REMOTE - An Opportunity for Indian Technology Industry to benefit masses profitably

Paper submitted to CSITM, IIM Bangalore

REMOTE is an attendance monitoring and teacher training model developed with easily scalable features that can effectively plug leakages in both central & state run schools.

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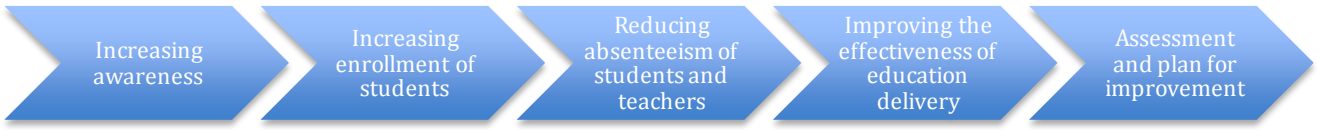
1 Introduction

Over the last few years, the Central and State Governments have been proactive in funding ICT infrastructure at government schools. Through an outsourced model, they have hoped to take computer education to all government schools. The outsourced model focuses on using outsourced trainers for computer training and does not involve the existing government teachers. While this addresses the need of students to be computer literate, it does not adequately leverage the ICT network to improve e-governance in the public education system.

The key problems in the education sector can be split as follows:



Over the last few years, consequent to India's growth, the importance of education has been realized and sufficient awareness has been built up. Of course, there are still several psychological barriers that exist especially for enrolment of girl children.

Further, successive governments have tried to increase incentives for children to attend schools, thereby trying to tackle student absenteeism. The foremost of these have been the Mid-Day Meal Scheme, which has drastically improved attendance as well as increase nutrition levels in children in India. Further, government schemes such as providing cycles for students as well as improving hygiene levels in toilets in secondary schools have been a step in this direction. Private sector initiatives such as the Solar Lantern initiative by SELCO have also helped tremendously.

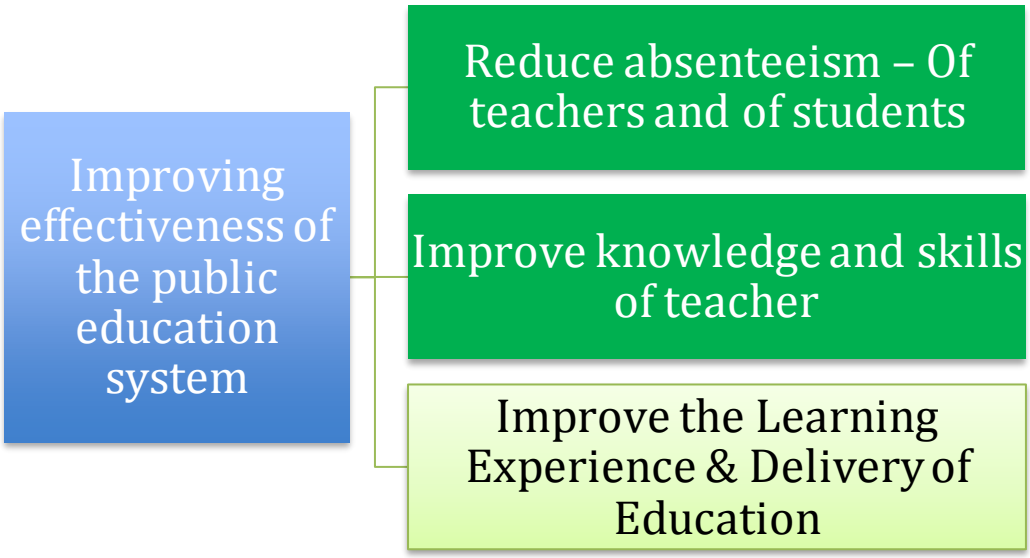
However, there continue to be challenges with quality of teaching in India. Governments have struggled to fill teaching posts in India. They have also struggled to reduce teacher absenteeism particularly in smaller schools in rural areas with 2-3 teachers. Larger schools have to some extent been insulated from this issue due self-regulation in a social setting.

Also, of particular importance has been the need to increase teacher skills and teacher training programs. While the government is spending a lot on setting up Teacher Training Institutes, further methods of continuous learning ought to be devised. It is also of importance to try and use the existing ICT infrastructure in delivery of education to increase quality of learning experience.

Our approach looks to tackle the 3 key issues affecting the government education delivery system:

1) Reducing absenteeism – of teachers and students
2) Enhance teacher training and improve the skills and capabilities of the teacher
3) Improve the learning experience

The model proposed by us, uses existing ICT network and other government infrastructure along with customizable last mile delivery systems as shown below:



We propose to try and use our model to tackle the first two problems initially, later expanding to cover other problems in the education field.

