Components of a Financial Education Technology for Micro-Entrepreneurs in Brazil

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Keywords: Financial education, education technology, pedagogy, economic development, entrepreneurship training

- A pedagogical framework for scalable, virtual micro-entrepreneurship trainers
- An analysis of micro-entrepreneurs' importance in economic development and educational needs
- A three-dimensional analytical lens to assess and develop micro-entrepreneurship training
- An examination of experimental micro-entrepreneurship training programs

Purpose: This article designs a pedagogy and scalable technological solution to provide Brazilian micro- and small enterprises with guidance in business management habit-development.
Approach: The study demonstrates the need for formalized micro-entrepreneurship training and, given general financial education programs' poor performance, considers micro-entrepreneurs' fundamental educational needs.
Findings: The analysis provides three fundamental components to consider in micro-entrepreneurship training design: content utility, communication intelligibility, and material interactivity.
Research implications: The proposed pedagogy and virtual trainer technology suggest further study and development of optimal approaches to content utility, communication intelligibility, and material interactivity to improve micro-entrepreneurial habit-development and economic development.

JSSE

Journal of Social Science Education
Vol. 19, No. 3 (2020)
DOI 10.4119/jsse-1197
pp. 40-65

1 Introduction

Financial illiteracy poses an acute risk to the world economy (Klapper et al., 2015). In the following article, I construct a pedagogy and education-technology to improve financial literacy for a particularly economically impactful, yet neglected, segment:

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micro- and small enterprises (MSEs). I aim to optimize learning, promote financially healthy habit-development and decision-making, and reach populations at sufficient scale to strengthen economies. Having initially developed this framework for Brazilian micro-entrepreneurs, I explain the economic rationale for focusing on MSEs, considering their learner profiles, and pursuing a technological solution.

In developing countries, MSEs provide crucial employment opportunities and countercyclical buffers for low-income communities, mitigating economic shocks (Lafortune et al., 2016; Messina & Silva, 2018; Roratto et al., 2017). These enterprises, however, rarely implement the standard business- and financial-management practices commonly observed in developed economies' MSEs (McKenzie & Woodruff, 2013). This phenomenon is concerning since the rate of business-practice implementation directly correlates to firm survival and productivity (McKenzie & Woodruff, 2015).

Governments, nonprofits, and financial institutions world-wide have recognized the issue and seek to improve financial literacy globally (Carpena & Zia, 2018). The World Bank alone invests $1 billion annually in initiatives, but despite these efforts, few initiatives have been impactful (Anderson et al., 2016). So far, successful initiatives have benefited school-age children (Bruhn et al., 2014). While such education will be critical to building more financially literate decision-makers in the future, improving adult financial decision-making is critical to bettering current precarity.

Unfortunately, adults are not primed to improve financial literacy through contemporary financial education. In developing countries' low-income communities, limited prior education; cognitive hurdles, such as procrastination and forgetfulness; and distraction by more pressing responsibilities restrict learning (Bruhn et al., 2014; Carpena et al., 2011, 2015;). Effective adult financial education, therefore, requires individualized attention, simulation and practice, and effective tools to overcome skill deficiencies (Carpena et al., 2011, 2015; Pontifícia Universidade Católica, n.d.). Nevertheless, most adult programs take the form of short-term classroom workshops and demonstrate little to no impact on financial behavior (Anderson et al., 2016; Bruhn et al., 2014; Cole et al., 2009;). Thus, adults require pedagogy that instills habits. Further, given their economic importance and the opportunities they provide their communities, micro-entrepreneurs deserve particular attention (Anderson et al., 2016).

Ultimately, more inclusive economic growth requires financially healthy MSEs, strengthening developing economies' very foundation. To achieve this, mass training for millions must generate sustained, widespread improvements in business practices. My proposal derives from a Brazilian economic context; however, MSEs' role and importance are similar across developing nations (Ayyagari et al., 2017; McKenzie & Woodruff, 2013). While the data I provide are unique to Brazil, they provide accurate proxies for global trends.

To conceptualize a scalable, technology-based training method throughout the rest of this article, I first examine Brazilian micro-entrepreneurs' socioeconomic context and demographics to construct learner archetypes, or *personas*. Then, I analyze experimental training programs, identifying effective pedagogical components. Section 4 proposes a scalable technological solution tailored for Brazilian micro-entrepreneurs, which I term *virtual trainer*.

2 The micro-entrepreneurial persona

The micro-entrepreneurial persona presents socioeconomic and educational obstacles to learning and habit-development. micro-entrepreneurs are socioeconomically stressed and lack formal education; nevertheless, they demonstrate incredible business resilience and technological literacy.

2.1 Socioeconomics

MSEs remain a critical pillar of Brazil's economy, representing 99% of total enterprise, producing 28% of GDP, and providing 55% of jobs and 44% of salaries (Governo Federal do Brasil, 2019). In 42% of cases, though, Brazilian micro-entrepreneurship arises from lack of employment or other economic opportunity, known as *necessity entrepreneurship* (Global Entrepreneurship Research Association, 2017). More critically, a vast number of Brazilian micro-entrepreneurs begin and run their businesses without a business plan or basic bookkeeping, impeding their long-term planning and data-driven decision-making.

Healthy economies require financially literate, healthy populations (Lusardi & Mitchell, 2011), but financially stable businesses represent a doubly critical component. Entrepreneurship ensures the financial health of not only business owners, but also their communities. Developing economies, with higher necessity entrepreneurship rates, could therefore benefit greatly from business-targeted training by reducing employers' financial vulnerability. In Brazil, for instance, MSEs provide this critical economic pillar yet also account for 95% of delinquent debt (Serasa Experian, 2018a, 2018b).

A new streamlined formalization process, Simples Nacional, has led to a steep rise in formal businesses with 17.3 million new businesses between 2010 and 2020, particularly within the individual micro-entrepreneur (MEI) category, representing a mass-influx of existing MSEs into the formal economy (Torrente, 2020; Serasa Experian, 2018c).

Brazilian MSEs' informal origins mean micro-entrepreneurs historically faced minimal governmental oversight and remained "off the books." Despite formalization, micro-entrepreneurs remain uninformed about accounting and business plan development, citing a significant need for financial-management guidance (SEBRAE, 2019). Micro-entrepreneurs recognize that improved business decision-making and management would help them, but they struggle to learn and implement proper techniques (Instituto de Estudos do Trabalho e Sociedade, 2012).

Over 60% of MEIs operate in the service sector; another third in commerce; both industries present few barriers to entry (Serasa Experian, 2017). Further, 48% of total MEIs in 2019 had already operated for ten years or more prior to formalization (SEBRAE, 2019).

Micro-entrepreneurs normally do not conduct bookkeeping, separate business and family financial accounts, or track inventory (Anderson et al., 2016; McKenzie & Woodruff, 2013). Not implementing these practices demonstrates owners' struggle to financially plan and/or consider the opportunity costs of allocating capital away from revenue-generating operations.

As Brazilian MSEs' economic contribution continues growing, their success or failure both reflects and directly influences that of Brazil's greater economy (Roratto et al., 2017). Training micro-entrepreneurs helps them achieve financial sustainability, bolstering their businesses and communities. Reaching the millions of MSEs, however, require a scalable educational solution.

