The AGEM project
Reforming Grades 6-12 in public schools in India

Samar J. Singh, PhD*

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*Email: samar@agem.in

Introduction

I am a former academic who returned to India in 1997/98 with the objective of helping to reform our school education system. I had realized during my academic career that tertiary productivity depends on the national quality of schooling. My mission has been to reform Indian school education particularly in the governmental sector through centralization both of content and core delivery. In addition in-line assessment creates added value through immediacy of feedback. Indeed, I believe - like the student who gets his results weeks or months after taking an exam - that feedback delayed is learning denied.

In order to ensure that my findings were based on ground realities, I researched, developed and refined over the last 16 years, innovative education technology and methods through:

- setting up two International schools,
- serving as the University of Cambridge International Examinations (CIE) consultant for auditing Cambridge Schools in India,
- partnering with Harvard University Graduate School of Education in trying to create an awareness through a projected Mind, Brain and Education program in India, to address the issues impacting reform of educational policy.
- working with children who find themselves in difficult circumstances through poverty or HIV/AIDS in 8 states of rural and urban India and about 40 schools in Bangalore through Janaagraha's civic education initiative.

1 The Mismatch - academic output vs needs of industry and academia

1.1 Briefly speaking

- Of every 100 students who started Grade 1 twelve years ago, 42 will drop out by Grade 8 and less than 20% of the remainder will get into university education. Of those who graduate less than 25% will be employable. The means for every 100 students who entered school in Grade 1, less than 3 employable university graduates are generated.
- More than 40% of our students drop out by Grade 8. It make sense to have a powerful focus on Grades 6 to 8 to provide them usable skills before they leave.
- The high dropout rate for girls by Grade 8 severely impacts our GDP. We can and should overcome this.

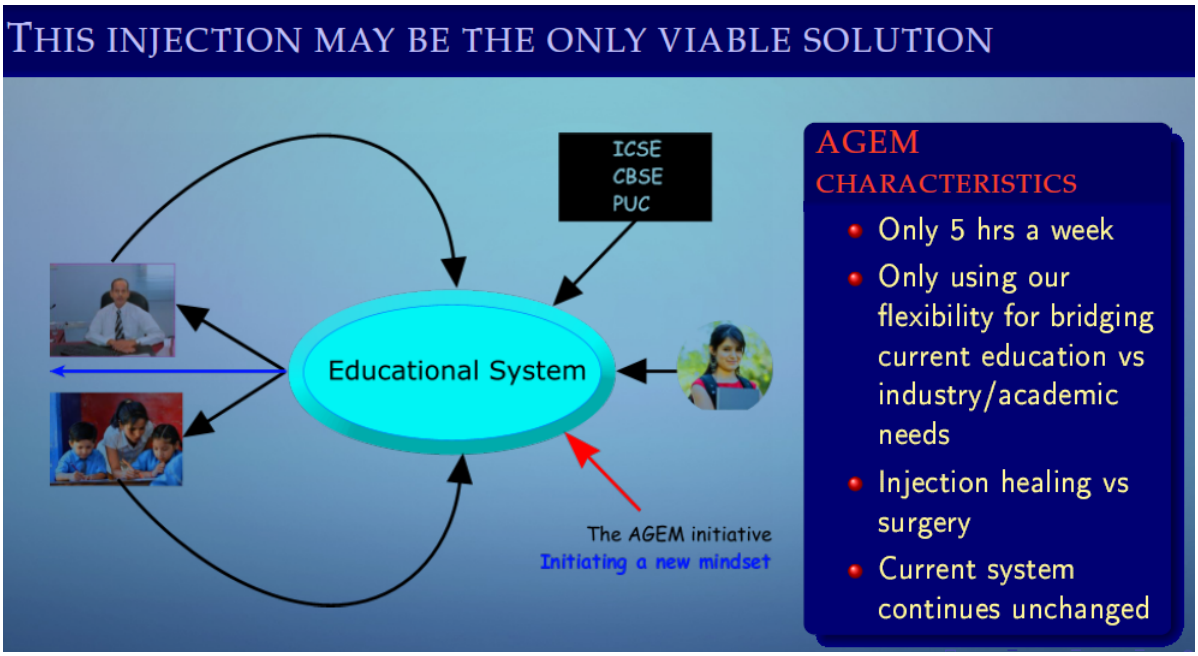
1.2 The details

Few would disagree with the argument of a widening gap between the needs of industry and the capabilities of graduating students given the extracts below from Ernst and Young's Higher Education report for FICCI in 2013.

