**A CASE STUDY- EGYPT’S FIRST STEM SCHOOLS: LESSONS LEARNED**

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**Abstract**

This is a case study focusing on the lessons learned from Egypt’s first STEM School which opened in the fall of 2011 and the implementation of its second STEM School in the fall of 2012. Both schools were designated for the gifted and talented high school aged Egyptian youth.

The paper will address the following school reforms: the school schedule; diversity of students’ English language and computer proficiency; understanding and creation of rubrics for performance/project-based learning; lateral thinking; teacher training; equipment; student activities, international experiences, and educational reform partners. Suggestions for the government’s goal to establish twenty-seven STEM schools over the course of the next three years will also be identified.

**Background**

For many Egyptian parents, the ultimate family goal has been to have their children become doctors or engineers. Sometimes a police or army officer may be the desired profession, in other instances: attorneys or teachers. Such goals are not usually educationally sound, simply desires for increased social and materialistic status. In spite of parental pressures, the proportion of students enrolling in the science section of the secondary school is declining. Beginning in the year 2000, figures show stark contrast with these family ambitions. (MOE, 2012) The following figures underscore this pattern.

<table>
<thead>
<tr>
<th>Year</th>
<th>Science Percentage</th>
<th>Art Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>1999</td>
<td>45.4</td>
<td>54.5</td>
</tr>
<tr>
<td>2003</td>
<td>30.3</td>
<td>69.7</td>
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<tr>
<td>2004</td>
<td>27</td>
<td>73</td>
</tr>
<tr>
<td>2005</td>
<td>25</td>
<td>75</td>
</tr>
<tr>
<td>2006</td>
<td>29</td>
<td>71</td>
</tr>
<tr>
<td>2007</td>
<td>30</td>
<td>70</td>
</tr>
<tr>
<td>2012</td>
<td></td>
<td>200,000 students left the sciences and enrolled in the arts section.</td>
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(Egypt MOE)

A number of adverse conditions led to what might be called the exodus from the science section of the Egyptian General Secondary Certificate to the arts section. According to
many Egyptian educational experts, the reasons behind this exodus are mainly practical and economic, not philosophical or cultural.

The first explanation is that shadow education, or private tutoring, is widespread in Egypt. The price for science and math private tutoring is higher than for courses in the humanities and arts. The cost is rationalized by the fact that the national science examinations in physics, chemistry, and biology have had a history of being very difficult. That peril pushed students away from math and science studies. Furthermore, the minimum grades required for admission to universities were higher for math and science students than for those in humanities and arts.

The next explanation is that the starting salary for a doctor or an engineer is still very low, in spite of professional prestige. Funding and resources to open a clinic or an office are not easily available to new physicians or engineers especially those in the middle class. In addition, during the years of 2000-2005, the Egyptian National Universities started programs that offered the study of law, commerce, media, political science and economics in English. Graduates with these majors acquired jobs in banks, foreign companies, and the stock market with higher salaries than those of doctors and engineers.

These crippling circumstances have accumulated and created a concern for the Egyptian people and the government. The shrinking number of math and science students and related negative consequences for the country’s economic future is disturbing.

This concern may have bestowed a feasible foundation for the 2011 Ministry of Education’s initiative to construct STEM schools which provide interdisciplinary science, technology, engineering and math studies combined through the instructional strategy of project based learning. At the same time, this STEM strategy might limit those students’ access to science majors at the university level and decline their admission to the humanities and social sciences.

The STEM educational innovation was a bold move in Egypt. A specialized high school for students with exceptional talent in math and science is a relatively recent phenomenon. Certainly unique, and unfortunate, is the fact that the STEM school is not impervious to the Ministry of Education’s policy and funding challenges.

The STEM reform was initiated to meet the needs of the gifted and talented students and to meet the demands of the future workforce and continue research and development that is central to the economic growth of the country. The goal is to establish twenty-seven STEM schools over the course of five years. This would mean one STEM school in each governorate. Thus, a shift of mind, or “metanoia,” according to Peter Senge, is a required trait for all involved in the STEM schools.