2.2 Demographics

Women represent 43% of all MEIs (SEBRAE, 2019). Considering Brazil's 67% growth in women heads of household between 2004 and 2014 and women's average 21 hours of weekly household work, these business owners must juggle many responsibilities (Caldas, 2017), impeding their habit-development.

Brazilians between ages 25 and 59 have completed 8.8 years' schooling on average (Instituto Brasileiro de Geografia e Estatística [IBGE], 2018a). Among MEIs, 39% completed secondary school; 30% completed less (SEBRAE, 2019). Generally, 27% of Brazilians are functionally illiterate (Catelli Jr. et al., 2016). In contrast, 76% of female and 90% of male "high-growth" entrepreneurs in Latin America hold a bachelor's degree or higher (Inter-American Development

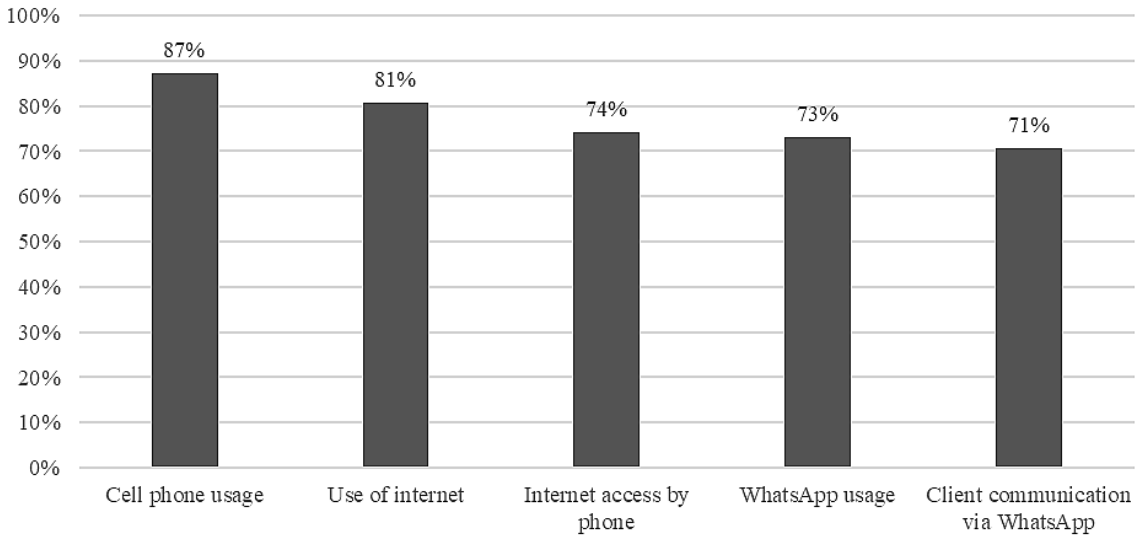
Bank & Mancera S.C., 2014). Therefore, 71% of MEIs operating five or more years reflects powerfully on micro-entrepreneurs' resilience and natural abilities (SEBRAE, 2019).

These businesses' survival rates, however, should not be confused with rates of "comfortable sustainability." 10% of low-income favela micro-entrepreneurs would explicitly prefer employment to entrepreneurship, and only 26% of businesses generate sufficient income to sustain micro-entrepreneurs' families (Instituto de Estudos do Trabalho e Sociedade, 2012). Among high-income Latin American enterprises, 72% of female and 96% of male entrepreneurs come from medium-high to high income brackets (Inter-American Development Bank & Mancera S.C., 2014). With 77% of MEIs relying exclusively on their business for household income, micro-entrepreneurs find themselves in unending pressure and financial stress, making them seek immediate rather than long-term solutions. These circumstances impede their ability to learn, apply, and benefit from business education and training (Carpena et al., 2015).

2.2.1 Technological literacy

While more unique to Brazil than other micro-entrepreneurial traits, technology usage rates offer a key advantage. In 2017, 93.4% of Brazilians over age 14 accessed the internet (IBGE, 2018b). Figure 1 shows MEIs' usage rates of the internet, cell phones, and WhatsApp messaging (Bedê & Lago, 2018). Considering the socioeconomic and educational challenges MEIs face, these rates are astounding.

Figure 1: Technology usage rates among MEIs



Source: adapted from Bedê & Lago, 2018.

3 Experimental methods and results

Given improved business practices' positive impacts on firm health (McKenzie & Woodruff, 2015), I now analyze a series of experimental training programs that provide valuable pedagogical components.

First, I explain three fundamental components of effective micro-entrepreneurship pedagogy and their unifying dialogue education-based framework, distilled from my research and teaching. Through this lens, I analyze experimental training programs.

3.1 Components of effective pedagogy

Sweller (1988) asserts experts and novices differ in problem-solving strategies, composed of problem-solving building blocks or *schema*, where learning is the process of acquiring schema. Greater expertise allows learners to draw upon previous experience; greater disparity between difficulty of *learning elements* and a learner's experience level decreases learning (Sweller, 1988). Content's difficulty is relative to the learner's expertise or experience level and affects the degree of learning achieved. Therefore, matching expertise levels with appropriately challenging content is critical for effective pedagogy.

Further research demonstrates that learning varies based on the effort needed for a learner to process the media presenting the elements. Interpreting the media can itself pose challenges whereby unintelligible materials divert learners' attention from understanding elements and acquiring schema (Van Merriënboer & Ayres, 2005). Intelligible communication minimizes this distraction and focuses learners appropriately.

Motivation also plays a key role. Greater motivation produces more focus and, ultimately, higher performance. Engaging learners immediately, through interactive experiences with learning elements, increases motivation and schema acquisition (Debue & Van de Leemput, 2014). Through interactivity, learners see how schema help solve problems, fostering positive feedback in an environment where they can seek guidance and resolve questions and confusions—stressors that obstruct learning and habit-development.

Appropriate elements for learners' experience levels; intelligible presentation; and hands-on practice comprise the three primary components of effective pedagogy. I hereon refer to these components as *content utility*, *communication intelligibility*, and *material interactivity*. Effective pedagogy requires these components; however, a framework must also unify them. Vella's (2008) *dialogue education* unifies the components in-classroom and can do so through technology as well.

3.1.1 Dialogue education

Dialogue education fosters learning through conversation between adult learners, "of whom the teacher is one" and to which all bring experience to be tapped, building upon each learner's contexts, experiences, and understandings (Vella, 2008). This mutual respect ensures teachers tailor content, communication, and interactivity appropriately and proves especially effective for disadvantaged communities with less formal education (Banda, 2014), such as Brazil's micro-entrepreneurial population.

In micro-entrepreneurs' daily lives, conditions are stressful, and time is limited (Carpena et al., 2015). Traditionally, dialogue education is in-person, limiting convenience and scalability; however, educators find that contemporary technologies facilitate dialogue online (Gunnlaugson & Moore, 2009). Considering Brazilian micro-entrepreneurs' high technological literacy, the internet offers an unparalleled communication channel.