However, while we have done a wonderful job of increasing school enrollment much needs to be done regarding dropout rates - particularly of girls before Grade 8(source: here). The quality of curriculum and delivery impacts the quality of tertiary education. The former not only impacts the quality of those graduating from school but also impairs the ability of universities and employers to educate and train the output of our school education.

2 The broad solution

While the intuitive solution would appear to be reform of the system as a whole, deeper reflection warrants more complex thinking. Much of the inertia of the system comes from both its size and its self reinforcing properties as shown in the diagram below where students graduate from school and take an education degree and often return to school - but this time to teach. This reinforcing loop is the primary contribution to the inertia that dominates our education system.



However, it is the exam boards like ICSE, CBSE and PUC that call the shots and define the system. The school system ensures that what is taught is what is examined, and little else besides.

Trying to create profound change in the education system through altering its basic structure may be intuitively attractive. However, the physiological analogue of that would be tantamount to providing a pancreas transplant for a diabetes patient, where a daily injection of insulin would suffice. It is this injection of an effective curative treatment that we seek to implement. through the AGEM solution for the Indian education system.

3 The general objective of the AGEM project

India is a land of contrasts. No contrast is so glaring as the contrast of wealth, purchasing power, and access to health resources. Many of these problems stem from access to quality education. In our country, government schools, which should be the primary providers of education, are giving over that space to private schools through deficient delivery. In Karnataka the percentage of students going to government schools is 27% and declining. The general objective of this project is to make government schools the preferred providers of quality education for 80% of participating communities within the decade.

4 What is the primary symptom of the mismatch problem?

In order to achieve that outcome, the quality of government schools has to improve. The quality deficit is most apparent in the increasing gap between the education that schools provide and the attributes that Industry and academia need.This is illustrated most forcefully by the statement by Manish Sabharwal that the company he heads - Team Lease - only employs 5% of those who apply to it for a job. He also says that his company which is also a training company finds that 40% of those who apply need more than a year of remedial training to qualify.

5 What are the reasons for the problem?

There are several reasons:

Inertia: The education system is hostage to many forms of inertia. The most fundamental is that the syllabus cannot easily be altered to meet modern needs as it involves retraining teachers, re-writing textbooks along with a host of other implications.

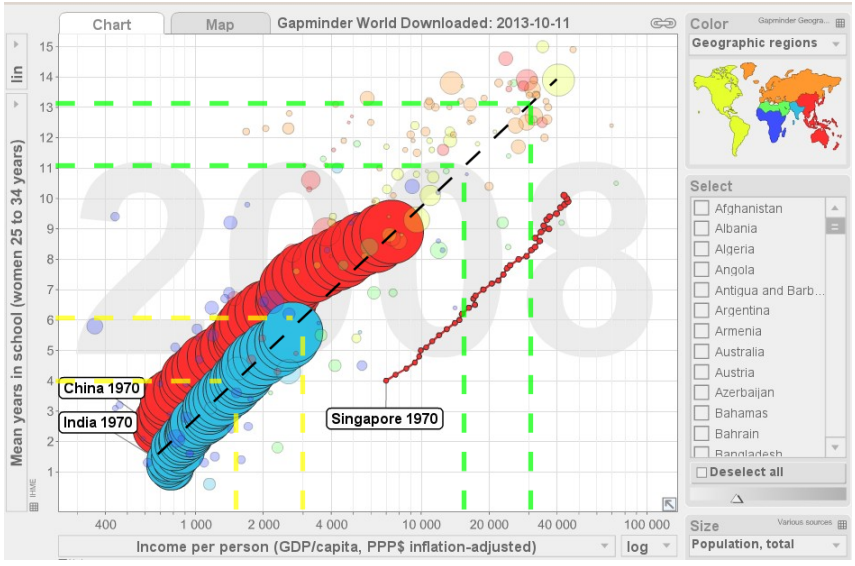
Scale: Karnataka alone has about 3 million students in Grades 6 to 8. It is difficult to use those staff who are part of the current system to change the system. The sheer scale of the enterprise would require an army of committed reformers willing to work to change the system.

For these and several other reasons, the possibility of reform of the education system to meet the needs of industry and academia is not on the cards in the near term. An essential element of our solution is that we leave these systems more or less intact while making education for secondary education more effective and more relevant to the needs of academia and industry.