Discussions between the Ministry of Education and USAID developed into the plan to establish Science, Technology, Engineering and Math (STEM) Schools, based on the American model promoted by USAID. The STEM schools program was introduced in Egypt during the 2011-2012 school year. The lofty costs to create high-quality laboratories with state-of-the-art equipment, the development and maintenance of a viable curriculum, provision of professional development and support for the faculty, and sustained commitment to this type of school are vital for the enhanced educational experiences. Start-up funding and faculty professional development has been provided
by USAID in the amount of $25 million dollars and a grant from ExxonMobil Egypt in the amount of $400,000. World Learning has been hired to provide curriculum and professional development. Misr el Kheir Foundation, the recipient of the ExxonMobil grant, funds STEM teacher salaries. Other contributors to the STEM School Program are the Academy of Scientific Research in Egypt, The British University (BUE), Cairo University, the American University in Cairo (AUC), The British Council, and Dr. Ahmed Zewail, Egyptian Nobel Prize Winner.

Egypt’s pre-university education system is enormous. The average school teacher makes LE 1,000 (about $200) a month. The selection process for STEM faculty began with a legal notice in the newspapers and the MoE website with applications returned to the Ministry of Education followed by an interview with a committee representing MoE, USAID, STEM school administration and the Misr El Kheir Foundation.

The faculty for each STEM School was selected by the Ministry of Education. Teachers applied with internet online forms and later were interviewed for this special assignment. STEM faculty and public school faculty salaries are identical. However, the prestige is attractive to those teaching at a STEM school. Unfortunately, selected teachers were only notified of their acceptance as a STEM school faculty member just weeks before students’ entry. Teachers are responsible for creating their own curriculum.

Professional development teacher training consisted of a two week visit to Philadelphia, Pennsylvania (USA) STEM schools. The STEM School for Boys faculty has had no hands-on or support training for curriculum development and instructional strategies since their initial two week visit to American STEM Schools.

Each Egyptian STEM high school corresponds to the American 10th, 11th and 12th grades. No student fees are assessed during the first three years of the program and each student receives a school uniform and personal laptop.

STEM instruction is intentionally designed to present problems requiring integration of subjects. In other words, the project leads the way. Engineering has been silent in the curriculum, now it is the creativity aspect of science. The “E” in STEM not only refers to engineering, but the “E” means engagement, or active learning, in order to avoid the “fright-flight-freeze” process experienced by some students. STEM instruction is not textbook science. Teachers are to guide inquiry. This creates a classroom community of learners which consists of communication, critical thinking, collaboration and creativity: the 21st Century Learning Skills. Students’ questions form the bridge to learning. The school’s daily timetable is built around a 4-Block system. Students are expected to take: English, French, Arabic, biology, chemistry, physics, electronics and multimedia. Weekly field trips are coordinated with the National Center for Scientific Research and the Ministry of Scientific Research in order to provide training in their labs. All students must complete capstone projects, which enhance critical thinking and are developed using the Understanding by Design (UBD) unit plan format.

The Capstone Project is an opportunity for students to demonstrate understanding of a challenge facing their community. It is intended to generate dialog among the scholars and encourage thoughtful debate as they work in teams addressing the topic of their Capstone. The culmination of their hard work comes in the final Capstone presentations,
which showcase students' potential for deep research and understanding of complex topics as well as development of their ability to thrive in collaborative settings.

The school year contains two capstones in addition to the exhibition. A capstone consists of integrated units based on “the big idea.” It could be in the form of a concept, theme, theory, issue, problem, process, paradox, and perspective. The units of the capstone are designed and operationalized by the teachers of the different subjects in integration among subjects aligned with national standards to engage students in inquiry, exploration, self-learning, investigation and application through rubrics that guide students. Each capstone has a product that a student creates and attempts to achieve mastery through guided rubrics.

**Capstone Projects for the 2012-2013 Academic Year**

<table>
<thead>
<tr>
<th>First year secondary</th>
<th>Second year secondary</th>
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<tbody>
<tr>
<td>Systems</td>
<td>Building</td>
</tr>
<tr>
<td>Scarcity and Abundance</td>
<td>Communication</td>
</tr>
<tr>
<td>Exhibition</td>
<td>Exhibition</td>
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</table>

To make a meaningful difference for student interest and persistence in STEM, schools must engage in a comprehensive approach that is research-driven. Unfortunately, both Egyptian STEM schools have a library, but insufficient for research. English as a primary mechanism to aid its students in becoming global citizens who are economically competitive. The school wants to ensure that its graduates are bilingual, speaking both Arabic and English. The study of English at the STEM schools is evolving with support by the British Council.