2 Problem Statement

2.1 Problem 1: Teacher absenteeism

Teacher absenteeism is a key challenge that needs to be tackled. An estimate of the economic loss on account of Teacher absenteeism amounts to over $2 billion as shown below:

Estimated Direct Cost of Teacher Absenteeism, Selected Countries				
Country	Direct Cost of absenteeism as percent of public budget [current expenditure primary education]	Direct Cost of absenteeism in primary education as a percent of GDP	GDP at market prices (Current $, billion)	Direct cost of absenteeism in primary education (current $ millions)
Bangladesh	-	0.14	56.6	81
Ecuador	-	0.05	30.3	16
India	22.1	0.29	691.2	2032
Indonesia	15.4	0.07	257.6	173
Peru	10.3	0.11	68.6	77
Uganda	23.6	0.86	6.8	59
Zambia	16.2	0.31	5.4	17
Source: Chaudhury and others (2006), UNESCO-UIS/OECD(2005), World Bank(2006b)				

2.2 Problem 2: Regularly updated teacher training materials and teaching content

It is essential to enhance teacher training by way of more regular profession training and interaction with other teachers. The existing systems aim to provide teachers trainings at Teacher Training Institutes. However, there are very little in the form of incentives to motivate teachers to learn on their own in addition to learning through these TTIs. Further, government has been allotting funds towards teacher interactions. While there exists a system for physical meeting and interactions, this fails to utilize the ICT infrastructure to create interactions particularly using the Internet.

The existing method of teaching and learning is also largely rote based, emphasizing oral delivery and use of blackboards. While textbooks act as visual mediums of learning, there has not been adequate use of AV teaching instruments like videos leveraging the ICT networks in delivering learning.

2.3 Problem 3: Delivery and last mile connectivity

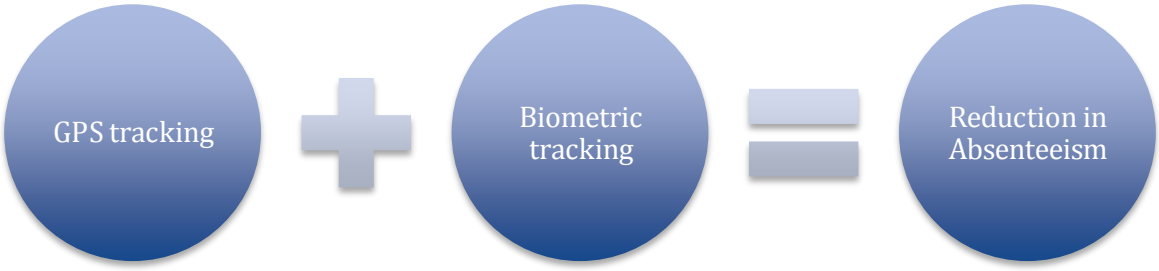
The above model uses existing ICT systems [refer to exhibit 1] rolled out by the government, where available (usually in urban and rurban schools) and Common Service Centers (CSCs) rolled out by the government in the rural areas. CSCs are broadband enabled centers setup by the government to provide several government services through a network of entrepreneurs. To provide last mile connectivity through CSCs in rural areas, we propose to use handheld devices/ netbooks for delivery of content as well as for the recording and monitoring systems. The model also foresees using existing prevalent systems such as mobiles and televisions for content delivery and certain cloud based solutions to reduce hardware costs.

3 Solution

3.1 Model Description

Problem 1:

Our model proposes to use a device with GPS and biometric to record attendance of teachers and students, in order to reduce absenteeism.



A few years back Prof Abhijit Banerjee and Prof Esther Duflo had conducted a study in Rajasthan on using film based photos to record attendance of teachers and students in schools and to effectively link teachers' salaries to these photos in order to increase attendance. Our proposed solution hopes to build on the success of the model to reduce absenteeism. However, our interactions with practitioners in the field have thrown up mixed feedback on acceptability of linking salaries to the attendance recorded on these devices. While biometric devices have been incorporated in a few Government offices in Bangalore, we still see significant psychological barriers.

Therefore at the initial stage, we only hope to use this data along with secondary data such as teacher training patterns, adverse climate conditions, crop harvest periods, epidemic outbreaks etc. to study patterns in these data, if any.

This device will also be used to capture children attendance twice a day, once just before mid-day meal scheme and once otherwise. This can be used to get accurate data on student enrolment levels, impact of mid-day meal schemes etc. and thereby, reduce expenses on mid-day meal schemes and school materials, which are often based on inflated numbers.

