The AGEM project

Reforming Grades 6-12 in public schools in India

Samar J. Singh, PhD*

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*Proprietor: A Generalized Education Metastructure (AGEM)

1 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.

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

2.1 Briefly speaking

- every 100 students who started Grade 1 twelve years ago, 42 dropped 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 makes 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.

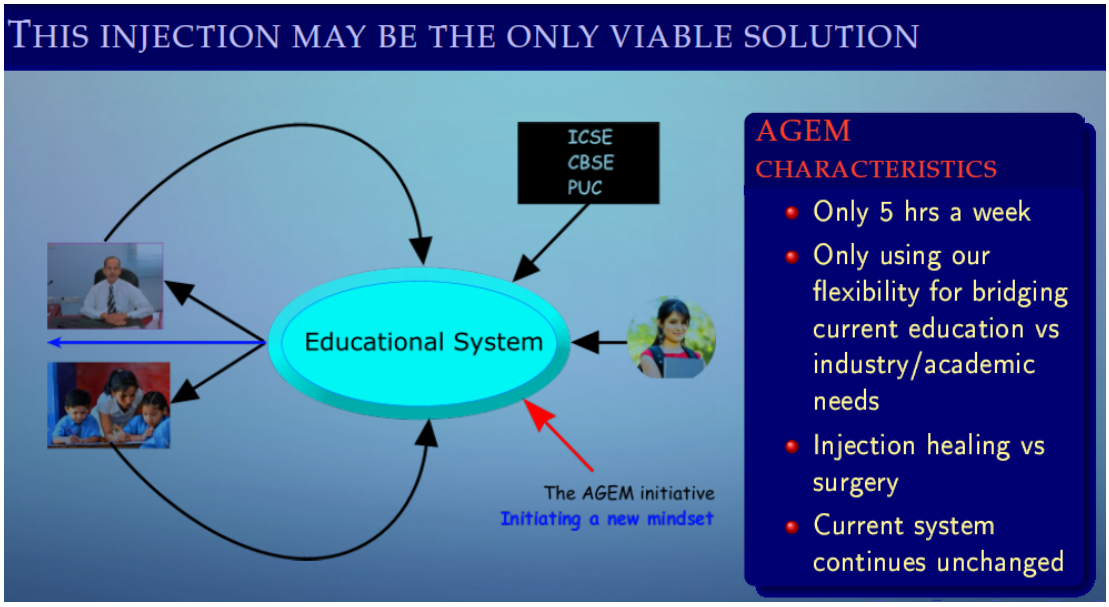
2.2 The details

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 quality, and dropout rates - especially of girls before Grade 8 (source: here). Quality of school education not only impacts the job prospects of those graduating from school but also impairs the ability of universities and employers to educate and train.

3 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.



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.

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.

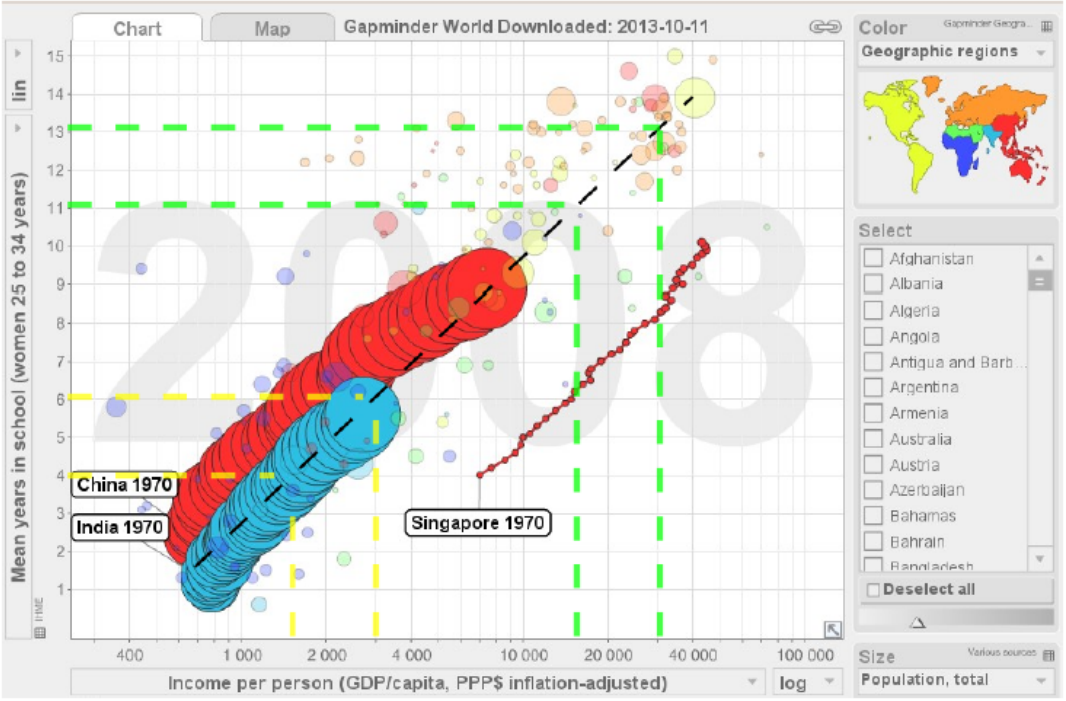
For these and several other reasons, the possibility of reform of the education system to meet the needs of industry and academia is not on the cards in the near term. An essential element of our solution is that we leave these systems more or less intact while making education for secondary education 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 initiate this shift to the right for India starting with Karnataka state.