**Case Study**

This case study is descriptive and correlational. This is the first of its kind in Egypt. No other comparison of Egyptian STEM schools exists. IRB and CAPMAS approvals were acquired in order to visit the schools, interview faculty, administration and students. Informal interviews were conducted. No standardized surveys were used.

This case study afforded researchers the opportunity to explore and describe the STEM school model in context of Egyptian educational reform using a variety of data sources. It allowed the researchers to explore the first two STEM Schools in Egypt, their individuals, innovations, relationships, and programs (Yin, 2003) According to Yin (2003) a case study design should be considered when: (a) the focus of the study is to answer “how” and “why” questions; (b) one cannot manipulate the behavior of those involved in the study; (c) one wants to cover contextual conditions because they may be relevant to the phenomenon under study; or (d) the boundaries are not clear between the phenomenon and context (Yin, 2003). This case study addresses each purpose.

**STEM School for Boys**

The STEM School for Boys was founded on September 17, 2011 in the Global Village by his Excellency, Dr. Ahmed Gamal El-Deen, the Minister of Education for Egypt. The school continues to be supported through the generous support and stewardship of his
Excellency Mr. Gamal Al-Araby, who was named the Minister of Education for Egypt in early 2012.

The school launched with the end goal of helping create quality citizens who are lifelong learners, economically competitive and globally-oriented. The means Egypt chose to reach that end included the intertwining of the theories of creating a “constructionist” educational environment as described by MIT Professor Seymour Papert. The theory is learner centered, project-based and fits the STEM school model. Constructionism distinguishes itself from constructivism mainly in its emphasis on technology/computer use and the belief that physical products should be constructed by the learners. Constructionism is built on the assumption that children will do best by finding or experimenting for themselves for the specific knowledge they need. This critical thinking focus is clearly one of the 21st Century required skills.

The STEM School for Boys is located in the distant Cairo suburb called The 6th of October. The tech specific campus is owned by the military. The entrance to this boarding school for gifted and talented students inspires images of Disneyland. Three dimensional cement sculptures and painted scenes of the River Nile, feluccas, the Mohammed Ali Mosque, and the pyramids border the half mile long private thoroughfare. These famous landmarks were chosen for their inspirational setting and strong links to the history of remarkable innovation and perseverance of the Egyptian people. A security guarded chain link fence encloses the defined school grounds.

The goals for this STEM school were identified as well as the school mission. They are for both schools and are as follows:

**GOAL 1:** Students must demonstrate a deep understanding of the scientific mathematical and social dimensions of Egypt’s grandest challenges as a country.

**GOAL 2:** Students must demonstrate understanding of the content and ways of knowing that display scientific, mathematical and technological literacy and subject matter proficiency.

**GOAL 3:** Students must exhibit self-motivation, self-direction and a hunger for continued learning.

**GOAL 4:** Students must exhibit the ability to think independently, creatively and analytically.

**GOAL 5:** Students must exhibit the ability to question, collaborate and communicate at a high level.

**GOAL 6:** Students must demonstrate the capacity to become socially responsible leaders

**GOAL 7:** Students must be to apply their understanding to advance creativity, innovation and invention with a real world vision with a consciousness and eye toward a more contemporary Egypt.

**GOAL 8:** Goals 1 – 7 must be implemented and viewed through the lens of a Digital Platform. Students must become fluid with technology to ensure that they maximize digital methods of data storage and communication.
Mission:
The school seeks.....
1. Partnerships with universities, research centers, factories, companies and those who care about education for developing, training and application for student and teacher learning.
2. To be linked with the latest innovations and research issues in a lifelong culture and to work as a team with the students and the teachers.
3. To develop the elements of innovation and creativity as an essential goal and to shed light on the role of science and engineering in the development of Egypt and the world.
4. To provide technical and financial support for the student-based learning focused on inquiry, projects and working as a team.
5. Ongoing evaluation of all student and teachers while concentrating on developing the highest skills and self-reliance possible

In the first year of operation, the boys’ school admitted the top 150 boys having the highest scores on the Ministry of Education’s science and math tests. These boys were personally invited to compose the grade 10 (sophomore class) in this STEM boarding school after taking an additional intelligence/personality test as well as a personal interview.