Within this online learning environment, dialogue education bridges human-computer interaction, embodying the technology's *user experience* (UX; Schär & Minder, 2006). Therefore, through analyzing the following experimental trainings, I seek concrete techniques to optimize the pedagogical components for a training technology with a dialogue education-based UX, or *dialogue-UX*.

3.2 Content utility

3.2.1 Actionable heuristics

Offering a method to improve content utility for learners, Drexler et al. (2014) compare two small-business accounting courses in the Dominican Republic: "standard" and "rules of thumb." Both courses occur in classroom settings, once a week, three hours per class, with university-educated instructors experienced in adult education; standard lasts six weeks, rule-of-thumb five. Both cover consumption, savings, and debt management in the first three classes. Standard then also teaches daily recordkeeping of cash sales and expenses, inventory management, accounts receivable and payable, profit calculation, and investment planning. Rule-of-thumb teaches "simple heuristics" or routines to aid decision-making without presenting extensive accounting concepts. Rule-of-thumb training focuses on separating household and business finances, with techniques including using separate cash boxes, paying oneself a fixed salary, not using business funds for personal expenses, and estimating profit via cash on-hand.

3.2.1.1 Experiment and results

Drexler et al. (2014) assign 1,193 participants randomly to a rule-of-thumb, standard, or control treatment. On average, participants are 40 years old, 90% are women, and 65% completed high school. Businesses consist primarily of local retail shops, general stores, salons, and food service. 60% are sole proprietorships, and another 32% employ one or two additional people.

Table 1 presents the impact on rule-of-thumb and standard participants' implementation rates of trained practices compared to the control. The results display a greater impact on rule-of-thumb participants' practices than standard course participants'. The only metric that increases more with standard treatment businesses is total employees, with setting aside cash for business expenses and the business practices index[1] the only other metrics to increase by 5% or more at all. Rule-of-thumb training, however, produces implementation-rate increases of 5% or better for nine of the twelve metrics. This includes an 11.2% increase in sales during bad weeks, demonstrating greater resilience against negative shocks (Drexler et al., 2014).

Table 1: Impacts on select business practices and performance metrics

Training Components	Standard	Rule-of-thumb
Separate business and personal cash	0.0%	8.0%
Keep accounting records	4.0%	11.0%
Set aside cash for business expenses	7.0%	12.0%
Calculate revenues formally	2.0%	6.0%
Business practices index	7.0%	14.0%
Savings	2.0%	8.0%
Savings amount	-19.6%	7.9%
Reporting errors	-4.0%	-9.0%
Total number employees	7.0%	-3.0%
Revenue index	-3.0%	9.0%
Sales, average week	-7.8%	4.9%
Sales, bad week	-7.6%	11.2%

Source: adapted from Drexler et al, 2014.

Further, Table 2 reports differing impacts across experience levels (completed high school, previous financial training), prior training interest (initially indicated interest), and initial business practices index. The researchers find both skill levels improve in business practices and book-keeping accuracy ("Reporting errors") from rule-of-thumb, but the lowest initial business management quartile more so. From the standard course, however, high-skilled participants improve in all metrics. Participants considered low-skill or in the first business-practices quartile improve revenue indices with rule-of-thumb by 17% and 27% respectively versus standard training.

Table 2: Impact of training, by subgroup

	All	Skill level		Baseline business practices (by quartile)		
		Low	High	First	Third	Fourth
Rule-of-thumb training						
Business practices index	14.0%	16.0%	11.0%	28.0%	13.0%	7.0%
Reporting errors	-8.0%	-10.0%	-6.0%	7.0%	-27.0%	-3.0%
Revenue index	9.0%	10.0%	8.0%	12.0%	7.0%	14.0%
Sales, bad week (RD$)	967.00	533.00	1,378.00	970.00	297.00	942.00
Standard accounting training						
Business practices index	8.0%	10.0%	5.0%	7.0%	18.0%	-8.0%
Reporting errors	-4.0%	2.0%	-12.0%	15.0%	-17.0%	-7.0%
Revenue index	-2.0%	-7.0%	7.0%	-15.0%	2.0%	13.0%
Sales, bad week (RD$)	-669.00	-1503.00	577.00	-2520.00	512.00	-735.00

Source: adapted from Drexler et al, 2014.

3.2.1.2 Analysis

Most striking is rule-of-thumb's heterogeneously positive impacts; both low- and high-skilled participants benefit from the training. Initially, this might suggest that learners' experience level and the content's relative difficulty is not necessarily related; however, high-level learners also benefit from the standard course—increasing business-practice and revenue indices and decreasing reporting-error rates. While more-experienced micro-entrepreneurs benefit from both heuristic and traditional strategies, less-experienced learners clearly do not benefit from more challenging standard content. Low-skill-level participants suffer decreased revenue indices and bad-week sales, and first-quartile participants suffer significantly less improved business practices indices, more reporting errors, and worse bad-week sales.

The utility of rule-of-thumb's heuristic approach is in paring necessary knowledge into relevant, actionable techniques (Drexler et al., 2014). Focusing on practical actions not abstract concepts, the material builds a foundation for novice learners to successfully problem-solve and acquire schema. But, matching difficulty and experience—inherent in dialogue education—and not just simplifying content appears impactful. More experienced standard-course participants improved bookkeeping accuracy over their experienced rule-of-thumb counterparts, benefiting from more

challenging abstract content. A dialogue-UX can provide rule-of-thumb and standard content based on determined learner experience levels.

3.2.2 Growth versus efficiency focus

Anderson et al. (2016) compare two business-training programs in Cape Town, South Africa. One provides marketing and sales training; the other teaches financial management.

Marketing training most impacts less-experienced micro-entrepreneurs, who adopt a "growth focus": implementing market research, obtaining customer and supplier feedback, and advertising. Financial training benefits the more experienced—with established revenue streams—who develop an "efficiency focus": financial management habits and more cost-efficient processes.

Trained volunteer instructors with academic business qualifications and experience teach the courses. Each course comprises ten weekly modules with four hours' classroom learning and four hours' at-home online learning and practice. Classroom sessions explain concepts; homework focuses on reflection and practice.

Marketing covers value and value creation, branding, market research, customer relationship building, creating and executing sales opportunities, listening and questioning, understanding and helping customer choice, post-sale satisfaction, sales pitching, and growth targeting. Finance includes financial vocabulary, money flow, bookkeeping, financial statements, cost structure, opportunity cost, financial analysis and decision-making, profitability and liquidity, budgeting, cash flow, working capital, creating business goals, and financial products.

3.2.2.1 Experiment and results

Anderson et al. (2016) randomly assign 266, 270, and 316 micro-entrepreneurs to finance, marketing, and control groups respectively. Participants are age 38 on average; 45% are female. 67% have taken part in some higher education program. The average business has operated for five or more years and employs two or more employees.

Analyzing the financial and operational impacts presented in Table 3 reveals the trainings have clear positive impacts over the control. The researchers find that within a year of training, marketing participants hire one additional worker on average, particularly sales staff, a rate 57% higher than the control group. They also, however, increase costs 66%, mainly from higher material, stock, and wage expenses. In contrast, finance participants improve efficiency, with output-input ratios five times greater than the marketing group's and much higher loan-repayment rates.