7 How will the AGEM project impact the problem?

The characteristics of the AGEM impact are:

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 Taking forward the AGEM initiative to reform K6-12 education in government schools

In early July, 2014, I met the Hon'ble Minister for Primary and Secondary Education with a proposal for a multiphase project to provide :

- A validation phase to be conducted by AGEM for about 100 students for 100 hours with appropriate pre and post testing to demonstrate the validity of the AGEM method.
- Following successful validation, gradually extending the AGEM program to government schools throughout Karnataka.

On 21 August 2014, the Govt. of Karnataka approved the validation phase of the project through Director, DSERT.

8.1 What is the overall design of the validation phase?

8.1.1 Selection of students

We expect to have 50 or more students in the experimental group from a class between Grade 6 and 8. The control group will either be the higher performing remainder of that class or a class in a higher grade.

8.1.2 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.
- Specific tests for Systems Thinking
- Tests of explanatory style such as CASQ, WHO-5, and WEMWBS.
- Hopefully, independent pre and post tests from an independent competent authority.

8.1.3 Conduct of the course

- We expect to conduct this course for about 5 hours a 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

9 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 CASQ1, 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.

10 How will this scale in practice

The general idea is to create the means to deliver learning that narrows the gap between the needs of industry/higher education and what school children have when they graduate. The scaling will be necessary provided the validation phase shows the desired impact.

10.1 Creating infrastructure for learning

Creating a learning space for about 100 children in each government school. Such a space needs to be well outfitted in terms of:

- furniture, projector, lighting, server, feedback devices and video recording facilities.
- It is vital that all electrical facilities should be powered by solar cells or other energy source independent of the mains supply which should only serve as a backup.
- High speed Internet availability is vital with a high download speed and a limited upload speed. Over the longer term the download for a large number of schools could be conducted by DTH through satellite transmission.

Such a facility should ideally be provided by govt. but may also be provided and maintained by local businesses and be named after them. It would also be usable for training sessions for teachers. Gradually, we would extend this to Grades 9 and 10 and later to Grades 11 and 12. If as expected this leads to larger classes in government schools, then the facility would be fully utilized.

10.2 Creating infrastructure for delivery

In the first phase this is totally managed by AGEM. In second and subsequent phases this process has to be institutionalized ideally within the government or through industrial support as an independent organization along the lines of ETS which provides the SAT and GRE services worldwide.

Partnerships would be an important element in such a large project. Such partnerships could be with the teaching department of a University, with institutions like McRel, or with organizations such as ETS.

10.3 Cost Centers

Development center: This will generate the topic plans, transmit them and monitor progress during transmission from a central studio. Staff at the development center will modify topic plans on the basis of reports from the Data Center. It will also be responsible for the development/transfer of new technologies e.g. sensor technologies to make K12 education a richer experience.

Data Center: This will receive, archive, and analyze all data received from student responses. It will work closely with the Development Center to generate improved materials for learning. It will also provide guidance to schools where student performance has sharply declined or improved or where there are early indicators of physical or mental health evident from student responses. Schools can then investigate matters in greater detail.

