EMBODIED LEARNING: A GLIMPSE INTO THE FUTURE OF SKILL DEVELOPMENT IN EMERGING MARKETS

Nimesh Mehta, Rajat Goyal

Dr. Reddy’s Cell for Employability and Skilling, Centre for Emerging Market Solutions, Indian School of Business (INDIA)
nimesh_mehta@isb.edu, gyl.rajat@gmail.com

Abstract

India is in the midst of an unprecedented phase of demographic change. Nearly 63.38% (about 760 million) of India’s 1.2 billion population is in the working age group (15-59 years of age). In 2010, 90% (437.4 million) of India’s total labour force was employed in the unorganized sector. However, only 5-10% of this workforce has received any kind of skill training. Therefore, we have an urgent need to exponentially increase the seating capacity of skill training institutes to reach government’s target of 500 million skilled workers by 2022. To understand the problems faced by current skill training institutes in India, we conducted a survey and various face-to-face interviews with students, instructors and administrators at Government Industrial training institute, Sanathnagar, Hyderabad. From the data, we observed that among other reasons huge set-up cost (cost of tools, machines, raw material, etc.) of training workshops is the major reason which restricts the growth of such skill training Institutes.

This paper looks towards embodied learning as a solution. Embodied learning in most simple terms is defined as using body for learning. It is a relatively new field which merges learning sciences and human computer interaction. It can be most effective form of learning in vocational training as the skills that are learnt are physical and involves body motion. We have combined research from multiple areas such as learning sciences, human computer interaction, simulations, and virtual reality to conceptualize our system. In recent past there have been significant innovations in the field of body motion sensors which can help us build such embodied learning environment with very low cost. We are using Microsoft kinect for body motion sensing. In our system we have created a virtual workshop environment which is similar to an actual skill training workshop. In the virtual environment the user can move around, pick up tools, and control a process just as he would do in real life. First the user has to follow a tutorial in which the avatar shows the user sequence of steps involved in doing the particular task, after this the user has to correctly replicate what the avatar was doing by using his own body. Application of such system ranges from learning wood working, machine operation to high end skills training like aviation, medical and combat. The system will be able to reduce the cost of skill training by 60-80% as the user will not require raw material, tools and machines for basic initial training.

Keywords: ICT, Skill Education, Technology for Emerging Markets.

1 INTRODUCTION

1.1 Skill Shortage

Skill and knowledge are the driving force of economic growth and development of any country. However, large proportion of Indian population is unskilled and because of this unskilled population India’s overall labor productivity is very low.

In 2010, India had a total labor force of 475 million out of which 437.4 million were employed in the unorganized sector [1]. Only 10% (47.5 million) of the total workforce in the country receive some kind of skill training (2% with formal training and 8% with informal training) [2]. The rapid development has increased the demand of skilled workforce and employers are finding it difficult to fill the jobs. All the public and private training institutes which provide vocational training in India are uniformly known as Industrial Training Institutes (ITIs). There are a total of 10,296 ITI in India under Ministry of Labor &
Employment out of which 2,060 are government owned and 8,056 are privately owned [3]. These ITI's train people in 282 trades ranging from welder, electrician, and carpenter to book binder. The total seating capacity in ITIs all over India is around 1.5 million students [3] but about 12.8 million people are expected to join the workforce every year [1]. From 2008 to 2011, we have increased on an average just 0.13 million seats per year [4]. Therefore, we have an urgent need of exponential growth in the seating capacity to reach government’s target of 500 million skilled workers [1] by 2022.

In India the total skilled work force is just 8-10% compared to 85% of the south Asian countries and 60-70% of the other countries. The educated work-force without professional skills constitute 69% of the total unemployed. Because of the unskilled workforce the overall labor productivity in India is also much lower ($ 5.45 per person per hour while the figure for Mexico is $ 20.51) [5]. In general, the present skill base of the Indian labor force is low compared to that in developed countries.

1.2 Embodied Learning and Virtual Environment

Embodied learning is a relatively new field which merges learning sciences and human computer interaction. In Embodied learning students use their body for learning. These kinds of systems has been used before in teaching computational science [6], English [7], mathematics [8], and chemistry [9] and effects of embodied learning to improve learning performance have previously been researched upon [10].

The effects of embodied Learning can be huge when applied in context of vocational training and skill development. Vocational training is practice driven education, the students need to learn various sequence of steps using repeated body motion. Therefore, simulations based on body motion can be very intuitive form of learning. We have developed a game like embodied learning environment in which, an avatar is placed in a virtual environment such as a carpentry workshop and the user controls the avatar using their body motion. We are using state for the art body motion sensors like Kinect and Asus Xtion for human skeleton tracking.