The researchers measure businesses' establishment—a composite index of the businesses' registration status, years of operation, size, and capital invested. A clear correlation appears between establishment and which training is beneficial. With financial training, while less established businesses do not improve profits, businesses with above-median establishment indices improve profitability 67% over the control. Further, participants' exposure—an experience-level composite index—and training also demonstrate a correlation, whereby marketing-trained firms with less experience produce a 123% increase in profit over the control group, and in fact low-experience finance-trained firms a 53% increase as well.

Table 3: Business performance compared to control treatment

	Marketing	Finance
Total number of employees (full- and part-time)	57.39%	21.35%
Revenue change	64.4%	25.3%
Cost change	66%	17%
Profit change over control group	61%	41%
Profit change among business with above median time established (5 years)	30%	67%
Profit change among business with below median exposure index	123%	53%
Output-input ratio growth	23%	120%

Source: adapted from Anderson et al., 2016.

Behaviorally, though, impact is even more distinct between trainings and control. In line with the marketing participants' growth focus, Table 4 shows that rates of marketing behaviors increase significantly among marketing participants, compared with control and finance participants. Finance behaviors increase more among finance participants than control or marketing participants. Interestingly, both treatment groups increased financial-behavior rates of business budgeting and spending analysis almost equally. The marketing treatment, in fact, shows greater financial-behavior increase in rates of using records to check sales growth and making a balance sheet, consistent with the value those two habits offer a growth-focus micro-entrepreneur: tracking sales growth and sales' impact on business net worth.

Table 4: Impacts on marketing and finance behaviors compared to control treatment

Behavior	Treatment	
	Marketing	Finance
Marketing		
Observe competitors	4.3%	3.5%
Discuss products with suppliers	20.3%	11.9%
Discuss preferences with customers	15.5%	2.1%
Ask former customers for feedback	16.0%	-0.7%
Research customer needs	18.3%	8.1%
Improve product/service design	13.5%	11.1%
Advertise business	11.5%	4.9%
Open new distribution channel	3.9%	3.1%
Change pricing	8.3%	0.5%
Develop new product/service	9.3%	5.2%
Analyze business capabilities	14.0%	12.4%
Offer advice to customers	12.9%	10.2%
Match customer mood	9.3%	0.5%
Rank products/services based on customer purchasing criteria	15.2%	8.8%
Contact customer after to evaluate satisfaction	9.8%	6.9%
Finance		
Separate business and personal finances	2.2%	9.5%
Create and track business records	6.1%	18.9%
Record total assets	4.9%	14.7%
Record total liabilities	2.2%	11.1%
Record all money in and out	5.3%	21.4%
Use records to assess available cash	11.9%	17.0%
Use records to check sales growth	14.1%	12.6%
Identify fixed and variable costs	-0.3%	12.4%
Compare performance against targets	0.4%	3.5%
Examine working capital of business	8.5%	12.7%
Make a business budget	13.2%	14.4%
Analyze spending against budget	14.1%	14.3%
Make an income statement	4.9%	9.9%
Make a balance sheet	9.6%	5.4%
Use records to assess affordability of loan or investment	13.0%	17.6%

Source: adapted from Anderson et al., 2016.

3.2.2.2 Analysis

Marketing and finance trainings' differing impacts on business practices across experience levels fit with content utility's role in learning outcomes. The trainings also offer dialogue-UX content options to foster behavioral changes based on learners' existing schema and their immediate needs and responsibilities. The results reflect how novices and experts differ in their responsibilities and the problems they are best equipped to solve, given experience and pre-acquired schema (Sweller, 1988; Banda, 2014). Inexperienced micro-entrepreneurs want to establish consistent revenue streams, key to initial survival. The opposite is true of experienced micro-entrepreneurs with existing revenue streams, now wishing to increase profits by reducing costs through accounting and financial-analysis techniques (Anderson et al., 2016).

3.3 Communication intelligibility

3.3.1 Video education

Carpena et al. (2011) test the effectiveness of a five-week, video-based financial education course for low-income urban households in India. The course covers budgeting, savings, credit, and insurance and presents topics based on "standard materials"—typically challenging for populations with limited schooling—through two- or three-hour videos featuring lectures, relatable fictional characters, and interviews.

3.3.1.1 Experiment and results

The researchers randomly assign two-thirds of 1,348 participant households—not necessarily with a microbusiness—to receive the financial education course and one-third the control. Participants take post-course tests to assess learning.

The average household comprises six members and earns US$115 in average monthly income. Women represent 57% of participants. 47% completed elementary school, 4% secondary school. The researchers assess participants' numeracy skills and financial knowledge at baseline. They find low numeracy; while most can add basic equations, only 50% can multiply, and "even fewer" can calculate percentages. Less than 10% can calculate interest rates, and 58% can identify—although not calculate—the time value of money. Almost all, however, know savings accounts earn interest.

Table 5 shows changes in participants' average aggregate scores to survey questions; the video method negatively impacts numeracy 0.9%. The program does, however, produce significant, positive effects on financial knowledge (awareness) and decision-making (attitude and perceptions), 7.7% and 7.8% respectively. Participants become 4.5% more likely to know the components of a budget, 8.6% more likely to appropriately recommend insurance, 16.8% more likely to know how to open a bank account, 19.6% more likely to recognize a loan that will not improve future earning potential, and 20.9% more likely to identify the benefits of budgets.

Table 5: Change in average aggregate survey scores

	Change in correct response rates
Aggregate financial numeracy score	-0.9%
Aggregate financial awareness score	7.7%
Aggregate financial attitude and perceptions score	7.8%

Source: adapted from Carpena et al., 2011.

3.3.1.2 Analysis

These results suggest that video presentation improves schema acquisition, reflected in improved financial awareness and attitudes. With visual and aural components, video presents information through two sensory channels, or *modalities*. Learners process visual and auditory information singularly, a means of presentation known as "multimodal," allowing learners to process information more fully and/or in greater volume (Stroud & Schwartz, 2010; Moreno & Mayer, 2007). As a result, learners comprehend elements more quickly.

Through the video presentation, participants learn to better problem-solve—selecting appropriate financial products for example—despite challenges that "standard" content otherwise normally poses to populations with less formal schooling.

3.3.2 Visual storytelling

Similarly, Tiwari et al. (2014) measure impacts when an Indian microfinance institution (MFI) incorporates an "alternate financial education" (AFE) program within its existing customer interactions to educate clients on other products and services. AFE employs a *visual storytelling* approach—combining comic-style flipbooks and verbal storytelling about a relatable character, the Financial Warrior—to overcome high illiteracy and semi-literacy rates and explain banking products and services.

Comic-style illustrations show the culturally relatable Financial Warrior's journey—financial challenges and solutions—to explain and encourage opening and using savings accounts among clients. The Financial Warrior, a woman, embodies the ideal manager of household finances.

3.3.2.1 Experiment and results

With five phases, AFE integrates into the MFI's normal operations over 14 weeks. During hour-long meetings already conducted by the MFI to collect loan payments and deposits and distribute cash withdrawals, managers present AFE's content for ten minutes. Tiwari et al. (2014) conduct baseline and endline interviews before and at six months (three months after program completion) with 120 participants—not exclusively micro-entrepreneurs. They also interview 16 MFI instructors to assess their impressions of program efficacy.

