Oppportunities for Social Innovation at the Intersection of ICT Education and Rural Supply Chains

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Abstract—The conventional model of education can be viewed as a linear transmission system, where information goes from a teacher to a student. At the same time, in rural business supply chains, products and services are delivered in a linear manner from producer to agents to consumers. These linear supply chains and education systems are top-down and hence struggle with quickly adapting to market dynamics and globalization. They are inherently inefficient and difficult to scale, resulting in widening educational divides and “last mile” supply chain challenges. This paper highlights opportunities for social innovation that emerge at the dynamic intersection of informal education systems and rural supply chains in the developing world. We discuss the largely untapped potential of ICT education in creating an unconventional means of education integrated into the supply chains that provide livelihoods for a large demographic in the developing world. Our approach seeks to utilize the potential of ICT education in three ways: to increase ease of access and relevance of material through its integration into the supply chains, teach life skills beyond conventional vocational training and introduce a feedback loop that enables players at all levels of the supply chain and education system to actively contribute to the design of the system. This multi-level information and communication technology (ICT) platform can be used to facilitate iterative learning where the knowledge emanates from the participants and their indigenous ways of knowing and doing. Interaction at all levels provides agency to the participants while serving as a means for the long-term preservation of such local knowledge. Our team has designed and piloted Prerana, an ICT platform in collaboration with the Self-Employed Women’s Association (SEWA) and the Rural Distribution Network (RUDI) in western India. We conclude the paper with a case study of the working mechanics and field-testing results of this system.

Index Terms—ICT education, supply chains, indigenous knowledge, knowledge democratization

I. INTRODUCTION AND CONCEPTUAL FRAMEWORK

The traditional “transmission” mode of communication and education emphasizes information transfer and retention, from a teacher (sender) to a student (receiver) (Figure 1a) [1]. The educational purpose is to enhance the students understanding in a variety of topics in order to lay a fundamental foundation of knowledge that will be used to improve their quality of life in the long term. In developing countries such as India, access to consistent sources of education or even information is privileged based on a variety of factors such as socioeconomic status, religion and traditional gender roles [2]. There is a large population without access to well-rounded education that fits into their lifestyle. The high percentage of children never enrolled in primary schools in rural India indicate that conventional education is not considered directly beneficial to enhancing livelihoods by a large portion of the population. The sustained prevalence of discrimination of lower castes in India has resulted in high dropout rates and low enrollment with a conservative estimate of 35 million children in India aged 6-14 who are not a part of the conventional school system [3]. During a study conducted in 2002-2004 in rural areas, amongst the lowest 20 percent of the socioeconomic strata, only 22 percent of male and 16 percent of female children completed at least five years of education [4]. Although enrollment numbers have increased since then, a study in 2007 found that almost half of the students entering first grade did not continue schooling past fifth grade [5].

The use of information and communication technologies (ICT) has rapidly emerged as an inexpensive and efficient way to disseminate information on a large scale and is being used extensively for education in the western world [6]. It is quickly integrating into developing nations as a tool for teaching valuable life skills [7-9]. Additionally, ICT education has also been implicated in lessening the gender gap in developing nations by empowering women through education [9-11]. Technology advances coupled with decreasing costs present an unprecedented opportunity for low-cost solutions to providing high value information that can provide immediate and tangible benefits. The traditional linear teacher-student model does not emphasize peer learning among students as well as reciprocal student to teacher feedback. This can be especially detrimental in developing countries, where lateral sharing of local knowledge and peer interaction is of significant cultural importance. An ICT system following the traditional model of education forces knowledge transfer to stagnate, especially within the lower socioeconomic strata where it is often only practical to devote a very limited amount of time to education. It is essential to develop systems that tackle both, the limited availability of time for education and the lack of integration of local knowledge into the educational...
system. In this quest, ICT-based education systems that are intertwined with rural business supply chains with the means of peer-guided learning and student/employee feedback at each step of the supply chain present unique opportunities. This vision of an integrated ICT educational system is a way to augment and complement other formal and informal educational systems.