6 What is the impact of the problem?

An educational system that is out of step with real-world-needs creates several problems.

- Boredom in the student body and the teaching faculty
- High dropout rates which are well known particularly at the Class 5-6 transition and the Class 10-12 transition. Ultimately only a very small fraction go on to higher education.
- Poor quality of undergraduate education. If the fundamentals are not formed in the schools, this is a problem that will affect the quality of undergraduate education. This was forcefully expressed recently by the Vice Chancellor of Delhi University who noted that a company which wished to employ a large number of of Delhi University graduates ultimately chose only 3 after interviewing over one thousand.
- Impact on GDP particularly in respect of the contribution of women in the workforce who enter the workforce with insufficient school education. The figure below shows the relationship between years of education prior to entering the workforce and the GDP per capita adjusted for puchasing power parity and inflation.



  - In the picture above, each colored circle represents a country. The region is correlated by color with the diagram in the top right corner. The size is a function of the population. Where

there are trails e.g. China, India, and Singapore, each circle represents a one year increment from the origin of the trail which in these three cases is 1970.

- The vertical scale indicates the mean of the number of years that women have spent in school for the subset of women who in 2008 were between 25 and 34 years of age. This period generally reflects the ages of working women.
- The horizontal scale indicates the GDP per capita adjusted across time and country for inflation and across countries by the principle of purchasing power parity.
- One can see from this that if we take the black dashed line as an approximate best fit trajectory for India then an increment of 2 years from 4 to 6 years (yellow dotted lines) leads to an increase in Income per person of about PPP$2000. However, an increase from 11 to 13 years leads to an increase of about PP$20,000. This makes the case for women's education specifically and for education generally.

  However, the figure above also shows an increase in PPP$ due to the spread which some countries, such as Singapore have to the right. Singapore in the mid 1960's focused on using school educational quality to position itself as a service provider to MNCs. It did not invest so extensively in University education till much later. More importantly, in the 1990's China modernized its education system to change its trajectory to the right thereby generating a higher Income Per Person.
- I would like to do that for India starting with Karnataka.

7 How will the AGEM project impact the problem?

7.1 The characteristics of the solution

Scalability: As the lectures can be delivered over an Internet link there is no limit to the number of schools that can receive this. However, each school will need one classroom with sufficient feedback devices. Large classes are an asset in this system as the quality of representations of responses increases. Such classes can come from multiple grades within the Grade 6 to 8 and 9 to 12 segments.

Effectiveness: The solution requires only 5 hours a week in the first phase and ten hours a week in the second phase for Grades 9-12

Meaningful Content: This will centralize content generation to reflect the real needs of industry and academia particularly for the future. This content complements the content delivered by the school by providing learning by methods and practices gleaned from the latest research in neuroscience but does not compete with the current system.

Assessment: The content contains embedded questions which are used for several purposes that include assessment. This assessment will be centralized and used to improve the content as well as to guide students to improved performance based on discrete data for each student and each student group.

Database: This program has the potential to create one of the world's largest databases of school performance. This has various implications:

- for replacing high stakes examinations due to the large number of questions that are answered per lesson varying from about 10 to 30 per hour, thereby freeing teachers from following examination constraints and actually using that time for helping students learn. This will create a better instrument for student development, career guidance and evaluation.
- for the centralization of content and evaluation methods which will help create a narrower range of performance thereby allowing higher education and industry to be more effective in providing education and training.
- for revising content on the basis of extensive feedback or for tailoring content to suit cultural or geographical circumstances.
- for identifying the talent of each child and helping the child to explore, nurture and develop that talent.
- for integrating new and better methodologies for learning derived from worldwide research or culled from the vast database of performance created by this system.

Homework: There is no requirement for homework in this system though students may be encouraged to do projects and produce a portfolio for employers and universities.

Textbooks: There are no textbooks required for students on this project.

MOOCs: Many elite universities are today providing educational modules on subjects varying from artificial intelligence to entrepreneurship through the medium of Massive Online Open Courses (MOOCs). The defining characteristic required to take advantage of this invaluable resource is a meaningful education in the teenage years. I believe that students graduating from schools deploying the AGEM method will be ideal populations to take advantage of the opportunities that MOOCs generate.