During the program, the MFI sees savings-account openings increase 13.6%, the average number of deposits increases 89%, and total savings rises 30% among branches that offered the AFE course, compared with those that did not. The AFE's second month sees an increase of 233% in account openings. Clients cite the visual presentation style as helping them understand the concepts more easily, whereas in the past they struggled to follow managers' lectures. Further, managers find that the presentation style increases excitement about products and recommended habits (Tiwari et al., 2014). Table 6 presents results.

Table 6: Impact on savings and behaviors

	Pilot MFI branches	Non-pilot branches
Savings account openings (versus non-pilot branches)	13.6%	-
Average number of deposits per month (versus non-pilot branches)	89.0%	-
Average total savings at branch (INR)	1,100,000.00	850,000.00

Source: adapted from Tiwari et al., 2014.

3.3.2.2 Analysis

Overall, the researchers find the visual storytelling presentation facilitates a shift from lecture-style teaching to dialogue education. AFE's visual approach and use of a characterized role model appear to improve communication intelligibility, especially given learners' limited literacy. The visual representations allow learners to more concretely consider and empathize with financial situations and—along with spoken storytelling—develop mutual language between learner and instructor about learning elements.

Visual storytelling, therefore, also provides multimodal presentation, facilitating habit-development through clearer communication between instructors and low-literacy learners about elements normally too abstract or complex in standard, single-modality courses.

Explained in Section 4, dialogue-UX can incorporate both experiments' multimodal techniques.

3.4 Material interactivity

Both content utility and communication intelligibility address how learners receive and comprehend materials; however, learners' applying learning elements in daily life and the appropriate UX to facilitate that transition are of equal importance.

3.4.1 Supplemental individualized training

McKenzie and Puerto (2017) test the change in impact of follow-up small-group and individualized mentoring for business training programs. They offer the International Labour Organization's (ILO) *Gender and Enterprise Together* (GET) program in rural Kenyan marketplaces to female micro-entrepreneurs who sell foodstuffs or provide beauty, tailoring, or food services.

Over five days, GET teaches business and management skills specific to low-income female micro-entrepreneurs. Trainers with five or more years' experience lead the four modules covering: gender equality and businesses' and people's life cycles; concepts of strengths and weakness and impacts of working environment; business-idea development, marketing, production, financial services, and accounting; and people and organizational management. The researchers consider GET highly participatory, giving ample opportunity for in-class practice and simulation. Participation includes role-play activities—rehearsing sales techniques and pitches—and hands-on lessons on business practices. For example, by making lemonade, participants learn different types of costs and how to conduct accounting for them.

After one year, the researchers randomly assign half of the training participants to a mentoring treatment group. The mentees meet with a trained peer female entrepreneur with 5.5 years' business experience, 75% of whom completed some post-secondary education—68% having studied accounting or business. Mentoring groups consist of three to six learners, meeting fortnightly for ten sessions as a group and five times monthly with their mentor individually.

Mentors guide mentees in developing business goals, identifying weaknesses and subsequent solutions, and implementing practices and objectives.

3.4.1.1 Experiment and results

The researchers assign 1,172 firms to treatment groups and 446 firms to the subsequent mentoring treatment.

Participant female micro-entrepreneurs are aged 36 on average, completed nine years' schooling, and have six years' entrepreneurial experience. Weekly sales and profits average US$65 and US$13 respectively; average capital stock is US$370. 35% keep business records, and the average micro-entrepreneur conducts 53% of McKenzie and Woodruff's (2015) 26 business practices—see McKenzie and Puerto (2017) for a complete list of practices.

As Table 7 shows, three years after training, daily sales, weekly sales, profits, and inventories increase among both trainees and mentees over the control. Differences in impacts on firms' financial performance vary between training-only and mentoring firms, not necessarily reflecting significant treatment impacts given the difficulty in matching treatments to financial performance (Drexler et al., 2014).

The researchers evaluate changes in business practices and knowledge through survey questions. To test knowledge, respondents read a business description, then answer seven questions to calculate "revenue, value of stock on hand, variable costs, total expenses, profits, fixed costs, and break-even point" (McKenzie & Puerto, 2017). One year after training, the rate of correct responses to numeracy questions ("business knowledge") changes -0.9% versus the control, consistent with the challenges of improving numeracy skills (Carpena et al., 2011).

On the 26-question business practices assessment, the researchers find all trained firms implement 9.2% to 12.8% more practices after one and three years respectively. Mentoring participants implement 18% more practices—compared with 6.2% more among training-only. Additionally, from 26.9% of control participants monitoring sales trends by keeping business records, training participants' rate increases 52.4% by year-three over the control, and mentoring participants' 72.1%.

Table 7: Impacts on control, training, and mentoring treatments

		All trained firms (versus control)		**3 years after training (versus control)**	
Impacts	Control	1 year after training	3 years after training	Assigned to mentoring	Assigned to training only
Daily sales (KSH)	1173	13.7%	14.6%	14.7%	17.8%
Weekly sales (KSH)	5763	4.9%	18.0%	21.1%	16.6%
Main product sales (KSH)	3368	4.5%	13.5%	17.4%	15.5%
Weekly profits (KSH)	1439	5.4%	15.4%	19.4%	20.8%
Main product profits (KSH)	1137	4.6%	13.6%	11.7%	20.8%
Photo inventories (KSH)	8567	5.6%	9.5%	22.3%	3.0%
Business knowledge questions	2.00	-0.9%	-	-	-
Business practices	53.3%	9.2%	12.8%	18.0%	6.2%
Monitors sales trends through business records	26.9%	41.6%	52.4%	72.1%	26.0%

Source: adapted from McKenzie & Puerto, 2017.

3.4.1.2 Analysis

As McKenzie and Woodruff (2015) conclude, although business practices strongly correlate with greater business health, training programs rarely foster these habits among learners because they are not sufficiently interactive.

Despite only five days of group instruction, GET offers a high degree of material interactivity by conducting in-class simulation and practice, and this already correlates with higher business-practice adoption rates increasing from 26.9% to 41.6% in year-one. By year-three, mentees' business practices and monitoring of sales trends through business records improve much more than among training-only participants. These results suggest that individual mentoring's personal guidance and feedback has significant impact.

3.4.2 Intensive individualized instruction

Bardasi et al. (2017) compare the impacts of "basic" and "enhanced," or individualized, business-training programs for female micro-entrepreneurs in urban Tanzania.

Basic training is classroom-based and teaches entrepreneurship and business-management skills and technical training specific to participants' business sector. The five entrepreneurship and business management sessions guide business-plan development, teaching "market analysis, ... leadership training, time management, and communication and negotiation techniques." Technical-course content differs across sectors but generally guides learners to improve and/or incorporate novel production components, such as "quality management, packaging and labeling, customer care, compliance with regulation, equipment maintenance, and traceability."