It is essential to define our interpretation of the diverse terminology associated with the conceptual framework for this platform. A business supply chain is the infrastructure within which products or services are transferred from producer to end-consumer. Rural business supply chains are slowly developing in rural areas with predominantly agrarian economies. For example, a simple linear rural business supply chain exists when a rice farmer (provider) in rural China sells his crop at the market to a local community member (receiver) (Figure 1b). However, due to information asymmetries and several levels of agents and middlemen, the supply chain can be much more complex [12]. These supply chains are the primary means of livelihood for the rural community and would be seen as valuable to learn about and improve because of the more immediate financial gains. This supply chain model of provider to receiver can be paralleled with the transmission model of education, where knowledge is the service or product that is being transferred (Figure 1).

Within these rural supply chains, indigenous knowledge (IK) relating to climate, terrain, agriculture, food science, animal husbandry and a variety of other topics is just as valuable as the education provided in formal schools. For example, a spice vendor would need to have a strong working understanding of the variety of uses of her products from cooking to medicinal applications. She would also benefit from learning about cultivation seasons for her goods in order to best advise her customers on what and how much they need, when they should buy, or what new products they should try. A dairy farmer would need a different indigenous knowledge base that consists of a strong understanding of the best combination of feed for her animals than a rice farmer who needs to be an expert on how local weather and seasonal conditions impact crop yields. Due to the inherently local nature of the knowledge, close social networks of the participants, and primarily oral traditions, the information flows are constrained to the word of mouth in a small community. Communities where this knowledge is most heavily used are often also more geographically isolated and technologically limited, resulting in limited access to knowledge outside of one’s own community as well as a loss of knowledge from generation to generation. The knowledge acquired by a community over time is also valuable to other communities with similar challenges. ICTs, specifically those enabled by the growing popularity of cellphones, have been suggested to be an effective way to share and preserve indigenous knowledge [13]. However, cellphones are not the only new entrants into these communities. In their quest for expanding markets and enhancing their bottom lines, companies – large and small - are starting to develop their supply chains to reach these rural communities. As infrastructure develops and communities are forced to open their doors to the outside world, questions related to consumerism, loss of indigenous knowledge and self-determination arise. While debates on the appropriateness and fairness of this market invasion are very healthy and necessary, this tide is unstoppable.

Figure 1. Traditional transmission model of communication and education (a); rural business supply chain (b); new supply chain after integration of ICT education with rural supply chain (c)
A core hypothesis of our approach is that effective and efficient multi-level learner-centered educational systems powered by ICTs can leverage the rural supply chains to create mutual socio-economic value and help communities make more informed decisions (Figure 1c). Our approach seeks to utilize the potential of ICT education in three ways: to increase ease of access and relevance of material through its integration into the appropriate supply chains, teach life skills beyond conventional vocational training and insert a feedback loop that enables players at all levels of the supply chain and education system to actively contribute to the design of the system. In this system, knowledge is infused at every point in the supply chain and can be used to benefit all parties involved. This iterative peer-to-peer education process leads to the democratization of knowledge through vertical and lateral knowledge flows. Knowledge democratization facilitates the creation of more efficient supply chains. For example, a door-to-door salesman can advise production managers on customer opinions and potential new products and markets. Through a similar channel, a production manager can provide a more comprehensive understanding of products, their manufacturing process and quality control measures to a salesperson. This information would help increase sales and expand markets while keeping the customers better informed and providing them products that meet their needs and preferences. This communication system allows for continued engagement of all parties, enhances accountability and promotes citizen scholarship. In terms of actual educational content, the emphasis of the system is on “transformative education” that can provide tangible and immediate benefits to the user. Transformative education addresses the shortcomings of vocational training by not restricting learners to focus on learning skills directed toward a series of non-fluid and specific occupations. The goal is to provide a broad range of general life skills that an individual learner can capitalize on for advancement in a variety of fields or lines of work. For example, understanding basic personal finance can help an individual manage resources in a small business, and save money for the needs of his or her family. Training laborers working on roads to become construction workers can boost their income from $2/day to $5/day for almost the same work. Posture training for workers that conduct laborious tasks allows them to perform their tasks more efficiently and ergonomically and ultimately helps them earn more money in a commission-based system [14].

