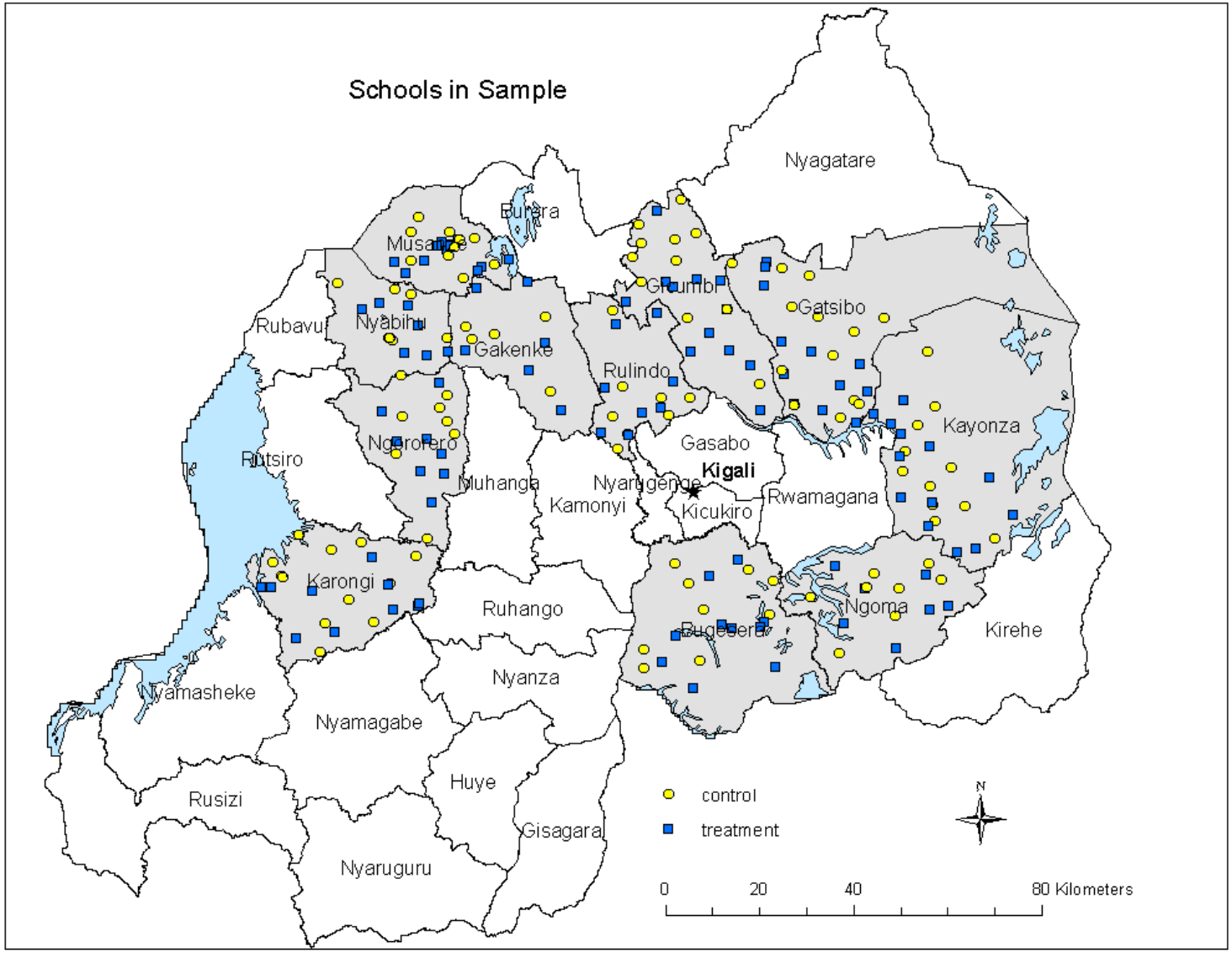

Figure 2: Timeline

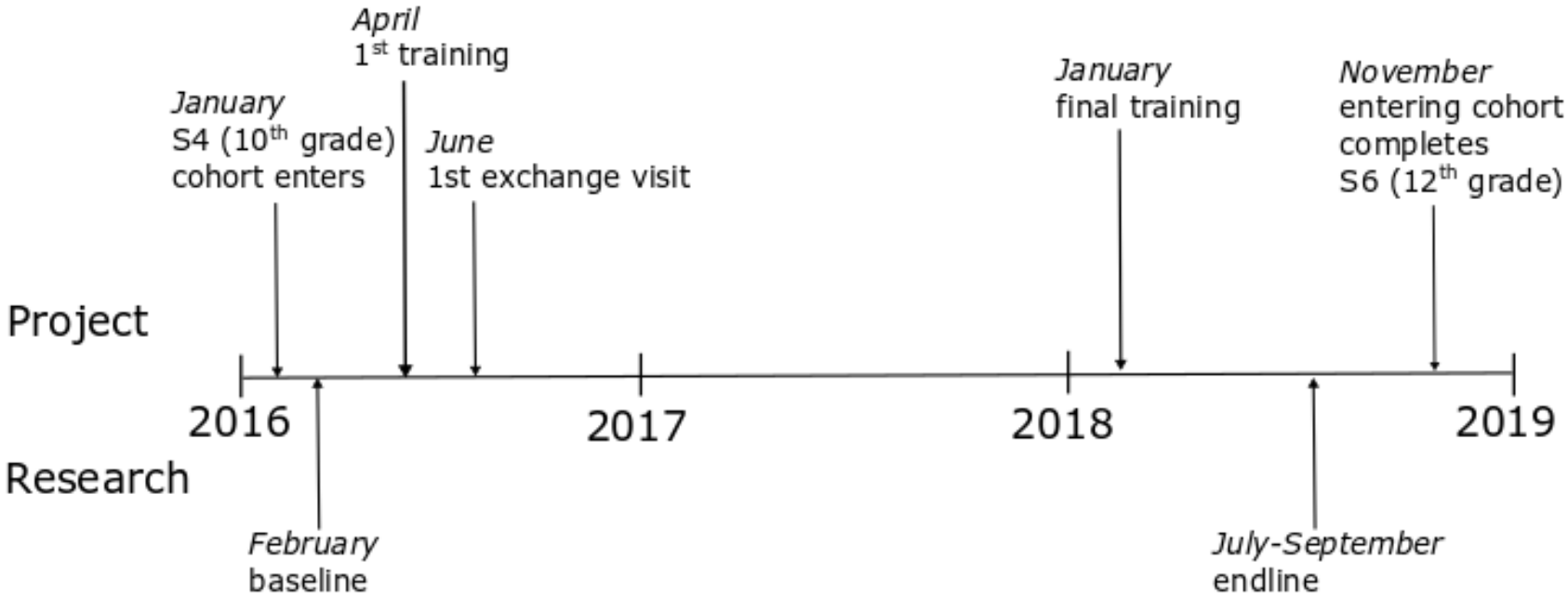

Figure 3: Theory of Change

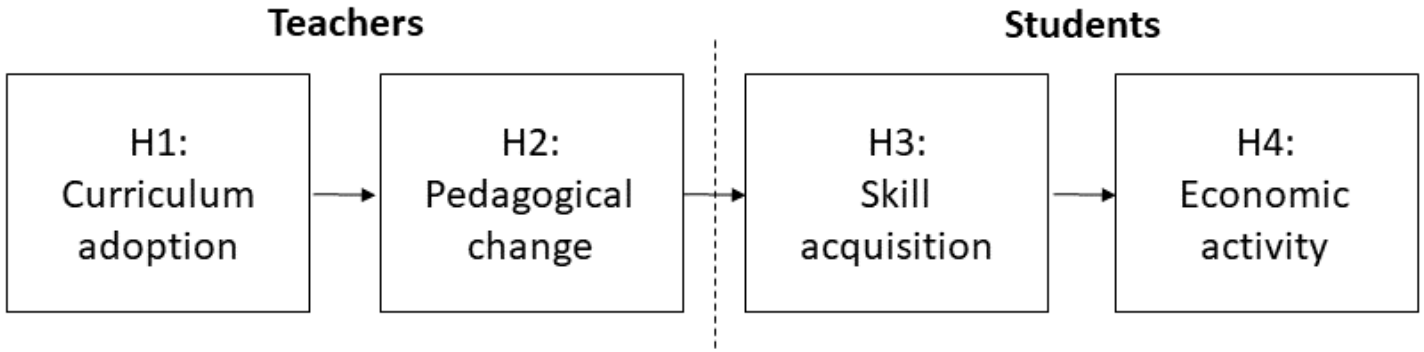

Figure 4: Power analysis, outcome in standard deviations

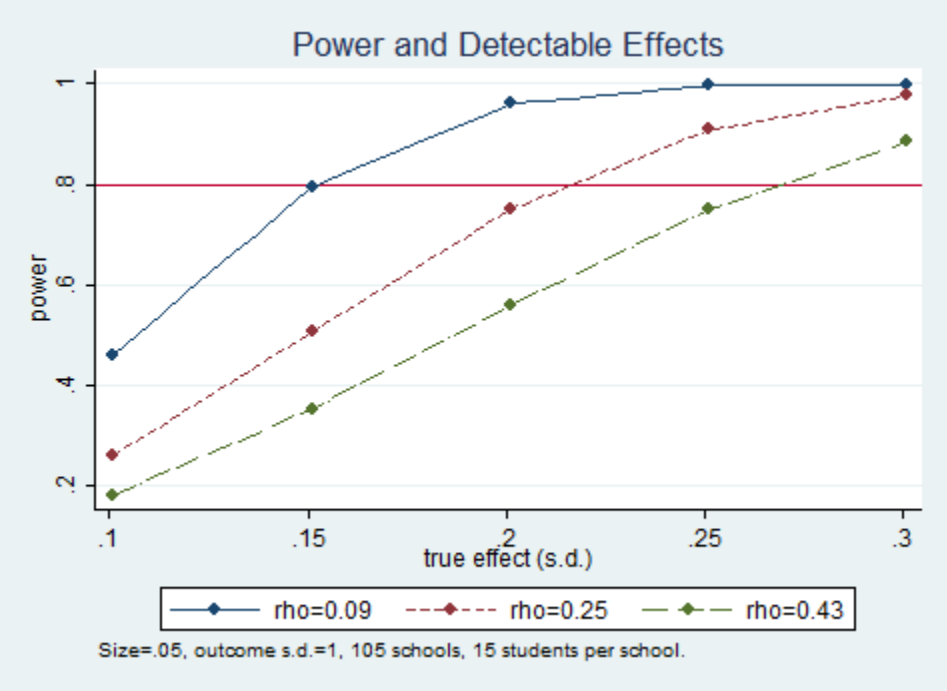

Figure 5: Power analysis, outcome in proportions

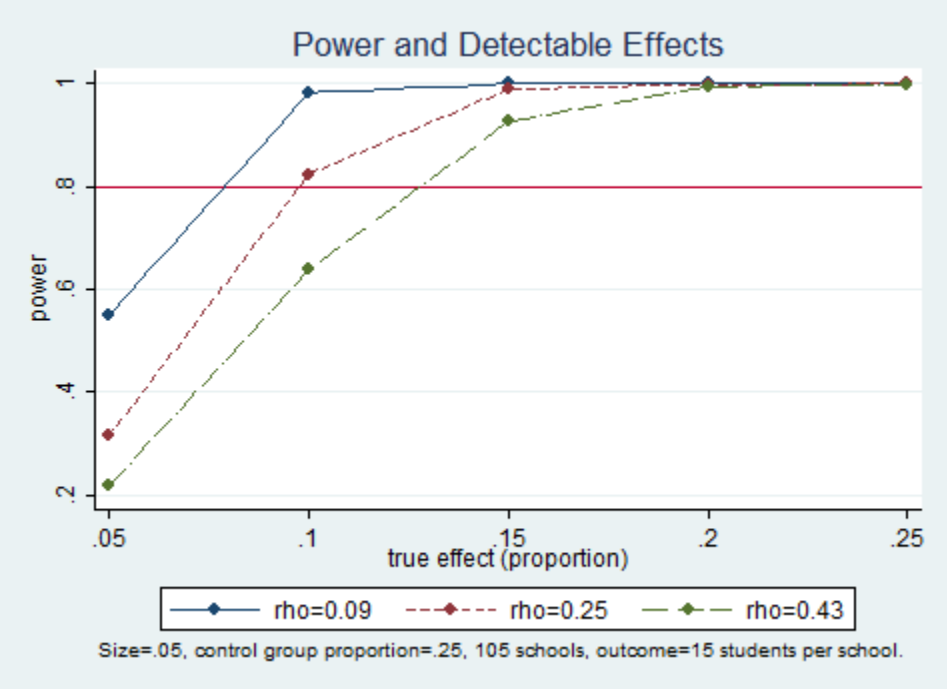

Table 1: Hypotheses

Hypothesis	Subhypothesis	Item	Outcome(s)
Compliance: Teachers take up the intervention.	C1: training attendance		administrative data
	C2: exchange visit attendance		administrative data
H1: Teachers adopt the curriculum.	H1(a): teacher curricular adherence	H1(a)(i): Skills Lab scheduled	ETQ, unnumbered[i]
		H1(a)(ii): use of lesson plans and notes[†]	ETQ407-408 (mean who showed plans)