Enhanced training adds to basic training a two-day orientation, where participants assess their businesses through strengths, weaknesses, opportunities, and threats (SWOT) analysis, as well as post-course individualized on-site coaching—both managerial and technical—for one year. Management coaches observe on-site the bookkeeping and business practices learned in class and help participants adhere to and refine business plans, advising on management, marketing, and financing and connecting learners to mentors. Technical coaches—successful entrepreneurs from the sector—provide individualized on-site mentoring on implementing technical-course techniques.

3.4.2.1 Experiment and results

The researchers randomly assign 821 participants to control, basic training, and enhanced training treatments. They conduct a pre-training baseline survey and an endline survey two years after the baseline—one year after the enhanced training finishes.

All participants are female, average age 43; 40% completed high school. The average business employs 1.3 people and generates US$440 and US$205 in monthly revenue and profit respectively. They operate "food or soap processing, trade, food retail, animal husbandry, handicraft or light manufacturing, textile and tailoring and services including beauty services, venue decoration or child care." Of note, 67% of participants already conduct accounting, 51% maintain a budget, 15% have a business plan, and 33% pay themselves a salary. As Bardasi et al. (2017) note, participant selection seeks promising candidates, presumably skewing these business-practice rates higher than other studies.

Table 8 shows that at endline, enhanced training generates between 7.56% and 14.90% improvements in behavior and habit-development, versus basic training's 2.10% to 3.55%. The probabilities of having a budget and business plan increase 9.80% and 9.93% respectively, formally registering the business with the Business Registrations and Licensing Agency (BRELA) rises 14.00%, and paying oneself a wage jumps 14.90%.

Table 8: Impact on business-practice implementation versus control

Business practices	Basic training	Enhanced training
Has budget	2.15%	9.80%
Has business plan	-1.84%	9.93%
Pays herself wage	3.55%	14.90%
Bulk purchases with others	3.32%	7.56%
Differentiates via neater premises	1.07%	9.55%
Differentiates via packaging	0.75%	8.83%
Registered with BRELA	1.65%	14.00%
Has tax identification number	0.98%	8.26%
Has license	-2.10%	8.43%

Source: adapted from Bardasi et al., 2017.

Further, Table 9 reveals a correlation with both trainings between micro-entrepreneurs' years of experience and impacts on revenues and household asset values. Micro-entrepreneurs with nine or more years' experience ("tenure") benefit most from enhanced training across all categories, and those with 14 or more even show benefit from basic.

Table 9: Impact on business outcomes by tenure quartile

Business outcomes	Revenue from main activity in typical month (ln)	Revenue from previous month (ln)	Revenue from previous year (ln)	Value of household assets (ln)
Basic training	-0.548	0.451	-0.743	-0.004
Enhanced training	-0.340	-0.380	-0.589	-0.242
Basic training (2nd quartile tenure)	-0.258	-2.193	-0.148	-0.212
Basic training (3rd quartile tenure)	0.312	0.730	1.964	0.290
Basic training (4th quartile tenure)	0.924	-0.833	1.593	0.135
Enhanced training (2nd quartile tenure)	-0.470	-0.983	-0.764	-0.051
Enhanced (3rd quartile tenure)	0.362	0.983	1.414	0.361
Enhanced (4th quartile tenure)	1.231	1.278	1.807	0.707

Source: adapted from Bardasi et al., 2017.

3.4.2.2 Analysis

Both basic and enhanced trainings improve business practices. This is particularly true of micro-entrepreneurs paying themselves a wage, implying business- and household-account separation. Individualized-training participants demonstrating the highest rate of business-practice adoption further suggests that increased material interactivity through one-on-one guidance is especially

effective at fostering habits. Additionally, increased impact among the more experienced micro-entrepreneurs supports the value of content utility, given learning elements were well beyond simple heuristics.

As with McKenzie and Puerto (2017), enhanced training's individualized approach appears to improve material interactivity. Instructors guiding learners as they apply problem-solving techniques inherently incorporate dialogue education as they adjust to each learners' needs and circumstances, increasing engagement, motivation, and schema acquisition. Prompt interaction with the material fosters habit-development, both the most critical and challenging aspect of business training. A business-training technology can improve material interactivity through a dialogue-UX, which facilitates individualized trainer attention (whether human or computer).

3.5 Conclusions: applications in Brazil

These experimental methods reveal techniques to improve content utility, communication intelligibility, and material interactivity within dialogue education-based micro-entrepreneurship training.

Both rule-of-thumb versus standard accounting and marketing versus finance trainings demonstrate the value, and provide examples, of tailoring content's learning elements to experience levels. Rule-of-thumb and marketing trainings' greater impacts among less experienced participants suggest that such content better matches new micro-entrepreneurs' needs, skills, and priorities. Brazil presents a caveat, however; 71% of microbusinesses have operated for over five years, with only 9% having under two years' experience (SEBRAE, 2019). Thus, micro-entrepreneurs are relatively experienced and could be best primed for an efficiency-focused training. That said, lower literacy, numeracy, and schooling rates might require rule-of-thumb heuristics to avoid over-abstraction and provide concrete, actionable steps. Therefore, Brazil may require blending advanced finance learning elements with heuristic steps to optimize content utility.

In parallel, the multimodal video and visual storytelling courses offer possibilities to improve communication intelligibility. Both improve learners' understanding and financial habits by augmenting the information learners can process. Each technique facilitates greater understanding through multimodalities and empathy through culturally relatable characters. Considering Brazilian micro-entrepreneurs' low education levels, dialogue education's inherently multimodal, culturally relatable presentation overcomes the hurdles written and/or overly abstract explanations pose.

For micro-entrepreneurs, motivation plays a critical role ensuring habit-development of learned practices. Their learning hinges on overcoming stressors such as indebtedness, community violence, and poor health. These stressors impede focus and diminish learning (Debue & Van de Leemput, 2014).

Individualized trainings' positive results offer particularly promising means to improve material interactivity and, therefore, motivation. Individualization poses significant logistical challenges, but as I explain in Section 4, a dialogue-UX offers the bridge between individualized and scalable material interactivity to reach 17.3 million Brazilian micro-entrepreneurs.

4 Virtual trainer and dialogue

The experiments provide examples of impactful business-training techniques. They divide into three components:

- content utility, matching learning elements to learners' experience and needs;
- communication intelligibility, tailoring modalities and cultural relatability for learners; and
- material interactivity, providing learners opportunities to apply their learning.

Effective training for millions of micro-entrepreneurs requires balance between scalability and these three components. Any solution striking this balance requires capacities to:

- measure experience levels to provide relevant and appropriately challenging learning elements;
- assess educational and cultural background to present content in the most efficient, intelligible, and relatable modality; and
- offer learners sufficient practice opportunity to apply acquired schema in their own businesses, guiding habit-development through immediate, implementable feedback.

As dialogue education achieves these tasks and optimizations in-person, a dialogue-UX does so online. UX represents users' emotions, perceptions, behaviors, and accomplishments within a program (Ritter et al., 2014). Essentially, dialogue-UX is to virtual business training what dialogue education is to in-person training. Embodying the holistic course experience, dialogue-UX translates dialogue education's pedagogical optimizations virtually by combining the pedagogical and technological solutions below into an online training that guides micro-entrepreneurs to develop and execute a business plan.