Thus, the biometric module through an Aadhaar compliant fingerprint sensor to a school's ICT infrastructure and number of unique ID based services can be enabled.
1) Bio-metric attendance of teachers & student
2) Tracking enrolment and drop out levels in schools and reducing over-reporting of students
3) Tracking gender ratio of students
4) Validation of continuous student performance monitoring (using ICT infrastructure for online tests)

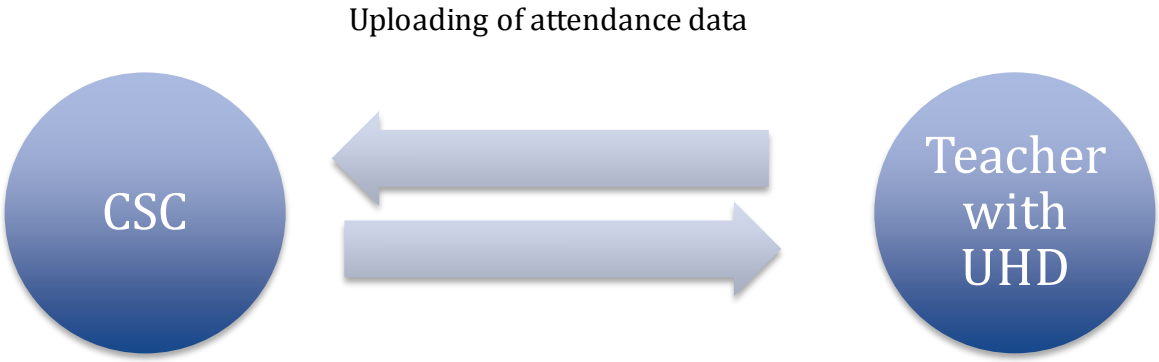
Problems 2 and 3:

Further, by incorporating these features in handheld devices/ netbooks should allow us to use same device to deliver teacher training solutions which the teacher can use even while at home for continuous learning. Examples of devices that can be used and that we propose to use for our pilot plan are given below:

<Atom laptop picture>

3.2 Proposed solution

The model as proposed by us for schools lacking ICT infrastructure is as follows:



- Training delivery through interactive classrooms/ e-learning programs
- Delivery of AV content to enhance classroom teaching experience

The aforesaid model uses the existing model of CSCs being promoted by the government. The CSCs would charge a small service fee for enabling the transactions, thus providing them with a revenue stream while providing access to backbone IT infrastructure. Thus, the CSCs can provide the following benefits especially in rural areas, on account of the following reasons:

- Lack of last mile data connectivity in India
- To enhance training and teacher interactions through interactive webinars
- To store content – cloud based solutions
- Provide spare batteries especially in areas with low electrification

In schools with ICT infrastructure, the above model can be scaled down by directly using the ICT infrastructure in place of the CSCs. The teacher training content can be provided free of cost by NGO's who are working in the field of improving teacher training content.

3.3 Advantage of open source technologies

Our model hopes to use open source software solutions to enable to aforesaid functionalities. Open Source solutions provide several benefits – Firstly, they provide interoperability amongst customizable solutions from different vendors. Next, they provide more secure systems. Last, but not the least, they are extremely cost effective as shown in exhibit 2, based on our preliminary estimates (Karnataka state ICT enabled Higher Primary and Secondary Schools):

3.4 Stakeholders in the model

The key stakeholders in the model described are the government and the government teachers. All the stakeholders are shown in the exhibit 4. Since the model is highly scalable, we consider both state and central government education departments to be stakeholders. The model can be scaled to include many modules as already shown in exhibit 3. Also, the model can be scaled vertically to solve the problem of absenteeism in rural healthcare etc. This makes the model scalable both vertically and horizontally.

Using Teacher Composite Scores (TCS) to address effectiveness of education delivery systems

Of course, all this would fail unless we build a model to incentivize and encourage government teachers to use the solutions developed. We hope to do this by using an incentive scheme based on a Teacher Composite Score (TCS), a sample of which is shown in exhibit 5.

4 Opportunity for Hardware Companies

The model requires developing customized hardware to suit to the Indian/emerging market needs. This requirement opens up huge opportunity & scope for innovation for the hardware companies. The potential challenges that the companies might face and the market size estimated are presented in this section.

4.1 Innovation Opportunities

The technologies considered for developing custom hardware in the current solution is a combination of biometric and GPS. Biometric devices help us in identifying the teacher/student uniquely and GPS devices would give us the location information with an accuracy of 10 meters. This would solve the problem of capturing the identity and location simultaneously. The extended solution includes a GSM modem to transfer the data from the device directly to the server.