8 How will impact be measured?

- In the past we have used placement tests developed and tested in the United States for the purpose of measuring academic impact and we will continue to do this. Past experience has shown that Grade 6 students are below the average level of Grade 3 placement tests both in English and Maths.
- Additionally, in this case, we hope to invoke the expertise of the Harvard Graduate School of Education or equivalent local body to conduct independent testing for academic impact.
- We also expect to test the impact on the sense of well being of the children. For this we intend to use Seligman's CASQ[1], WHO-5 and the WEMWBS tests which represent established methods of measurement.
- In addition, the embedded questions in the topic plans are also used for measurement of student response and progress over the duration of the course.
- Finally, we measure changes in the end of term examinations prior to the program and those taken at the end of the program. This demonstrates that our students have learned how to learn and will therefore see an overall improvement across the board.

[1] Children's Attributional Style Questionnaire

9 What is the overall design of the study?

9.1 Selection of students

While we expect to test the full set of Grades 6, 7 and 8 for the study, we will select half the full set to form the experimental group while the remainder become the control group.

9.2 Pre and Post testing

The following tests are envisaged both before the start of the course and at the end of the course:

- Placement tests for English and Maths conducted by us.
- Specific tests for Systems Thinking
- Tests of explanatory style such as CASQ, WHO-5, and WEMWBS.

9.3 Conduct of the course

- We expect to conduct this for about 3 hours on Saturday's and about 2 hours at one other day in the week.
- The topics covered include English, Maths and Systems Thinking.
- The approach is generally interdisciplinary so a topic plan may cover all three disciplines
- We generally prefer longer classes to avoid the wastage of time that is involved in start up processes. Our experience has been that students can take our classes for 5 to 6 hours at a time with short breaks.
- We expect students to work on collaborative projects using computers and open source software as this is an important element of real-world environments.

10 What are the technology aspects of the project?

Technology in terms of hardware and software is deployed as follows:

Feedback devices: Our fourth generation proprietary feedback devices are wireless transceivers interfaced to a keyboard that operates on two AAA batteries which last for about 2 years in normal operation. We log details of any instance when any key is pressed or released. The current version is the 4th generation of hardware and we have a fifth generation planned.

Software: Software is deployed at multiple levels.

- Embedded software provides the hooks for us to interface with the keyboard.
- Interfacing software is written in C and provides low level access to the data streams
- Application software is written in Perl and provides the interface for management of the feedback devices.

- Representation and analysis is done in R and generates the graphics that are displayed for the students after they have responded to a question.

Distribution Hardware: If multiple schools are being catered for, then a centralized studio will be required to broadcast content to multiple locations. However, control signals will also need to be broadcast to permit the opportunity for students keyboards to be activated. This process will also require a server in the classroom.

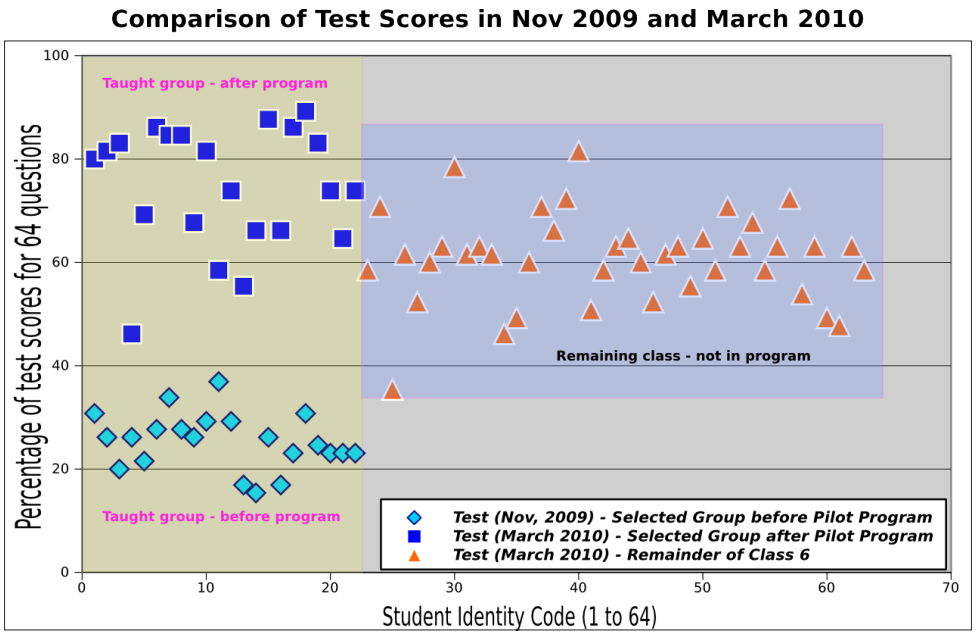
11 Prior work - Initial Pilot Program in Maths