The Egyptian STEM School for Boys is, no doubt, modeled after American established residential secondary STEM schools which were established to meet the needs of these motivated students living in rural and impoverished school areas.

A language lab equipped with the latest devices is one of the modern facility features on this campus. In addition, each student is provided with a laptop and are trained by Microsoft and Google corporations personnel. An e-mail (using Google) and is Outlook are provided to help teachers, students and parents communicate. The school publishes a quarterly newsletter of events and selected achievements and distributes it to all stakeholders of the STEM community.

The boys have no choice in their dorm room assignment. Four boys are initially assigned alphabetically by name to a dorm room but are mixed up each year to allow the boys to become acquainted with more of the students in each grade level.

Although there is an advisory system, there are no after-school activities for the boys. The administration has voiced interest in establishing community service projects, but as of yet, none have taken place. Boys are left on their own to kick a soccer ball about on a cement tennis court. No basketball hoops have been installed. No arts are included in the curriculum. These gifted and talented students are not provided an education for the whole child.

STEM School for Girls

The STEM School for Girls opened its doors a year after the boys’ school. The principal was transferred from the STEM School for Boys where she worked as a biology teacher for a year. The school is located in Zahra Maadi, another Cairo suburb. The property is not as vast as the boys’ desert campus. In fact, all courses are held in the same three story school building, as opposed to separate lab buildings for the sciences and media on the STEM School for Boys campus. The girls dormitory with its dining hall is the only
other structure on the campus. It is interesting to note that all signage at the girls school is in Arabic.

The STEM School for Girls is located in a busy residential and commercial area of the city. In fact, the superstore, Carrefour, is at its backdoor!

119 girls have been invited to comprise the school’s first sophomore class in the 2012-2013 school year. Students are housed in a dormitory building and four students are assigned to a bedroom. The girls are allowed input regarding their choice of roommates, but the final decision is made by the principal. Students are able to go home with their families on the weekends. Family visits are allowed 3-4 times a semester.

Each teacher in the school is responsible for an advisory group of eighteen students. This is a looping experience, as the advisor/student relationship spans all three-years of the high school experience. The advisor is to guide the students academically, socially and psychologically. The advisor also communicates with the parents and the school administration to achieve the ultimate success for the students.

Because the “gym” and its exercise equipment are not yet available for the girls, they took matters into their own hands. The girls initiated a physical exercise element to their day. They run around the school premises each morning before breakfast. They are also attending art classes after required classes have ended. Girls have expressed interest in additional courses of aviation and robotics to the school principal. The girls are very enthusiastic about the STEM school and continually make suggestions for improvement to which the administration is receptive.

Unfortunately, the library collection consists only of textbooks (previously approved for international schools) donated by the Ministry of Education. Some are well over five years old. Research is limited to the internet, which also has limited connectivity.

**Comparison of STEM Schools and Lessons Learned**

STEM school parents have voiced concerns about student safety in a boarding school setting. However, their biggest worry is that of future university admission requirements. Promises by the MOE have not been consistent. Asking parents to take a leap of faith and embrace a new educational approach that may result in lower test scores or missed opportunities to attend certain universities might be asking too much. Examples include:

- The “gym” in each school actually consists of a small classroom containing exercise equipment. There is no physical education teacher. Thus, the “gym” is not used.
- The library collections are extremely limited.
- Modern lab equipment is incomplete.
- IT/WIFI connectivity is not reliable at the STEM School for Girls. Each student was asked to provide an internet stick.

The initial class at the STEM School for Girls had twenty-six fewer students than the STEM School for Boys. Homesickness initially struck students at both schools. Consequently, twenty-three boys left the STEM School for Boys during the first year.
Two girls left the STEM School for Girls during the first six weeks of operation; however, they returned within two weeks’ time.