Researchers agree that playing is a powerful method of learning skills [11]. Games allow players to be producers, whereas in schools the students consumes but do not produce [12]. Virtual worlds are a good medium for skill training as situated learning occurs when students work on authentic tasks that take place in real-world setting [13]. In virtual worlds the students can learn both complex concepts and abstract ideas.

2 CASE STUDY

2.1 Methodology

We conducted a survey with students and various face-to-face interviews with students, instructors and administrators at Government Industrial Training Institute, Sanathnagar, Hyderabad to understand the problems faced by the current skill training institutes. Total 74 students from various courses participated in the survey.

2.2 Overview

Some highlights about the institution are:

- The institute teaches 9 courses (electrician, electronics, draftsman, refrigeration & air conditioning, computer operator, fitter, welder, mechanic motor vehicle, and painter). All courses except computer operator and welder are of 2 year duration.
- The Institute has 315 seats for which around 1500 students applied in 2013.
- The minimum requirement to join most of the courses is secondary school education with high cutoff percentage.
- There is very high job availability for these students. A requirement of 5000 students were posted to the institute by various industries in January 2013.
We need to understand why there is a shortage of seats even when there are so many people eager to join and when there is such high job availability.

2.3 Problems with the current scenario

2.3.1 Huge setup cost

The total cost to setup one Industrial Training Institute which trains 250 students per year is 1 million USD. The average setup cost per course is 0.1 million USD (Table 1) which teaches 20 students every year and taking the maintenance cost and degradation of equipments over time this cost is supposed to be much higher.

2.3.2 Less intake

For an institution with a very high setup and maintenance cost the intake of students is very low. Only 250 people graduate from the institute per year.

2.3.3 Less number of ITIs

As mentioned earlier the total seating capacity all over India is around 1.5 million students [2] but about 12.8 million people are expected to join the workforce every year Also, because of the less number of ITIs, students have to travel a lot to reach these ITIs (Fig. 1).

Table 1: Intake and Approximate setup cost of some courses in a typical ITI.

<table>
<thead>
<tr>
<th>Course</th>
<th>Intake (students/year)</th>
<th>Approximate Setup Cost in USD¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electrician</td>
<td>20</td>
<td>110,000</td>
</tr>
<tr>
<td>Electronics</td>
<td>20</td>
<td>90,000</td>
</tr>
<tr>
<td>Draftsman Civil</td>
<td>20</td>
<td>55,000</td>
</tr>
<tr>
<td>Refrigeration and AC</td>
<td>20</td>
<td>180,000</td>
</tr>
<tr>
<td>Welder</td>
<td>15</td>
<td>70,000</td>
</tr>
<tr>
<td>Motor vehicle mechanic</td>
<td>20</td>
<td>90,000</td>
</tr>
<tr>
<td>Painter</td>
<td>20</td>
<td>35,000</td>
</tr>
</tbody>
</table>

2.3.4 Students require more practice than theory

Most of the students prefer practice over theory and think that they need more time with the machines. Although the institutes have all the machines required, in most cases, devoting more time to practice is not possible because raw materials are limited and instructors does not have enough time to supervise students.

¹The cost are approximate and indicative. Source: Head of the Institution.
Table 2: Practice Vs Theory

<table>
<thead>
<tr>
<th></th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you need more time to practice on machines?</td>
<td>72</td>
<td>2</td>
</tr>
<tr>
<td>Do you prefer practice over theory?</td>
<td>69</td>
<td>5</td>
</tr>
</tbody>
</table>

2.3.5 Improper utilization of infrastructure
Adding new infrastructure to the ITI’s is very costly and the utilization of equipment is very less. A lot of equipments in ITIs/ITCs are used only for few weeks in a year. Some of the equipments are used only for a week out of total duration (1 to 2 Year) of training i.e. many equipment remains idle for 80-90% of the total course duration [5].

2.3.6 Little use of technology to assist in training
Adoption of new modern training technologies can help reduce the duration of the course. 97% of the students supported the idea of using technology to assist them in their course.

2.3.7 No short term or demand driven courses
The ITIs should be able to adapt to the changing needs of the industry. They should be able to create new trades and modify old trades based on the needs of the industry. There is a lack of short term courses, most of the courses are either one or two year long. Many student who want to work, take low paying jobs and do not contemplate going to ITIs (Fig. 2) because the courses are very long and they need to earn money fast.

2.4 Focus Areas
From the background research and our study we recognized three major areas where we have to focus in order to increase the percentage of skilled workforce.

- Reducing setup cost of ITIs.
- Increase the capacity utilization of ITIs.
- Find ways to introduce short term and demand driven coursesers.