In 2010, I decided to conduct a Pilot Program to measure the effectiveness of the process we had defined for improving government schools. As working with government is a complex process we decided to work with the Maria Niketan School in Bangalore which caters to the needs of the economically deprived. The results of that work convinced me that a process of low profile injection for 5 hours a week would be adequate to make government schools the preferred schools for 80% of participating communities. This represents a low profile approach to reform which does not face the inherent resistance of the current system. This resistance is greater in government schools though it is significant also in private schools.

This program was only to teach the fundamentals of mathematics.

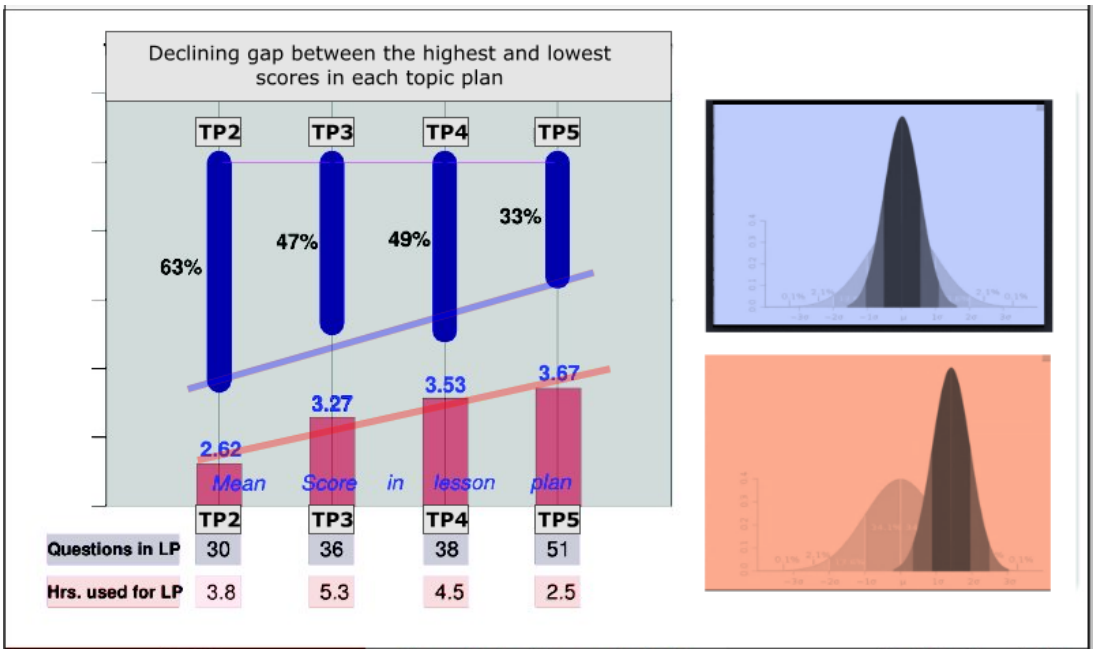
11.1 What was the outcome of the pre/post testing?

The first indicator of impact was the outcome of pre and post tests which were actually Grade 3 Maths placement tests from the US.



The left side shows the results of the pre and post testing before and after the course. One can see the very low grades of students in the pre-test. In general these were children below average or well below average of the total class. On the right side the red triangles show the results of the placement tests for the rest of the class. Unfortunately due to some limitation with the initial design of our equipment we could not conduct a test with the total class of 75 students.