10.4 Profit centers

Certification Center: This will use archived data to certify the performance of students, teachers and schools. It will also generate a School Performance Index for subscribing schools and will advise schools on ways to enhance the School Performance Index through the Consulting Center. Additionally it will offer AGEM teachers certificates to those who complete an AGEM Teachers course. It will offer additional services to former students to permit potential employers to quiz records for evidence of specific talents.

Lecture theater: As our systems benefit from large numbers in the audience, the Lecture theater will permit upto 100 students to receive free instruction and thereby allow AGEM to do initial testing of new materials.

Consulting Center: This will build a knowledge base for enhancing educational institutions through collaborating with the Data Center to identify and integrate learnings from the repository of student performance data. This unit will also offer training to teachers for a fee.

Annual Maintenance Contract Center: This will be an outsourced activity.

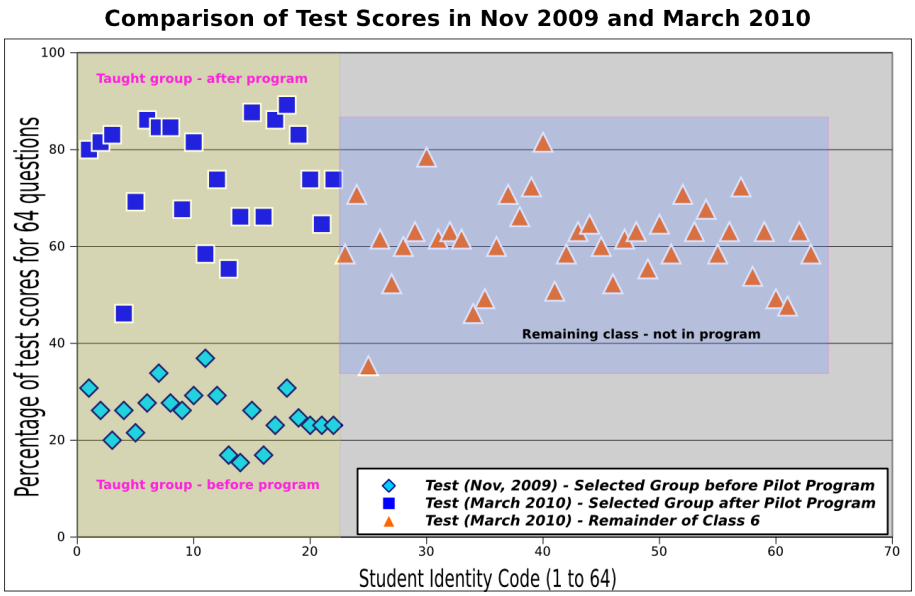
11 Prior work - Initial Pilot Program in Maths

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?

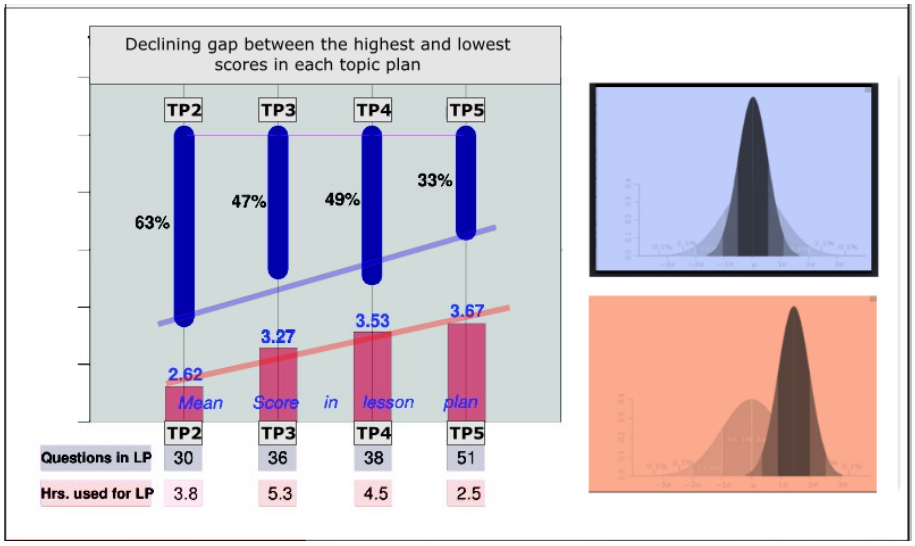
The first indicator of impact was the outcome of pre and post tests which were actually Grade 3 Maths placement tests from the US.