Hardware companies should innovate in building a custom black-box that is easy to handle, rugged since it will be used in rural areas and is low on maintenance. One of the most important factors to be considered is the cost. The aim of the hardware companies should not be to integrate the existing modules available in the market, but to actually go deep in to each of the technologies and eliminate all the redundant modules to decrease the cost.

There is no restriction that the above said technologies are to be used. The hardware companies are free to develop a custom solution which can ***solve tracking the identity and the location problems***. For example, near field communications can be used instead of a GPS device. The cost of the NFC devices are much lesser compared to GPS units and they can track the user with an accuracy of 2 meters. But would installing a NFC device require every user to own a device that can communicate with the NFC instrument? And would that

increase the cost of the entire set-up to a great extent? These are some of the question to be answered before finalizing any technology.

Another completely different approach is to use the existing technologies/devices instead of developing a new hardware. Is it possible to use the existing the mobile phones with a small unit added to it via the 3.5 mm audio jack? ***Square[i] is an amazing innovation where they developed a small unit that can be plugged into an iphone audio jack and transform the mobile phone in to a payment gateway***. Also, we found a ***Bangalore based Start-up Company which developed hardware at a cost of 2500 INR capable of running Android apps and streaming content from internet to a TV***. This kind of innovation will immensely help teachers get trained at home at their convenience. Streaming content through DTH operators is also an option since by July 2012 all the major metros would need to go digital and other parts of the country will also shift to digital mode by 2015.

4.2 Challenges

Working with rural population and addressing all their needs will remain a great challenge for the hardware companies given the inherent problems. Power supply is the first major bottleneck. Most of the villages in India get power supply only for 6 to 8 hours in a day, and in some cases remain without electricity for a few days in a row. The hardware that would be built should be able to work with ***minimum power consumption and with long lasting battery life.***

Ruggedness and difficult to break hardware is another features that is a must. Since, there can be some resistance from both the teachers and the children when asked to use the new system, there is every possibility of the device getting damaged to avoid recording attendance. Even if not done intentionally, the device can get damaged due to poor maintenance and rough handling by the teachers/administrators.

One another major feedback received from the IAS office in charge of Bhoomi project in Karnataka is that the biometric devices stop working after a year. They get dusty and cannot recognize the thumb impression and need replacement. Such short life cycle would not go well with the government departments that would fund this project. The devices should have a significant life time and free of maintenance.

4.3 Market size

The market can be broadly divided into three segments. The first one is the state government schools. The second Central government and finally the state run schools in the emerging economies. The first segment is where the actual trails happen and based on the results a nationwide role out is possible. There is INTEL-NSRCEL Youth Enterprise forum working with the Government of Karnataka and the Department of Science & Technology, Government of India to bring out this project live based on the results of the pilot project. ***Karnataka itself has 25979 Lower Primary, 33619 Higher Primary and 13866 High Schools.*** Each school would need multiple devices to record the attendance.

Even by a worst case estimate of only 2 devices per school a total of **1,46,928** devices are required for the state run schools. The total estimate for the government schools is given in exhibit 6 and exhibit 7. The data in exhibit 8 shows the current government spending on secondary education. If the model can show significant improvements in the school education system government will be more than willing to allocate a significant portion of the funds allocated to the education system as a while.

5 Opportunity for Software Companies

Given the enormous scale of the project and the multiple stake holders involved, highly robust and scalable software solutions form the core of the project. The different front-end and back-end requirements are listed out here.

Back-end requirement

The service provider will have to maintain the data at the server. This will involve maintaining the server website, attendance modules data, teacher training content and related streaming software. Since the data is presented to multiple stake holders with different views, designing and maintaining access rights to different views is also a major task.

Front-end requirement

The front end requires a custom application design and development that can be run on multiple platforms like Desktop, Smartphone, Tablets and TV with an interface device. The software in a nut shell has to be platform agnostic. The model also requires the software to be highly scalable so that it can handle enormous data at later stages as well as plug-in interface to include modules that can be developed at a future date. The main school application should be a stand-alone application confirming to the above requirements. The views for different stake-holders can be presented via a web-interface which requires a website design and development that can provide different views based on the user type who logged into the website.

5.1 Service Revenue Model

Though the hardware installation is a one-time cost for the government, the software module can be run on a service agreement. Since, the project would save a huge amount of money to the government by plugging in the leakages; the service provider can charge an annual service fee to render efficient services. Maintaining the system to provide real-time data to different stake-holders, training the school administration to use the system, troubleshooting etc. are a few aspects which could bring a steady stream of revenue to the software companies. They can also tie up with the government CSC's to get last mile connectivity in data collection. The service fee can be a per-school annual fee based on the strength of the school. The market size has already been discussed in the hardware section. Even with a very small margin there is a huge scope for being profitable given the size of the project.