		H1(a)(iii): knowledge of entrepreneurship curriculum content[†]	ETQ413-416 (proportion correct)
	H1(b): head teacher support	H1(b)(i): adherence to student-centered teaching style[ii]	EHQ507-508
		H1(b)(ii): promotion of skills-based learning outcomes[†,iii]	EHQ502/505/506
H2: Teachers alter pedagogy.[iv]	H2(a): proportion of classroom time in active instruction[†,v]		ETO Stallings classroom observation
	H2(b): use of active instructional techniques[†,vi]	H2(b)(i): based on classroom observation	ETO307-325 (mean)
		H2(b)(ii): based on student reports	ESQ600-603 (mean of at least one use)
H3: Students acquire skills.	H3(a): academic skills	H3(a)(i): dropout	EHQ, unnumbered
		H3(a)(ii): exam scores	ESQ504-505, administrative data[vii]
	H3(b): financial and entrepreneurship skills	H3(b)(i): monthly discount rate less than 100%	ESQ801
		H3(b)(ii): monthly discount rate less than 300%	ESQ802
		H3(b)(iii): understands definition of compound interest	ESQ803
		H3(b)(iv): any savings	ESQ804
		H3(b)(v): amount of savings (conditional on any)	ESQ805
		H3(b)(vi): entrepreneurship knowledge	ESQ900-906 (proportion correct)
	H3(c): non-cognitive skills	H3(c)(i): aspiration: university education or beyond	ESQ1000
		H3(c)(ii): aspiration: business or professional occupation	ESQ1001, responses 2/5
		H3(c)(iii): aspiration: intends to start business	ESQ1003
		H3(c)(iv): locus of control[†]	ESQ1200/1202/1204/1206/1208 (mean)
		H3(c)(v): persistence/grit[†]	ESQ1300-1303 (mean)
H4: Students engage in economic activity.	H4(a): business involvement	H4(a)(i): any business type	ESQ401, responses a/c
		H4(a)(ii): own business	ESQ402
		H4(a)(iii): student business club	ESQ402
	H4(b): employment		ESQ401, responses b/c
	H4(c): income	H4(c)(i): total income[viii]	ESQ401a
		H4(c)(ii): business profit (conditional on business involvement)	ESQ409-410

Table 2: Sample sizes

	Baseline	Endline (*projected*)
Schools	207	*207*
Treatment	103	*103*
Control	104	*104*
Surveys		
Head teachers	207	*207*
Treatment	103	*103*
Control	104	*104*
Teachers	207	*334*
Treatment	103	*167*
Control	104	*167*
Student	3,095	*3,095*
Treatment	1,554	*1,554*
Control	1,541	*1,541*

Endline projections of teacher surveys assumes 80 schools with one entrepreneurship teacher and two entrepreneurship teachers surveyed in remaining schools, consistent with initial preparations for endline survey in June 2018.