In summary, transformative education provides agency and develops skillsets and mindsets amongst individuals to create and find opportunities in a self-chosen direction, rather than vocational training’s predetermined path of advancement. Agency is exhibited when the individuals themselves, in collaboration with peers, create and determine their path towards a better quality of life and brighter future. The added value of transformative education through ICT is especially important in rural supply chains of individuals where conventional education is not easily accessible. Through the integration of transformative education into ICT systems via rural supply chains, this democratized form of learning is more relevant and accessible to individuals for whom conventional means of education are not feasible. These supply chains face a variety of challenges including cost efficiency, effectiveness in terms of reaching the largest customer base, ease of transit, sustainable infrastructure and organization and establishment of trust in a chaotic informal sector.

Examples of the relationship between transformative education through ICT education and rural supply chains can be seen in many contexts. For rural farmers, the risk of unpredictable weather can ruin crops and severely impact revenues for the season. Learning how to obtain weather insurance would be a piece of transformative knowledge that could reduce risk and provide relief in the event of unpredictable crop seasons. Another example is seen through small business owners. Low product sales can occur due to the limited reach and size of the local market. Transformative education occurs through the creation, management and upkeep of a cell phone-facilitated business. The business owner is now able to market and sell to customers outside of his normal market using mobile technology. Getting a preventable illness such as malaria forces the worker to miss work and thus lose many days’ worth of wages. Door-to-door education on how malaria is transmitted and techniques to prevent malaria at home could greatly reduce risk of disease. The use of bed nets, prevention of stagnant water collection, and learning to stay indoors during peak mosquito infiltration times prevents unnecessary illness so that the worker stays healthy and can continue to provide for the family. In all these situations, the person sharing the knowledge could be educating their own customers on the benefits of their products like weather insurance plans, cellphone apps or low-cost mosquito nets. The next section introduces organizations in western India that are engaged in various educational initiatives and rural supply chains. This sets the stage for a case-study on the design and field-testing of Prerana, an ICT education system that relies on rural supply chains in India. This proof-of-concept model validates the integration of transformative education with rural supply chains, and is a novel method of examining and improving the livelihoods of people in developing communities.

II. SELF-EMPLOYED WOMEN’S ASSOCIATION AND THE RURAL URBAN DISTRIBUTION INITIATIVE

Self Employed Women’s Association (SEWA), is a trade union based in the state of Gujarat, India registered in 1972 with the aim of empowering women workers of the unorganized labor sector and helping them obtain full employment and self-reliance [15, 16]. In 1977, SEWA’s General Secretary, Ela Bhatt, was awarded the prestigious Ramon Magsaysay Award, which brought international recognition to SEWA. SEWA has over 1.25 million members as of 2009, with hundreds of different occupations within its fold. To satisfy the goals of full employment and self-reliance, SEWA promotes micro-entrepreneurship amongst women through 84 cooperatives. SEWA also provides a variety of essential services including but not limited to a means of savings and credit provided by SEWA bank, capacity building
and literacy improvement provided by SEWA Academy [17]. Rudi Multi Trading Company is a partner company of SEWA [18]. RUDI’s (Rural Urban Distribution Initiative) primary goal is to provide a more self-sufficient means for local women farmers to distribute and market the highest quality goods on a large scale. The RUDI supply chain handles the production of its goods and spices from procurement to marketing and distribution [19] (Figure 2). RUDI facilitates every step of the supply chain from procurement, processing, packaging to marketing and selling of rural farm produce by rural women. This eliminates the middleman from the rural agriculture supply chain and increases profits for small-scale farmers. RUDI enhances both the quality and efficiency of farmers’ production through warehousing and the use of farming technology in post-harvest processing of agro-commodities. In addition, RUDI expands farmers’ capacity via bulk procurement and a well-organized sales distribution network to scale up profit margins for farmers. At one end of the supply chain, raw agricultural goods are procured from small and marginal farmers. These goods are then sorted, processed and packaged at the HAAT centers (an acronym here, “haat” is also Hindi for “market”). Processed goods at this stage can be sold back to the farmer at a low price or be distributed in the market. At the distribution hubs operational in 14 districts, packaged materials are distributed to village-level retail outlets. The village outlets then utilize door-to-door saleswomen called RUDI-ben (shown in red in figures) for marketing and sales to individual houses. RUDI-ben (the suffix ‘ben’ means ‘sister’, signifying respect) are involved in every step of the supply chain from the procurement of local goods, to various levels of processing, packaging and sales with varying levels of responsibility and seniority based on experience level. RUDI encourages RUDI-ben involved in sales to become micro-entrepreneurs by providing each woman with low-risk weekly stock and opportunities for earning 20% commission on goods sold. Additionally, RUDI provides these women training to improve their marketing, selling and goods management skills. Although RUDI is a marketing company, its affiliation with SEWA has created not only an economic but also a social bottom line for improving women’s literacy, agency, and livelihoods [20].