6 Conclusion

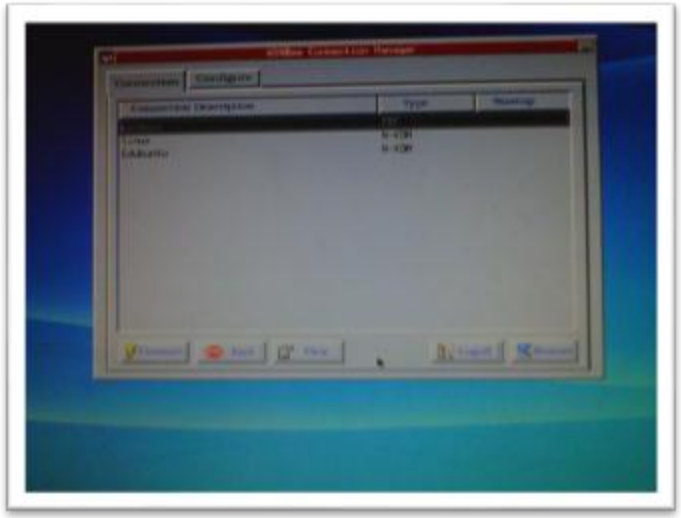
We hope to use our model to improve effectiveness of the public education system by building on existing infrastructure and systems to provide better monitoring and content delivery systems.

The opportunity for both the software and the hardware companies in the implementation of this model is enormous given the scalability and the size. Custom low cost hardware and software can be developed to solve the problems in the education system and companies can profit from the volumes. A research shows that only 6 % of the money spent by the government reaches the students[ii]. If this model is used with some custom low cost hardware and software to improve the reach even to 30%, government would be more than willing to pay the companies involved in the project.

Exhibit 1 Current State of Computer Labs

Server Computer Loaded with Windows Server Edition

Thin Client where Students Learn MS Office



Option of Operating System while Login[Only Windows Works]

Power back-up in the Computer Lab

Exhibit 2 Cost Comparison of Open Source and Licensed Software

Cost Item	Open Source	Licensed Software [Windows in this context]
Server Cost	0	150 USD for 5 users
Productivity Tools [presentation, excel etc.]	0	5249 INR per license
Cost for 10 clients in a school	0	(300 USD + 5249[iii] INR) 0.4 [assuming bulk license cost 40% of retail price for education]
Cost for the schools with ICT implemented	0	20249*0.4* 3,814 = **30,891,874.4 INR**
Cost for all the schools to be ICT enabled [Higher primary+ Secondary Schools]	0	20249*0.4*47485 = **384,609,506 INR**
Support & Maintenance Costs	X*	X*