Table 3: Baseline balance

Variable	data source	control (1)	treatment (2)	difference (1) vs. (2)	p-value (1) vs. (2)
School characteristics					
boarding school	BHQ109	0.25	0.30	-0.05	0.25
		(0.04)	(0.05)	(0.06)	
S4 enrollment, male	BHQ209	27.1	25.5	1.6	0.51
		(2.0)	(2.2)	(3.0)	
S4 enrollment, female	BHQ209	32.9	41.4	-8.6	0.02
		(2.3)	(3.3)	(4.0)	
teachers, upper secondary	BHQ210	13.2	13.1	0.0	0.95
		(0.5)	(0.6)	(0.8)	
teacher absence (%),	BHQ213	0.05	0.05	0.00	0.87
last 3 Tuesdays		(0.01)	(0.01)	(0.01)	
currently has electricity	BH216	0.85	0.80	0.05	0.57
		(0.04)	(0.04)	(0.05)	
head teacher knows	BHQ611	0.06	0.07	-0.01	0.74
Skills Lab definition		(0.02)	(0.03)	(0.03)	
head teacher considers interactive	BHQ614	0.97	0.93	0.04	0.27
pedagogies as effective		(0.02)	(0.03)	(0.03)	
Teacher characteristics					
female	BTQ200	0.36	0.38	-0.02	0.88
		(0.05)	(0.05)	(0.07)	
age	BTQ201	33.6	33.7	-0.1	0.85
		(0.7)	(0.7)	(0.9)	
qualified	BTQ202	0.60	0.66	-0.06	0.42
		(0.05)	(0.05)	(0.07)	
showed written entrepreneurship	BTQ224	0.46	0.44	0.03	0.83
lesson plan		(0.05)	(0.05)	(0.07)	
comfortable with	BTQ300	0.89	0.92	-0.03	0.50
interactive pedagogies		(0.03)	(0.03)	(0.04)	
can calculate business profit	BTQ402	0.92	0.92	0.00	0.84
		(0.03)	(0.03)	(0.04)	
knows definition of	BTQ405	0.93	0.85	0.08	0.08
business profit		(0.03)	(0.04)	(0.04)	
holds another job	BTQ600	0.25	0.35	-0.10	0.06
		(0.04)	(0.05)	(0.06)	
Student characteristics					
female	BSQ301	0.54	0.62	-0.09	0.00
		(0.02)	(0.02)	(0.03)	
household assets	BSQ306	0.29	0.29	0.00	0.90
		(0.01)	(0.01)	(0.01)	
mother completed primary school	BSQ310	0.54	0.57	-0.03	0.13
		(0.02)	(0.02)	(0.03)	
repeating S4	BSQ402	0.04	0.04	-0.01	0.27
		(0.01)	(0.01)	(0.01)	
S3 exam score (aggregate)	BSQ404	53.5	52.7	0.7	0.53
		(0.8)	(1.0)	(1.3)	
employed during school holiday	BSQ700	0.29	0.25	0.05	0.04
		(0.02)	(0.02)	(0.02)	
understands compound interest	BSQ803	0.68	0.64	0.04	0.14
		(0.01)	(0.02)	(0.02)	

has savings	BSQ804	0.33	0.30	0.03	0.25
		(0.02)	(0.02)	(0.03)	
can calculate business profit	BS1002	0.55	0.51	0.04	0.27
		(0.02)	(0.02)	(0.03)	
wants to enroll in post-secondary	BSQ1100	0.72	0.74	-0.02	0.26
		(0.02)	(0.02)	(0.03)	
plans to start a business	BSQ1102	0.76	0.78	-0.01	0.15
		(0.01)	(0.01)	(0.02)	
grit index	BSQ1300-1303	2.88	3.01	-0.12	0.01
		(0.03)	(0.03)	(0.05)	
Schools		104	103		
Teachers		104	103		
Students		1,554	1,541		
p-values from omnibus tests:					
all school characteristics					0.08
all teacher characteristics					0.30
all student characteristics					0.00
all variables					0.13