SEWA has also established 40 community-based Community Learning Centers (CLCs) to raise women’s basic and computer literacy as well as to provide vocational training in teaching, ICT and a variety of other fields [21]. SEWA administrators develop courses that range in duration from two days to a few months, at its headquarters in Ahmedabad. Depending on the nature of the training and the availability of qualified teachers, SEWA members attend courses at the headquarters itself or at their local CLC. SEWA’s goal is for CLCs to serve as independently maintained microcenters for the various educational courses developed at the headquarters. The CLC education system and the RUDI supply chain currently function as independent entities. Integrating the CLC education chain and the RUDI supply chain would be of immense value and could be done by initially targeting coursework development towards improving RUDI-ben’s skill sets in their specific occupations and making them aware of how the RUDI system functions as a whole. This will help them understand everyone’s role within the larger system, understand barriers and identify strengths and opportunities for improving operations. Such a system will develop business and life skills amongst the RUDI-ben with additional income and a more stable, safe and healthier lifestyle. This will ultimately impact SEWA’s and RUDI’s bottom line too.

The novel ICT distance education provided through CLCs delivers immediate value to SEWA women. Over 34% of SEWA’s members in Gujarat work in rural areas surrounding their headquarters in Ahmedabad [22]. This places almost 200,000 women out of reach from the hub of resources and training SEWA provides at its headquarters. The SEWA centers at Pij, Anand and Surrendranagar are located a little far away from the SEWA headquarters in Ahmedabad. These centers are between 50 to 80 miles away by road transportation, requiring a 2 to 3 hour train journey. For this trip, India Rail website estimates a round-trip cost of Rs. 20. For a woman that makes $2 USD/day (~Rs. 100), a single round trip train journey can equate to 20% of her daily salary. More importantly, the limited frequency of these trains and the transportation time via road or track causes women to lose at least a day of work, which has a significant impact on their income. The availability of SEWA training in rural areas reduces the time and resources spent by members to receive the relevant training that can help improve their earning power.

Examples of the beneficial interdependence between transformative education through ICT and rural supply chains include new product/market analysis, customer base expansion, and consultation for improvement of the supply chain. In the first example, the expansion of a product into a new area can be piloted in a small area first. Based on the high amount of personal interaction with customers, RUDI-ben are better able to gather accurate analyses of market needs for a specific area as well as potential market expansion. The resources and knowledge from a RUDI center with experience gained from ICT education ensures that all aspects of the product (distribution, sales, marketing) can be easily translated to the new location. RUDI’s customer base and users of the multi-
level ICT education system can also be expanded. Incentives could be given to RUDI customers or SEWA members in the form of vouchers for exemplary work, product purchase or friend referrals. These vouchers could then be used to enter lotteries for RUDI products or applied to the cost of a learning module. Incentives and prizes will encourage participation and the formation of a learning community.