* Assuming same cost

Exhibit 3 High Level Architecture of the Model

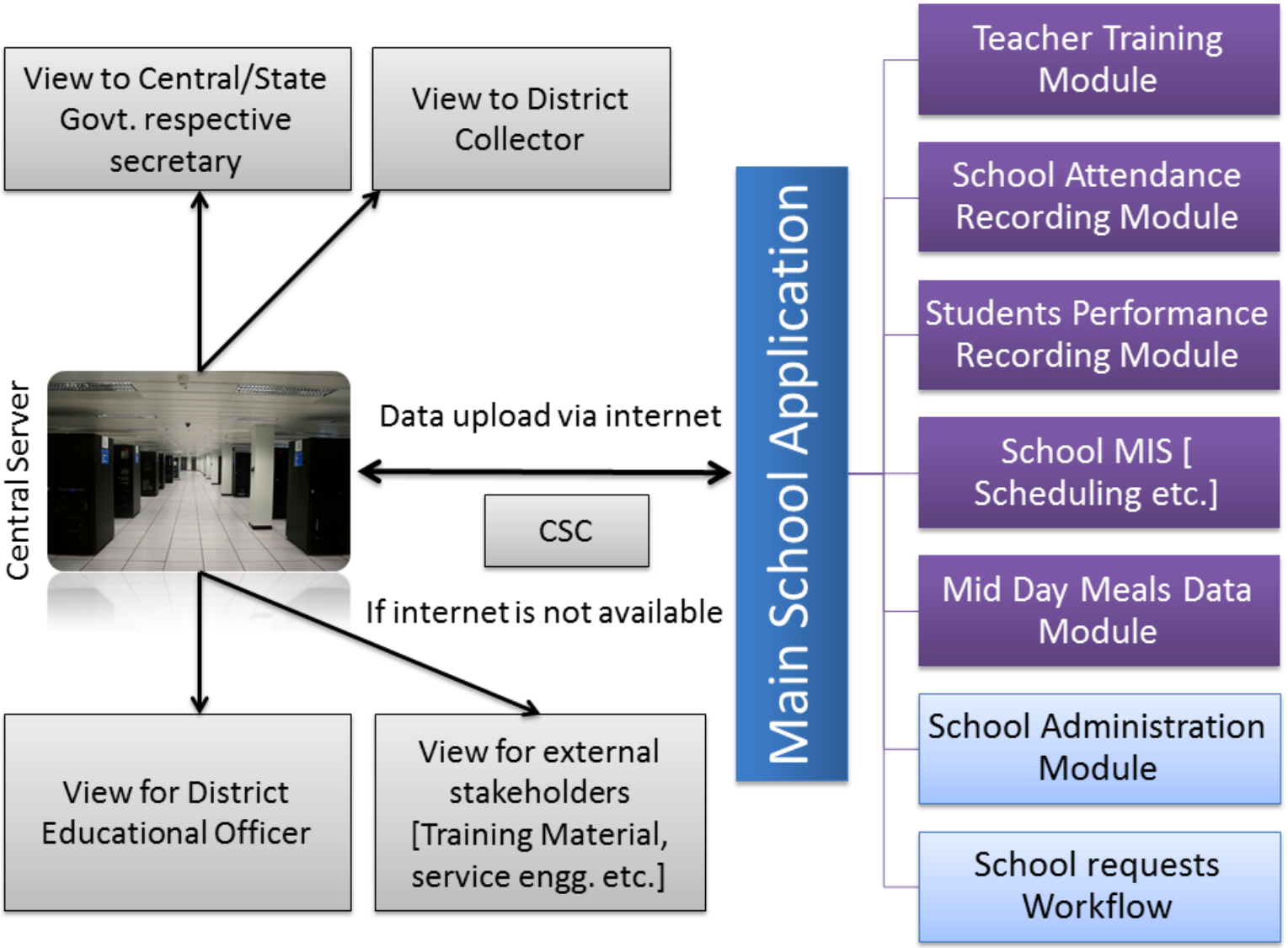


Exhibit 4 Stake Holders in the Model

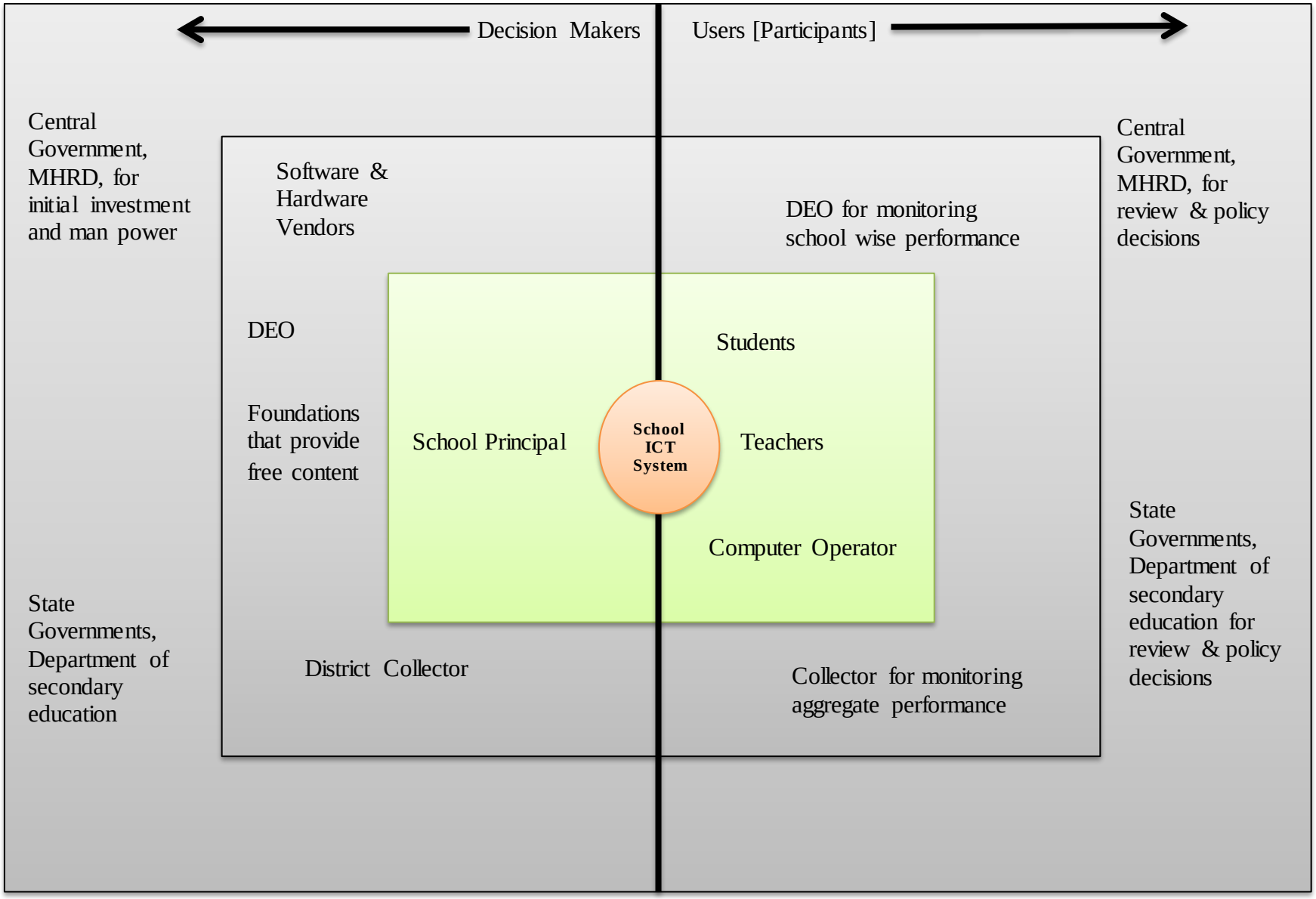


Exhibit 5 Teacher Composite Score [TCS]

Component Name	Weightage		Criteria for giving Weightage
	Phase I	Phase II	
Attendance	60%	40%	This is given the highest weightage so as to make sure that the teachers are available in the school.
Training	20%	20%	This module enables the teachers to keep up with the current happenings, but doesn't guarantee that they will use these skills in the schools.
Technology & System Usage	20%	20%	This is the source of motivation for them to use the technology based resources.
Performance of Students Taught		10%	This comes in the second phase where children performance is also made a part of teachers' evaluation. Since there can be instance of children genuinely not interested in studies, the weightage is kept at a 10%
Performance of School relative to other school in the same region		10%	This is given to promote competition among the schools in a region, and is used to identify the best schools in a region to replicate the same model across other schools.

Exhibit 6 Number of Pre-Primary/Pre-Basic Schools in India

State/Management-wise Number of Pre-Primary/Pre-Basic Schools in India (2009-2010)				