Sample is baseline survey, conducted February-March 2016. Columns (1)-(2) show means by treatment status. Column (3) shows difference between (1) and (2). Column (4) shows p-value of difference, adjusted for stratification by district and public/non-public school. Standard errors in parentheses. Head teacher coded as considering interactive pedagogies to be effective if he/she lists two interactive methods (question and answer; group work; games; activities outside classroom; experiment; portfolio) as among three most effective. Teacher coded as comfortable with interactive pedagogies if he/she lists two interactive methods as among three most with which he/she is most comfortable. Household asset index is proportion of items owned among radio, television, telephone, refrigerator, bicycle, motorcycle, and automobile. Grit index is mean response on 1-5 scale (1=least, 5=most) to four items about passion and perseverance in pursuit of goals.

Table P1: Sample sizes and attrition

Panel A: Sample sizes	Baseline		Endline	
	control	treatment	control	treatment
	(1)	(2)	(3)	(4)
Schools	104	103		
Teachers	104	103		
of which:				
baseline	104	103		
added sample				
Students	1,540	1,554		

Panel B: Attrition from endline	control	treatment	difference	p-value
	(1)	(2)	(3)	(4)
teachers				
students				

Table P2: Baseline balance

See Table 3.

Table P3: Program take-up and curricular implementation (hypothesis H1)

	take-up		teacher curricular implementation			administrator perceptions	
	training attendance	exchange visit attendance	Skills Lab scheduled	lesson plans	entrepreneurship knowledge	student-centered teaching	skill-based learning
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
treatment	coef.	coef.	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N							
R-squared							
Control mean							
Baseline mean	N/A	N/A					
Data sources							
Endline outcome	administrative	administrative	ETQ, unnumbered	ETQ407-408	ETQ413-416	EHQ507-508	EHQ502/505/506
Baseline outcome	N/A	N/A	BTQ315	BTQ224-225	BTQ400-405	BHQ614-615	BHQ606/608/610

Table shows estimates of equation (3), including baseline outcome where indicated. Skills Lab scheduled is an indicator for whether the school reports Skills Lab in its weekly schedule when enumerators called to plan their endline school visit. Baseline outcome for Skills Lab scheduled is knowledge of Skills Lab definition.

Table P4: Pedagogical change (hypothesis H2)

	active instruction time						active instructional techniques		
	all observed classes			Skills Labs only			observed		student
	full observation	first half	second half	full observation	first half	second half	all classes	Skills Labs only	reports
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
treatment	coef.	coef.	coef.	coef.	coef.	coef.	N/A	N/A	N/A
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)			
N									
R-squared									
Control mean									
Baseline mean									
Data sources									
Endline outcome	ETO Stallings	ETO Stallings	ETO Stallings	ETO Stallings	ETO Stallings	ETO Stallings	ETO307-325	ETO307-325	ESQ600-611
Baseline outcome	BTQ300-302	BTQ300-302	BTQ300-302	BTQ300-302	BTQ300-302	BTQ300-302	N/A	N/A	N/A

Table shows estimates of equation (3), including baseline outcome where indicated. Active instruction time is the proportion of classroom time in Q&A/discussion, student presentation, and project/interactive activity. The baseline outcome for columns (1)-(6) is an indicator for whether the teacher considers at least 2 interactive pedagogical tools as among 3 most comfortable forms of teaching (question and answer; group work; games; activities outside classroom; experiment; portfolio). Active instructional techniques include group discussion, research, case study, role play, debate, finance/practice activity.