3 EVALUATING SOLUTIONS
Technologies such as videos [14], computer simulations and e-learning [15] have previously been researched upon as a supplement and alternative for increasing the accessibility of vocational education. The current interface for e-learning and computer simulation requires students to be computer literate which has a major drawback because most of the students enrolling in vocational education are not computer literate. To meet our target of skilled population we also need to provide basic skill training to the illiterate population. However, that is not possible using the existing solutions as they rely heavily on reading the content. Moreover, vocational training is practice driven education, students need to learn various sequence of steps using repeated body motion. Hence, using videos and computer simulation has very limited impact in vocational training. Therefore, we need more radical solutions to address this problem.
4 SOLUTIONS

The logical next step is to develop a system which involves the instructional approach of videos, experience of simulations and involves body motion. Embodied learning when combined with virtual reality and body motion tracking meets all of our requirements.

4.1 Technology

In the last five years there have been significant innovations in the field of Human Computer Interaction, particularly body motion sensors which can help us build such embodied learning environment [16] with relatively very low cost. Kinect is a body motion sensing device by Microsoft which is extensively used in gaming and natural user interfaces. In our system we have created a virtual workshop environment which is similar to an actual skill training workshop. In the virtual environment the user can move around, pick up tools, and control simulation of a process just as he would do in real life. First the user has to follow a tutorial in which the avatar shows the user sequence of steps involved in doing the particular task, now the user has to correctly replicate what the avatar was doing. For example, in the tutorial mode the avatar will show user the steps of making a table such as using paper, pencil and a ruler to plan out the rough design, selecting the wood, going and picking up the tools, precisely cutting the wood and gluing and clamping the table top. After this the user will have to replicate the whole procedure by following the correct sequence of steps, selecting the correct tools and making the correct gestures for the correct amount of time. Application of such system ranges from learning wood working, operating machines to high end skills training like aviation, medical and combat. Additionally, it can also provide job preview to the students so that they can choose the course they like after trying out various courses.

4.2 Pedagogy

The system is easy to use, instantly fun and gets student’s whole body and attention into learning. The system works on the concept of Intuitive Embodied learning. The user interacts with the system using body motion and voice commands. Therefore, the learners having lower literacy are not left behind. By keeping a score in the system based on the performance of the user the system not only works as a tool for actual skill training but also as an assessment tool. The issue of trainee’s learning pace is also well addressed. The system is self-paced so the learning can happen at learners own pace. In regular classroom setting, all trainees are treated as having equal abilities and there is little flexibility in terms of timing and completion of the course. In our system the content can be re-played and the scores can be re-calculated according to the needs of the user as there is no constrain on the availability of raw material or teacher’s time. Two or even more users can be simultaneously trained on one system and can also collaborate to complete a task.

The most important factor for considering environment like this one for education is motivation and engagement [17]. Motivation is the key ingredient for students and for learning, people play games because the process of playing is engaging instead of the learning process which can be painful [18]. Immersive virtual environment allow people to participate in new worlds, inhabit roles that were previously inaccessible for them [19]. This allows people to think and act in new ways.
4.3 Operations

- According to our observations in the case study, average setup cost for a workshop to train 20 people in a particular course is around 1,00,000 USD. Whereas, the setup cost of this system to train 20 people simultaneously is just 10,000 USD.

- A single setup can be used to provide training for any number of skills, because you don’t need specialized hardware for every course.

- As the system can work unsupervised, we also envision a ‘ITIs on the road’ model. Here we make the whole system portable and but the hardware in vans or modified buses and take it to remote, tribal and violence stricken areas. Using face recognition we can automatically make a profile for the students and keep track of their score and skill level.

4.4 Application areas

- To provide skill training to areas where there are no ITIs. This is the next best alternative to learning on actual machines. We need to providing training to the people in rural areas where there is no penetration of training institutes. We need a major initiative to put skill development opportunity at the doorstep of youth in hard to reach areas.

- To increase the capacity utilization of the ITIs. Adding new infrastructure to the ITIs is very costly, as previously discussed above, it takes about 1,00,000 USD to setup a workshop to train 20 people per year which is not cost effective. Therefore, to significantly increase the intake of students we can implement a hybrid model where students first get training on this system and then move on to real machines to complete the training.

- To introduce new courses in the existing ITIs. Each ITI has on an average 10 courses. However, there are 282 vocational training courses [3] in India and it’s not possible to have all the courses in all the ITIs. However, if each ITI has this system then the students can get basic training in any course and then go the ITI which has that particular course for a shorter period of time.

5 CONCLUSION AND FUTURE WORK

We firmly believe that this is the future of vocational training in terms of pedagogy, technology and scalability for skill training institutes around the world. The look, feel and closeness to reality of such a system depends largely on execution of the idea. We are conducting various experiments to see if the skill improves over time with practice on kinect. Also, we are developing a prototype of our system initially targeted to teach wall painting and looking for partners to collaborate with us to deploy and test the effectiveness of the system. We have designed the system keeping in mind the possibility of its extension, we plan to capture and use movement of fingers and not just the hands by using devices like Leap Motion and MYO. This will help us provide more precise training environments and train people for skills that require high precision like metal working and welding.

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