Selected STEM school students did not have to pass any English or technology proficiency exams. Thus, these math/science gifted students possess many levels of proficiency in English and computer science. The previous schooling models of the students also explain this diversity. English may or may not have been used as a means of instruction for science and math. In addition, advanced English courses were not consistently offered.

**Conclusions**

Metanoia continues to be a requirement for stakeholders to establish and support the STEM schools. The Ministry of Education has to develop unique policies for admission, teacher recruitment, teacher salary, student fees, and college admission.

As of November 1, 2012, the Ministry of Education has communicated that examinations for STEM school students will not be traditional exams, but will test the innovation and creativity of students. Exams will be in the form of creating a project (60%) to solve one of the society’s problems in a new way in addition to a little (30%) theoretical (content) test of the basic concepts of science and math, plus (10%) for performance at school during the school year.

The Graduate School of Education at the American University in Cairo has established a STEM Center. This initiative will provide professional development for STEM school educators, conduct action research at STEM schools, and assign graduate students to STEM schools for required fieldwork. The AUC STEM Center will be a first in the Middle East. As AUC has a signed Memorandum of Understanding (MOU) with the University of Minnesota’s STEM Center, cutting edge educational research and practices will be available to boost STEM student achievement in addition to faculty development in inquiry-based teaching and project-based assessment strategies.

Students at both schools are acquiring the 21st Century Skills of communication, creativity, critical thinking and collaboration.

Character education is the hidden curriculum being acquired by students in these boarding schools. It is interesting to note that the boys are experiencing a new social status. Once each was the top student in his former school, now each is in competition with similar peers. This competitive drive is not happening at the STEM School for Girls. Students are learning how to respect others, be honest and respectable in their shared living spaces. They are also taking responsibility for their learning by suggesting additional courses and activities.

It appears that both STEM schools are addressing every element of the school mission statement. The American University in Cairo, USAID, and World Learning are partnering with the STEM schools to enhance this innovation.

The principal of the STEM School for Girls had the experience of one year of teaching in the STEM School for Boys prior to her administrative appointment. This made for a smoother transition. The principal was able to tweak policies and practices to make for
a positive and successful boarding school for the girls. The principal has developed a strong rapport with faculty and students. In fact, she stays overnight on campus to be with the girls several days during the week. On one occasion, the principal personally paid for the bus transportation to a field trip site when the Ministry of Education buses did not show up. She has established trust among all the stakeholders on this campus.

The principal of the STEM School for Boys has changed for a third time in the year and a half of the school’s existence. Building trust and consistency has been challenging for that school.

**Recommendations**

For any school seeking to implement a new sort of governance and theory of learning, developing a coherent vision amongst the school stakeholders is paramount. Future STEM school principals should have a minimum of one year of experience teaching in a STEM school and the faculty should have received sufficient training in project-based learning and assessment. Leadership is key to the school’s success and if trust is high among the stakeholders, the cost is low. (Covey.) Faculty should be given additional time to write curriculum and should receive a stipend for their work. Student voice should be included in decisions for scheduling, projects, board policies, and strategic planning.

Faculty professional development must be on-going. There should be some sort of a liaison between these STEM schools. Possibly teachers could swap teaching assignments from one school to another or video conferencing could take place for professional development. After all, the time tables are similar and success stories or difficulties found in one school may be shared for building professional learning community experiences and teacher capacity.

The schools’ libraries are not labs of learning as few print resources exist to support teaching and learning. Online sources for science and engineering must be identified and increased on a regular basis. I Pods, I Pads are not available. One Smart Board is displayed only in the boys’ library; however, little or no tech training has been provided for its use. There is no Smart Board at the STEM School for Girls.

The Egyptian Ministry of Education must enact its proposed policy for STEM School students’ college admission process. The STEM School initiative should be expanded to STEAM so the arts are included in students’ studies.

In conclusion, the vitality of a country’s economy “is derived in large part from the productivity of well-trained people and the steady stream of scientific and technical innovations they produce. Without high-quality, knowledge-intensive jobs and the innovative enterprises that lead to discovery and new technology, our economy will suffer and our people will face a lower standard of living.” (COSEPUP 2007). Egypt is on the right track, but needs much support to make the STEM schools and their respective faculties and students successful.

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