Table P5: Student academic outcomes and entrepreneurship skills (hypothesis H3)

	Academic skills			Entrepreneurship skills					
	exam scores			monthly discount rate		understands	savings		entrepreneurship
	S6 overall	S6 entrepreneurship	S4/S5 promotional	<100%	<300%	compound interest	any	amount (if >0)	knowledge
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
treatment	coef.	coef.	coef.	coef.	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N									
R-squared									
Control mean									
Baseline mean									
Data sources									
Endline outcome	administrative	administrative	ESQ504-505/admin	ESQ801	ESQ802	ESQ803	ESQ804	ESQ805	ESQ900-906
Baseline outcome	BSQ404	BSQ404	BSQ404	BSQ801	BSQ802	BSQ803	BSQ804	BSQ805	BSQ1000-1005

Table shows estimates of equation (3), including baseline outcome where indicated. Baseline outcome for academic outcomes is S3 exam score. Monthly discount rate based on stated preference for 5,000RWF today versus larger amount one month from now. Entrepreneurship knowledge is proportion correct on 7-item test. Results using administrative data will be omitted if data unavailable.

Table P6: Student non-cognitive skills (hypothesis H3)

	Aspirations			Locus	Grit
	university or beyond	business or professional	business creation	of control	
	(1)	(2)	(3)	(4)	(5)
Panel A: without baseline outcomes					
treatment	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N					
R-squared					
Control mean					
Panel B: with baseline outcomes					
treatment	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N					
R-squared					
Control mean					
Baseline mean					
Data sources					
Endline outcome	ESQ1000	ESQ1001	ESQ1002	ESQ1200-1208 (even)	ESQ1300-1303
Baseline outcome	BSQ1100	BSQ1101	BSQ1102	BSQ1200-1208 (even)	BSQ1300-1303

Table shows estimates of equation (3), including baseline outcome where indicated. Baseline outcome for academic outcomes is S3 exam score. Locus of control is mean of 5 items about personal control over outcomes, with each item scaled from 1 (no control) to 10 (total control). Grit is mean of 4 items about personal persistence, scaled from 1 (not true) to 5 (very true).

Table P7: Student economic activity (hypothesis H4)

	dropped out	business participation				business characteristics		employment	income	
		all	own	student club	family/ peers	non-agricultural	has paid employees		total	business profit
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
treatment	coef.	coef.	coef.	coef.	coef.	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N										
R-squared										
Control mean										
Baseline mean	N/A									
Data sources										
Endline outcome	EHQ, unnumbered	ESQ401	ESQ402	ESQ402	ESQ402	ESQ407	ESQ406	ESQ401	ESQ401a	ESQ409-410
Baseline outcome	N/A	BSQ600	BSQ604	BSQ604	BSQ604	BSQ601	BSQ600	BSQ500	BSQ503	BS608

Table shows estimates of equation (3), including baseline outcome where indicated. Business involvement (all) is indicator for choice (a) or (c) in item ESQ401. Business characteristics refer to main business only. Baseline outcome for "business has employees" is indicator for involvement in any business. Employment is indicator for choice (b) or (c) in item BSQ401. Income measured in RWF, previous two months. Business income conditions on any business profits.

Table P8: Heterogeneous treatment effects

	Interaction term					
	female student	baseline exam score	above median SES	female teacher	teacher experience	qualified teacher
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Outcome = business involvement [ESQ401/BSQ600]						
treatment	coef.	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
treatment x interaction	coef.	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N						
R-squared						
Control mean						
Panel B: Outcome = employment [ESQ401/BSQ500]						
treatment	coef.	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
treatment x interaction	coef.	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N						
R-squared						
Control mean						
Panel C: Outcome = income [ESQ401a/BSQ503]						
treatment	coef.	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
treatment x interaction	coef.	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N						
R-squared						
Control mean						
Data source for interaction term	BSQ301	BSQ404	BSQ303-310	BTQ200	BTQ206	BTQ203

Table shows estimates of equation (3), including baseline outcome and main effect of term interacted with treatment. Baseline exam score normalized to mean zero and standard devation one. SES is first principal component of household assets, parents' education, and indicator for parents in business or professional occupation.