4.1 User interface

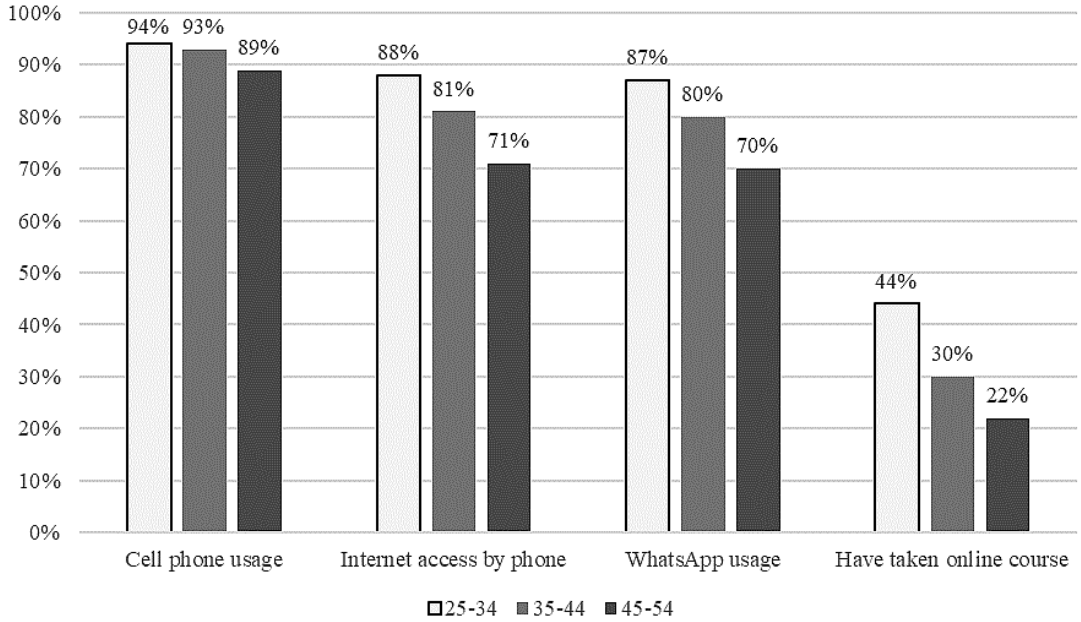
User interface (UI) is the dimension of a computer program with which a user interacts, providing mechanisms to submit inputs and receive outputs (Galitz, 2002). McKenzie and Puerto (2017) and Bardasi et al. (2017) demonstrate one-on-one training produces habit-development, and a (virtual) one-on-one trainer offers an intuitive UI. Cognitive-tutor and chatbot technologies provide this solution.

Cognitive tutors are computer programs that conversationally guide learners through problem-solving and personalize methods for learners to establish sound habits (Anderson, Corbett, Koedinger, & Pelletier, 1995). Tutor programs provide feedback based on Adaptive Control Thought – Rational cognitive models. Programs monitor learner work on a problem, comparing to the cognitive model—mapping learning elements to proper problems—and providing error feedback when work deviates, an algorithm known as model-tracing (Stamenković, 2014). Users learn material three times faster than typical classroom environments, more efficiently using adults' time and appearing most beneficial when interactions involve immediate feedback—as with in-person dialogue (Anderson et al., 1995). Cognitive tutors are the function that processes user-inputs and produces program-outputs.

Smartphone-based *chatbot* technology offers an intuitive UI input-output mechanism, given Brazilians' adoption of online mobile messaging technology; 90% of Brazilians used online text and audio messaging in 2017 (IBGE, 2018b). As Figure 2 depicts, this trend extends to the

principal Brazilian MEI segment—between 25 and 54 years of age—with 94% and 87% cell phone and WhatsApp usage rates respectively (Bedê & Lago, 2018).

Figure 2: Usage rates among MEIs aged 25 to 54



Source: adapted from Bedê & Lago, 2018.

Of significant note, only between 44% and 22% have taken an online course, suggesting current online education does not meet MEIs' learning and business needs and/or does not align with their internet and technology usage patterns. The chatbot-based cognitive tutors—or *virtual trainers*—facilitate personalized dialogue and provide UI in line with learners' existing technological literacy.

4.2 User personas

Personas are archetypes developed in technological design processes. They can leverage the large data volumes to better understand the millions of micro-entrepreneurial learners, their needs, and abilities.

Dialogue education requires dynamically adjusting to learners' unique needs, and personas are particularly applicable when designing chatbots. They can automate matching user archetype to conversational system—the optimal content utility, communication intelligibility, and material interactivity for each user (Ali Amer Jid Almahri et al., 2019). Further, virtual trainers can apply machine learning algorithms to learner data for persona development and user-persona identification. One technique, *clustering*, scours millions of data points to group users by algorithm-identified commonalities. Ali Amer Jid Almahri et al. (2019) apply *K*-means clustering to university student data and construct a series of data-driven personas. They then develop a chatbot to improve student engagement with specific versions for each persona, identifying a students' persona and matching them to the persona-appropriate program.

Bedê and Lago (2018) provide foundational demographic data—age, gender, years of schooling, location, and business size and sector—from which clustering can refine initial micro-entrepreneurial personas.

4.3 Experience level measurement

Dialogue education requires matching experience and learning elements. Drexler et al. (2014) and Anderson et al. (2016) provide content utility optimization techniques—rule-of-thumb and marketing content for less experienced micro-entrepreneurs and standard (or traditional) accounting and finance content for those more experienced.

4.3.1 Pedagogical solution

Vella (2008) recommends conducting learning needs and resources assessments (LNRAs) prior to training. LNRAs ensure courses address learners' knowledge, skills, needs, and hopes. Aside from studying the learners' general demographics, LNRAs inquire about learners' experiences with the topic and their expectations before and throughout a course.

Before the training, the virtual trainer conducts the LNRA, having micro-entrepreneurs:

- explain their business and its story,
- describe their market,
- analyze their current operations, and
- generate initial financial records and plans.

This LNRA allows learners to input as much information as they feel capable of or comfortable with. Assessing what and how learners respond reveals their skills and experience in each area. Upon these results, initial learning elements and tasks are based.

For example, micro-entrepreneurs displaying little knowledge of their market, with relatively few years' experience, probably require marketing and sales content to establish the growth focus more beneficial for younger businesses. Further, financial elements for this persona follow a rule-of-thumb format, ensuring learners still train in finance too but focusing on simple, actionable steps to avoid distracting or discouraging.

Business age and sector and micro-entrepreneur age and years of schooling inform the experience variable of a micro-entrepreneur's persona.

4.3.2 Technological solution

Applying clustering to learners' personal and business information, the virtual trainer establishes an initial proxy for the experience level variable of their persona. As the volume of learners and their data expands, clustering techniques increasingly granularize experience-level groupings and strengthen identification capabilities.