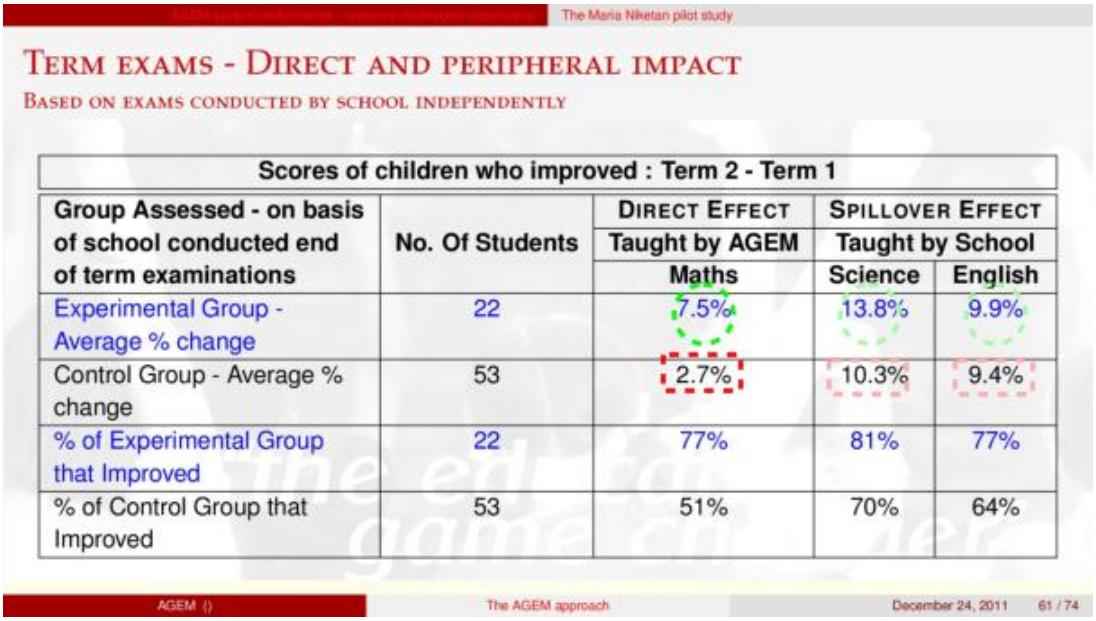
11.2 What was the result of the embedded questions scoring?



- The red bars on the left side show the gradual increase in scores over the Topic Plans. This could well be the students and myself getting used to each other but also building up accumulated skills.
- The blue bars are based on the premise that the student who did best in each topic plan was assumed to have scored 100%. Incidentally in each case, these were different individuals. The percentage was than calculated for the student with the lowest score. This provides us a measure of the range of scores. We can see that this range is getting less i.e. the weakest students are learning faster than the strongest students.
- On the right handside, the decline in range would manifest itself in a larger population to be a reduction in standard deviation visible in the upper right diagram, while the gradual increase in average scores over successive topic plans would be a movement of the bell curve to the right.
- A good educational system should strive to both reduce the range of performance and increase the average performance score.

11.3 How did our program impact performance on school administered tests?

As these results appeared to be unusually good, we decided to see if the program could have had an impact over a wider domain. We therefore tracked - as an afterthought - the results of the students in the school's end of term exams. These exams were conducted by the school before we had started and again after we had left the school so we had no role in that work.



The Maria Niketan pilot study

TERM EXAMS - DIRECT AND PERIPHERAL IMPACT

BASED ON EXAMS CONDUCTED BY SCHOOL INDEPENDENTLY

Scores of children who improved : Term 2 - Term 1				
Group Assessed - on basis of school conducted end of term examinations	No. Of Students	DIRECT EFFECT Taught by AGEM	SPILLOVER EFFECT Taught by School	
		Maths	Science	English
Experimental Group - Average % change	22	7.5%	13.8%	9.9%
Control Group - Average % change	53	2.7%	10.3%	9.4%
% of Experimental Group that Improved	22	77%	81%	77%
% of Control Group that Improved	53	51%	70%	64%

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- The first row below the headers, shows - for those students who had done better in the term exams after our course - the percentage increase in Maths, and also as a spillover effect in Science and English. As Maths was the only subject we taught - and by extension our classes led to some increase in English fluency as a lot of comprehension of materials and typing responses was called for - the effects on Science and English compared to the Control Group represent a spillover effect.
- In terms of the percentage of students that improved, the experimental group also showed an interesting difference vs the control group.

12 Next steps

We have proposed to the Government of Karnataka(GoK) and GoK has agreed, that we implement a validation program for 50-100 students for 100 hours of teaching. We also expect independent measurement of the outcomes to be conducted. If this shows the desired results, the GoK will put this into 10 government schools in the first phase of operation in Bangalore, in all govt. schools in the second phase and finally over all of Karnataka.

We would welcome collaboration from companies to take this forward and from Universities to act as independent evaluators.