Finally, CLCs can act as consultants to improve the efficiency of each hop of the supply chain. Utilizing CLCs as consultants ensures the transparency of the supply chain – the less efficient RUDI supply chains can learn best practices from the more efficient ones. Marketing, procurement, production and packing can all be optimized using this technique. RUDI-ben that interact directly with the customers are able to predict market needs and trends, while RUDI-ben that work with farmers can create processes for determining product grades for raw goods. Farmers could utilize knowledge from CLCs to assess efficiency of cultivation practices and growing conditions to yield a healthier and more bountiful crop. RUDI-ben who work at processing centers could advise on improving sorting practices, workplace safety, or optimize packaging materials to reduce waste and costs. Once RUDI-ben find the immediate tangible and growing benefit of this unconventional education resource, it will improve the CLC education chain. Increased interest will help mainstream this approach to education and extend its reach to more remote areas. Integrating a means of regular feedback from the RUDI-ben would help tailor resources to the needs of SEWA women. This increased feedback within the integrated business-education supply chain would allow women to contribute their own knowledge to the education system, thus expanding its breadth of knowledge as a whole (Figure 3). For example, farming practices tend to be specific for a region or a certain crop. Incorporating local knowledge into the ICT education system will allow farmers who farm on similar soil or crops to share information that is relevant to their business. Perhaps a certain method of irrigation is more efficient for growing tomatoes than rice. Without this lateral communication, each component of the supply chain is not able to learn about best practices. Having a better crop yield helps everyone in the supply chain, from the farmers that receive a higher payout, to the end consumers that are able to eat more nutritious food. Therefore, knowledge democratization is able to improve the entire rural supply chain, as well as advance the cumulative knowledge pool.

III. CASE STUDY: PROJECT PRERANA

A multi-level, supply chain integrated ICT education platform named Prerana was developed by our team in the Humanitarian Engineering and Social Entrepreneurship (HESE) Program at The Pennsylvania State University. Prerana developed as a partnership with the Self Employed Women’s Association (SEWA). The Prerana platform sought to understand and address the educational and business challenges of self-employed women affiliated with SEWA. For these women, formal education that focuses on long-term value is not realistic and is demonstrated by the fact that very few women finish middle school. Although some ICT education opportunities already existed via SEWA’s CLC centers, Prerana sought to integrate learning material relevant to improving a RUDI-ben’s skill set and the RUDI supply chain as a whole in order to begin the integration of the ICT education system and RUDI supply chain (Figure 3). This merger hoped to create immediate financial value to its users, giving Prerana the opportunity to teach life skills that create immediate tangible value beyond vocational training. Additionally, the current SEWA ICT system did not facilitate the sharing of local knowledge that was widely used by the RUDI-ben. Prerana sought to introduce a means for SEWA women to contribute their own insights and knowledge.

For the initial pilot study, the Prerana team created an extensive list of possible topics for educational modules and collaborated with SEWA administrators to determine which modules should be implemented. From the topics selected by SEWA staff, our team created a sample curriculum of several 5-10 minute modules including “How to reduce physical strain during work: clothing, posture, exercises” and “How to record and manage inventory more efficiently”. These modules were set up in the Moodle-based content management system and used as examples to help RUDI-ben create their own videos and learn to navigate the course software in the subsequent workshop (Figure 4). Moodle learning management system is a free, highly adaptable and open source platform for content hosting and development. Due to the low literacy rates and
number of different dialects among women in differing rural areas, oral knowledge transmission is extremely important. Thus, audio was a crucial aspect of this system and Moodle provided excellent multimedia support for our needs.

A four-day pilot Prerana workshop was held at the SEWA headquarters in Ahmedabad, India in May 2011. In attendance were eight SEWA master trainers, women who were more experienced members of SEWA and remain highly active within the organization. Each woman had her own specialty in IT, education, agriculture, health, business or animal husbandry. The women's ages ranged from 25 to 65 years and had been members of SEWA for 6 to 30 years. The master trainers came to the Ahmedabad location primarily from the surrounding SEWA centers of Pij, Anand and Surrondranagar. During the pilot workshop, a rich and diverse amount of indigenous knowledge was found to exist amongst the traditionally “uneducated” women – none of whom had received formal schooling. The women were challenged to identify topics of interest to other women in their locations and occupations. Module topics chosen by the team members ranged from vermi-composting, animal husbandry, and first aid using local materials. Final topics were chosen based on the expertise of each woman and the impact she thought it would have on the group. The workshop focused on the process of creating a Prerana educational module on a PC using Windows Movie Maker and Sound Recorder and its integration into the Moodle system. The workshop also covered the Moodle installation process, general guidelines on how to interact with the system and the process of creating individual profiles.