Further, clustering facilitates *personal recommendation systems*—such as those on ecommerce and video-streaming websites—to match experience and learning element. Numerous studies demonstrate success clustering learner-persona preferences with educational outcomes to dynamically recommend appropriate content based on experience level (Huebner, 2013). Researchers compare the learning outcomes from various content to learners' quantified initial experience level, revealing contents' utility to each persona. Clustering-based recommendation systems identify learners' personas and then automatically match content to their experience.

4.4 Background assessment

Tiwari et al. (2014) and Carpena et al. (2011) provide examples of how cultural relatability and appropriate presentation modalities ensure greater communication intelligibility and, thus, learning and behavioral change.

4.4.1 Pedagogical solution

Employing culturally relatable language facilitates greater understanding and communication intelligibility (Moreno & Mayer, 2000; Vella, 2008). This requires avoiding assumptions of learners' prior knowledge and vernacular. For example, Brazilians generally consider "credit" and "debt" as different concepts (Itaú Unibanco, 2015). Recognizing such sociolinguistic nuances prevents confusion and learning impediments.

Providing relatable comparisons through analogies and anecdotes like making lemonade (McKenzie & Puerto, 2017) or the Financial Warrior (Tiwari et al., 2014) ensures adult learners—regardless of educational background—can most intuitively understand concepts. Analogies provide a seemingly unrelated, yet familiar, concept that allows learners to transfer understanding from the familiar to the new (Stroud & Schwartz, 2010).

Low education and literacy levels, however, require modalities beyond reading. Therefore, assessing learners' educational and cultural backgrounds informs the most appropriate cultural language, analogies and anecdotes, and modalities for each's respective persona.

4.4.2 Technological solution

Much of a MEI's learner-background can be determined by the demographic data per Bedê and Lago (2018), collected through virtual trainer questions. More specific analysis is possible through natural language processing technology—applying machine learning algorithms to parse, understand, and communicate human language (Crossley et al., 2015). By analyzing the learners' lexicon and syntax, natural language processing informs learners' cultural language and can assess education level.

Current technology allows a virtual trainer to provide appropriate modalities and/or multimodal learning environments, and clustering demonstrates success determining learners' preferred media (Huebner, 2013). Despite relatively low literacy and schooling rates, 46% of MEIs with a high school education or less use YouTube videos to learn, and 60% of MEIs with the same level of schooling communicate via the online messaging app WhatsApp (Bedê & Lago, 2018). A significant portion of this latter usage rate derives from the ability to send and receive audio and video messages, avoiding reading and writing modalities. Upon assessing users' preferred media, virtual trainers can employ text-to-voice and/or pre-programmed audio messages as well as short videos to communicate through persona-appropriate modalities.

4.5 Practice opportunity offering

Bardasi et al. (2017) and McKenzie and Puerto (2017) demonstrate interactive material's benefit. They find individualized attention an especially effective method to improve motivation. Learners practice and acquire schema in engaging environments that provide feedback and guidance, reducing confusion- or demoralization-based attrition.

Learning tasks train learners as active decision-makers by posing open-ended questions to reflect upon or solve (Vella, 2008). The tasks contextualize elements and schema individually for learners, reveal elements' and schema's novelty, provide practice opportunity, and expand the elements' and schema's applicability. The four requirements of learning tasks—connecting with the learner's life, providing new content, working with the new content, and projecting to outside application (Vella, 2008)—establish a framework to optimize material interactivity.

4.5.1 Pedagogical solution

Learners' business-plan projects meet these requirements, especially considering when users must complete specific business-plan components, such as financial analysis, with little prior

experience. At moments of challenge, the virtual trainer provides guidance and feedback, for example, walking the learner through composing a budget and interpreting the numbers and results.

The virtual trainer engages learners through open-ended questions they respond to, prompting them to discuss and reflect on their current business processes, identify and apply relevant learning elements and schema, and reflect and evaluate schema benefits (Banda, 2014). Examples include "How does customer feedback help your business?" and "How does determining total costs benefit your business?"

Karlan et al. (2014) found that text message reminders, or *nudges*, via cell phones improve financial decisions, such as savings rates. Virtual trainers can identify behavioral patterns, such as what time learners conduct bookkeeping, and provide appropriate nudges to ensure greater habit-adherence and reflection.

4.5.2 Technological solution

Cognitive tutors add a degree of personalization to nudges, demonstrated to improve outcomes in education substantially (Lavecchia et al., 2015). One technique to achieve this capability is Bayesian Knowledge Tracing (BKT), which offers predictive power through machine learning to identify and intervene at moments of difficulty, when the learner risks giving up, better simulating human tutors. Combining Bayes' Theorem, Hidden Markov Model and Knowledge Tracing algorithms, and data mining, BKT allows virtual trainers to predict that learners apply schema appropriately and calculate the probability a learner has acquired schema in real-time (Sande, 2013).

BKT requires four parameters, the probabilities of a student: 1) already possessing the schema, 2) guessing correctly without possessing the schema, 3) making a mistake despite possessing the schema, and 4) acquiring the yet unpossessed schema. The Hidden Markov Model applies residual sum of squares or Maximum Likelihood tests (Sande, 2013) so that virtual trainers can predict learner performance. In conjunction, Knowledge Tracing algorithm applies statistical recursion to the same parameters to determine schema-acquisition likelihood after task completion (Sande, 2013).

Comparing predicted schema application and assessing acquisition probability allow for early intervention and nudging to prevent attrition and maintain habit development.

5 Discussion

Virtual trainers, in the form described, for micro-entrepreneurs do not exist. My goal has been to construct a theoretical framework for a technological solution optimizing the three fundamental components distilled from pedagogical and business training research: content utility, communication intelligibility, and material interactivity. Developing, testing, and refining virtual trainers are the next—and probably recurring— phases in providing enough MSEs with accessible educational support to produce positive economic impact.

Establishing such an iterative development process for education technology, though, requires foundational knowledge about the learners, pedagogically effective methods, and appropriate technological components. This means that technology identifies learner personas and matches them to the optimal content and presentation modalities; facilitates interactive materials, simulation, and individual pedagogical attention; and ultimately fosters financial and business management habits to improve MSE health. I have outlined technological components that, if combined, offer these capabilities and can improve efficacy with greater scale, given the machine learning involved increases in accuracy with more data.

Technology, however, is the tool, not the solution. The solution is fostering sustained, supportive, and educational dialogue with micro-entrepreneurs individually, providing them the care and backing that they deserve and that developing economies require. MSEs are economic pillars, yet they have not received support commensurate to this importance. In fact, only 1% of financial education programs in Brazil address MSEs (Associação de Educação Financeira do Brasil, 2018). Micro-entrepreneurs deserve attention, but the traditional approach of telling them what to know and do has not worked. Considering this research into financial and business training programs, the need for dialogue is irrefutable, recognizing and utilizing micro-entrepreneurs' abilities and knowledge.

Equally clear, the scale at which training must occur to shift habits and improve MSEs' health is enormous, and that is where virtual trainers and their dialogue-UX can produce impact. At the least, such technology can initiate this necessary dialogue. At best, if virtual trainers can optimize content utility, communication intelligibility, and material interactivity, dialogue will prove merely the beginning.

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ENDNOTE

[1] The researchers construct business practices, personal financial practices, and revenue indices that summarize changes in multiple habits related to each index.