States/UTs	Govt.		Local Bodies	
	Number	%age	Number	%age
Andhra Pradesh	0	0	0	0
Arunachal Pradesh	1674	99.17	0	0
Assam	0	0	0	0
Bihar	1	100	0	0
Chhattisgarh	603	44.8	3	0.22
Goa	0	0	0	0
Gujarat	0	0	0	0
Haryana	17	100	0	0
Himachal Pradesh	14	100	0	0
Jammu and Kashmir	0	0	0	0
Jharkhand	95	100	0	0
Karnataka	0	0	0	0

Kerala	0	0	0	0
Madhya Pradesh	0	0	0	0
Maharashtra	29064	51.77	17700	31.53
Manipur	1	100	0	0
Meghalaya	301	42.33	0	0
Mizoram	0	0	0	0
Nagaland	0	0	0	0
Orissa	0	0	0	0
Punjab	0	0	0	0
Rajasthan	7	87.5	0	0
Sikkim	775	66.24	0	0
Tamil Nadu	0	0	0	0
Tripura	0	0	0	0
Uttar Pradesh	0	0	0	0
Uttarakhand	0	0	0	0
West Bengal	0	0	0	0
Andaman and Nicobar Islands	0	0	3	11.11
Chandigarh	1	100	0	0
Dadra and Nagar Haveli	0	0	0	0
Daman and Diu	13	52	0	0
Delhi	0	0	50	100
Lakshadweep	18	100	0	0
Pondicherry	289	52.93	0	0
India	**32873**	**48.47**	**17756**	**26.18**

Note: As on 30th September, 2009.
Source: Ministry of Human Resource Development, Govt. of India. (ON214)
Retrieved from IndiaStat.com on 20th April 2012

Exhibit 7 Number of Middle/Senior Basic Schools in India

State/Management-wise Number of Middle/Senior Basic Schools in India (2009-2010)				
	Govt.		Local Bodies	
States/UTs	Number	%age	Number	%age
Andhra Pradesh	395	2.57	8757	56.93
Arunachal Pradesh	744	85.42	0	0
Assam	7315	51.76	28	0.2
Bihar	20540	99.25	0	0
Chhattisgarh	13057	86.2	0	0
Goa	137	30.86	0	0