At the end of the workshop, each woman had researched, designed and created an individual module on a learning topic she thought would be of value to other SEWA members. Each module was informally peer-reviewed by the other participating women. The topics included the art of vermi-composting, making a powerpoint presentation, the uses of aloe-vera, beverage recipes to maintain low body temperature in the heat, first aid, practices in animal-husbandry and food preservation through pickling. Interestingly, the starting point for each the modules was a discussion and paper-and-pen exercise to develop the content (Figure 5). The workshop facilitated the introduction of the Prerana concept to SEWA and was favorably received by both by the participating RUDI-ben as well as SEWA coordinators helping to facilitate the event. Modules were posted on the Moodle site and shared with SEWA members to elicit feedback. Suggestions for immediate implementation of the system were in entrepreneurial and business management courses. Amongst the stakeholders, there was consensus that the Prerana education platform, if carefully designed and strategically implemented, could serve people with limited time and resources for conventional education. The RUDI-ben agreed that the integration of the ICT platform into local supply chains enhances access and relevance of the material. The incorporation of life skills training related to health, safety, finances and other relevant areas facilitates long-term self-determined improvement in lifestyles.

The Prerana workshop also demonstrated some of the difficulties in democratizing information when users have
varying levels of computer literacy. The women with proficiency in computer use were the most involved in learning as well as content creation. However, group work with teams of women with varying computer literacy proved to be the most efficient and effective means to engage the entire team. It also alleviated anxiety of computer use amongst women lacking computer literacy. Choosing and adapting a suitable platform that was accessible and usable without being expensive or heavy-weight was a challenge. In addition, the platform itself needed to directly integrate into the CLCs current infrastructure of basic Windows PCs. Another challenge was creating content of high immediate value for the women. Prerana sought to understand the current knowledge base in SEWA to determine the most relevant content to make accessible to its members. Challenges faced during the implementation process centered on familiarizing SEWA members and administrators with the platform itself and showing the depth of potential a novel ICT platform such as Prerana could have to SEWA members. It was a hurdle to express the immediate tangible benefits to SEWA members of setting up infrastructure for a learning management system on a macro level. However, after providing training on both content and learning assessment creation, attitudes toward the Prerana system became more positive. During the workshop’s feedback session, SEWA women increased their understanding of the challenges of creating valuable content and applicability of such a system in their own lives.

IV. CONCLUSION

This paper highlights the broad applicability and potential for social innovation at the intersection of ICT education systems and rural supply chains in the developing world. Future work that builds upon the Prerana model includes increasing the platform’s ease of access by introducing a mobile platform that makes the educational modules available with or without internet access. Challenges that must be overcome before successful technical implementation include providing available and ongoing technical support, reliable power supply, and hardware/software upgrades and maintenance. A community-driven content regulation mechanism also needs to be standardized to ensure that the content is highly-relevant and user-appropriate. The team is looking into ways to integrate user feedback throughout the system, with the additional goal of recognizing the most prolific knowledge sharers. Another future direction is an incentivized credit system that integrates more organically into the supply chain. For example, credits can be issued to RUDI-ben based on the quality of work, amount of sales or another measure of productivity. RUDI could reach a consensus with SEWA CLCs to allow conversion of credits to lessons in SEWA CLCs. The same credit system could also be used for the end customer, where credits would be based on the amount of RUDI products purchased or amount of valuable feedback given to RUDI-ben. RUDI-ben could collect feedback regarding RUDI products and services and customers’ personal daily needs from each household. SEWA could then act as a consultant and aid RUDI in improving products and services. CLCs can use this information to design a supply chain management system for RUDI-ben to track their daily inventory. The money generated for the CLCs can be used to hire more computer-savvy former students from CLCs to train more RUDI-ben on using the system, increasing employment and giving feedback to benefit the rural business supply chain. Adding a marketing aspect would improve the financial sustainability of the project, lessening the need for funding by external sources. This project can take many different directions in its quest for leveraging the dynamic interdependence between the ICT education system and rural supply chains.

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