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.

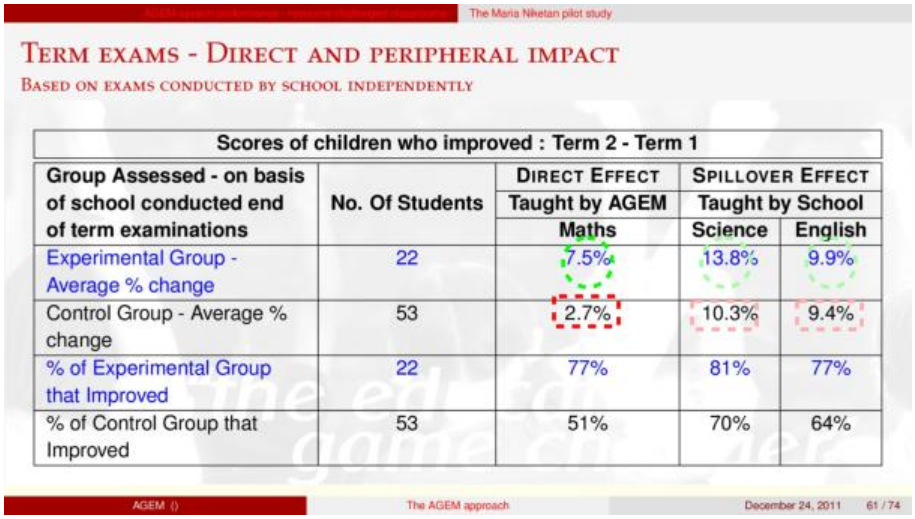
11.2 What was the result of the embedded questions scoring?



- 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 hand side, 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 Partnerships with industry

In the final analysis, this project holds promise of the shortest time lag to an improved workforce on a massive scale. The graduates of this system should have the following attributes:

- An audit trail of performance: Every hour of the AGEM program requires students to answer 10-20 questions during the course of daily learning, the output of which is analysed and reported. It will also be used to create profiles of student performance to better define their specific strengths. From Grade 6 to Grade 10, students will expect to respond to approximately 15,000 questions varying from multiple choice questions to short essays.
- Project portfolios: Students will have portfolios which record and provide evidence of original thinking, teamwork, and writing ability.
- Relevant knowledge: As the syllabus is not constrained by examination board requirements, industry relevant knowledge can be included at short notice.
- Entrepreneurial skills: These will form part of the content for Grades 9 to 10.
- MOOCs: Students will be encouraged in Grade 10 to specialize in their area of interest by taking appropriate MOOCs from the best universities. Hence, even those who do not go to Grade 12 will have the potential for industry-ready skills.

All these attributes should be of value both for employers and for universities. For that reason alone industry should be attracted to support this project.

12.1 Nature of support desired

There are several potential areas of support from the immediate to the long term.

12.1.1 Immediate support

For the first phase of the project, we need support in the following areas:

- Provision of one classroom of optimum and scalable design for 100 students, with the infrastructure cited in Section 10.1.
- Independent pre and post testing by a reputable and competent organization.

12.1.2 Long term support

Rapid rollout of this project is only possible with industrial support for government schools using a Public Private Partnership (PPP) model. This will require support of corporates to provide optimally designed classrooms for thousands of schools.

Support will also be required to set up and maintain an organization through endowments to fulfill the requirements cited in Section 10.2.

Finally, the support of industry in spreading this to other states and other countries particularly India's littoral states will be vital for long term development of peace and harmony in this part of the world.

12.1.3 Potential benefits for partners

Collaborators can assist in three ways:

- Public private partnerships: These can include scholarships or internships for children whose talents - as revealed by the performance data generated - are meaningful for the private partner.
- Manufacturers: Supporting the design of the feedback devices and the infrastructure has implications for long term sales across the developing world.
- Corporate Support for expenditure: Nothing could make a brand name more popular than the provision of education that is geared to jobs and higher education.