Gujarat	0	0	17757	72.88
Haryana	2205	64.12	0	0
Himachal Pradesh	4362	88.64	2	0.04
Jammu and Kashmir	6962	78.43	0	0
Jharkhand	9469	94.73	0	0
Karnataka	22713	70.89	25	0.08
Kerala	979	31.97	0	0
Madhya Pradesh	26928	68.65	0	0
Maharashtra	926	3.4	21804	79.95
Manipur	303	38.26	0	0
Meghalaya	56	2.48	0	0
Mizoram	538	40.97	85	6.47
Nagaland	287	61.72	0	0
Orissa	18666	84.05	0	0
Punjab	3776	41.45	2	0.02
Rajasthan	24857	63.92	0	0
Sikkim	146	59.84	0	0
Tamil Nadu	390	3.91	7892	79.19
Tripura	1113	97.72	0	0
Uttar Pradesh	39602	76.23	0	0
Uttarakhand	2990	69.6	0	0
West Bengal	1033	24.05	1696	39.48
Andaman and Nicobar Islands	52	77.61	4	5.97
Chandigarh	11	61.11	0	0
Dadra and Nagar Haveli	112	88.19	0	0
Daman and Diu	23	95.83	0	0
Delhi	37	6.35	14	2.4
Lakshadweep	10	100	0	0
Pondicherry	62	52.54	0	0
India	**210796**	**57.32**	**58066**	**15.79**

Note: As on 30th September, 2009.
Source: Ministry of Human Resource Development, Govt. of India. (ON214)
Retrieved from IndiaStat.com on 20th April 2012

Exhibit 8 Government Spending on Education

State-wise Plan and Non-Plan Expenditure (Revenue Account) on Secondary Education (Government Secondary Schools) in India (2009-2010)				
				(Rs. in ' 000)
States/UTs	Budget Estimates			
	Plan	Non-Plan	Total	%age*
Andhra Pradesh	2460151	2542832	5002983	16.17
Arunachal Pradesh	69600	458902	528502	74.36
Assam	0	430114	430114	3.89
Bihar	0	9845902	9845902	68.22
Chhattisgarh	6002830	1345700	7348530	82.92
Goa	10000	304146	314146	9.52
Gujarat	714552	660146	1374698	8.78
Haryana	1414213	13475670	14889883	83.08
Himachal Pradesh	0	4727921	4727921	83
Jammu and Kashmir	400000	0	400000	5.04
Jharkhand	534150	3184813	3718963	73.37
Karnataka	1045244	2440345	3485589	12.31
Kerala	258000	8882387	9140387	34.58
Madhya Pradesh	1216792	8347663	9564455	63.24
Maharashtra	67	95070	95137	0.12
Manipur	0	1272259	1272259	85.18
Meghalaya	68367	218746	287113	18.95
Mizoram	218600	574530	793130	72.75
Nagaland	23350	522612	545962	62.28
Orissa	275323	10709140	10984463	76.48
Punjab	253250	20694524	20947774	93.29
Rajasthan	756317	26563357	27319674	90.6
Sikkim	12100	0	12100	1.05
Tamil Nadu	1668366	24636827	26305193	62.13
Tripura	47499	0	47499	1.26
Uttarakhand	900969	9591470	10492439	77.99
Uttar Pradesh	157279	3429344	3586623	7.64
West Bengal	0	601405	601405	1.2
States	**18507019**	**155555825**	**174062844**	**34.75**
Andaman and Nicobar Islands	184900	566312	751212	87.15
Chandigarh	45900	555165	601065	91.39
Dadra and Nagar Haveli	-	-	-	-
Daman and Diu	-	-	-	-
Delhi	0	10482250	10482250	44.98

Lakshadweep	61958	220450	282408	51.99
Pondicherry	376999	536097	913096	77.07
UTs	**669757**	**12360274**	**13030031**	**48.57**
India	**19176776**	**167916099**	**187092875**	**35.46**

Note: *: %age to Total Expenditure on Secondary Education.
Retrieved from Indiastat.com on 20th April 2012
Source: Ministry of Human Resource Development, Govt. of India. (13039)

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[i] https://squareup.com/
[ii] http://timesofindia.indiatimes.com/articleshow/12361365.cms
[iii] http://www7.buyoffice.microsoft.com/asia/product.aspx?family=o14_officehs&country_id=IN&culture=en-IN&WT.mc_id=ODC_enIN_HomeStudent_Buy&action=buy