Table P9: Mechanisms

	Interaction term				
	proportion trainings attended	proportion exchange visits attended	active instruction time	active instructional techniques (observed)	active instructional techniques (student reports)
	(1)	(2)	(3)	(4)	(5)
Panel A: Outcome = business involvement [ESQ401/BSQ600]					
treatment	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
treatment x interaction	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N					
R-squared					
Control mean					
Panel B: Outcome = employment [ESQ401/BSQ500]					
treatment	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
treatment x interaction	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N					
R-squared					
Control mean					
Panel C: Outcome = income [ESQ401a/BSQ503]					
treatment	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
treatment x interaction	coef.	coef.	coef.	coef.	coef.
	(s.e.)	(s.e.)	(s.e.)	(s.e.)	(s.e.)
N					
R-squared					
Control mean					
Data source for interaction term	administrative	administrative	ETO Stallings	ETO307-325	ESQ600-603

Table shows estimates of equation (3), including baseline outcome and main effect of term interacted with treatment. Baseline exam score normalized to mean zero and standard deviation one. Active instruction time is the proportion of classroom time in Q&A/discussion, student presentation, and project/interactive activity. Active instructional techniques include group discussion, research, case study, role play, debate, finance/practice activity.

Table A1: Youth education and economic activity, 2012 Rwanda Census

Sample	National			Sample Districts			Non-sample districts			Non-sample districts (excluding Kigali)		
Age group	15-19	20-24	15-24	15-19	20-24	15-24	15-19	20-24	15-24	15-19	20-24	15-24
Education												
never attended school	6%	11%	8%	6%	12%	9%	5%	11%	8%	6%	12%	9%
attended primary school	62%	55%	59%	64%	59%	61%	61%	53%	57%	64%	56%	60%
attended secondary school	32%	29%	31%	30%	27%	28%	33%	31%	32%	30%	29%	29%
attended university	0.2%	3.8%	1.9%	0.1%	2.1%	1.0%	0.2%	4.7%	2.4%	0.1%	2.8%	1.3%
currently attending school	63%	24%	44%	61%	21%	42%	63%	26%	45%	64%	25%	46%
literacy	86%	82%	84%	85%	80%	83%	86%	82%	84%	85%	80%	82%
Economic activity												
employed	25%	54%	39%	27%	59%	42%	23%	52%	37%	23%	53%	37%
self-employed/family worker	73%	75%	74%	81%	83%	82%	68%	70%	69%	77%	79%	79%
agriculture sector	67%	67%	67%	76%	77%	77%	61%	60%	61%	73%	73%	73%

Data from 2012 Rwanda Census. Employed refers to those who answered "Yes" when asked "Aside from your own housework, did you work at least 1 hour during the last 7 days preceding the census night?" Self-employed and employed in agriculture condition on employment. Literacy refers to the ability to read and write with understanding at least one language.

Tables A2-A4: reprise of Tables P5-P7, separately for male/female students

[i] Data source: teacher mobilization data collected by enumerators in preparation for endline visit. These data record each entrepreneurship teacher's weekly class schedule, and whether the class is a Skills Lab.

[ii] Measured by indicators for whether head teacher considers at least 2 interactive pedagogical tools as among 3 most/least effective forms of teaching entrepreneurship. Interactive pedagogical tools include question and answer; group work; games; activities outside classroom; experiment; portfolio.

[iii] Index constructed as mean of indicators for ranking "student skills" first in EHQ502 and knowing definition of Skills Lab in EHQ505-506.

[iv] For hypothesis H3, we will report results separately for all classes and for Skills Labs, because Skills Labs focus more explicitly on active learning pedagogy. For hypothesis H3(a), we will report results separately for the full, first half, and second half of the classroom observation. We expect a greater discrepancy in active instruction in the second half of the observation because teachers will have had sufficient time to introduce an interactive activity.

[v] Active instruction is the proportion of classroom time in Q&A/discussion, student presentation, and project/interactive activity.

[vi] Active instructional techniques include group discussion, research, case study, role play, debate, finance/practice activity.

[vii] At the time of writing, it is unclear if administrative data to measure these outcomes will be available for research.

[viii] For hypothesis H5(c)(i), our preferred measure of income is a simple question about income from all sources in the previous two months, consistent with the recommendation of de Mel, McKenzie, and Woodruff (2009) regarding measuring microenterprise profits. However, we will check robustness to an alternative measurement, the sum of profits and earnings from ESQ409-410/415-416/420-421.