

Physics From Teaching to Coaching! Tesla Hands-on Science Academy

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Abstract: The aim of this contribution is to scope briefly, why and how I have just established — with the aid of a smart teamwork — Tesla Hands-on Science Academy. As a start up project, I had to set up the scientific framework of it including vision, mission, objectives, strategies, curricula and other basic standards. The kids have been classified into two levels: level-1, 5–8 years, called (junior Explorer), and level -2, 9–15 years, called (Junior Scientist)! The kid should have tasks via hands-on science activities in 5 categories/strands according to scope and sequence topics.

Key words: tesla, hands-on science, inquiry, guided, directed and full inquiry, project-based learning (PBL)

1. Introduction

From switching schools since the pandemic started to pursuing new opportunities, I started — as a Senior Physics Teacher — to think of change and making shift to my career.

It's been a rough year for all of us — no one has a corner on the stress caused by the pandemic.

I've been teaching Science & Physics for about 25 years from elementary schools to high schools, for National and International curricula (IGCSE: *AS, A levels*, SAT, IB: *PYP & DP*) in Egypt, Jeddah, Saudi Arabia and Tokyo, Japan. I enjoyed teaching so much and explored some talented students who are now highly educated, and have participated in science contests as *ISEF Egypt, National Physics Olympiad, the junior Innovator*, and *6th Cairo International Exhibition of Innovation*.

Now, It's Time for a Change! I intended to establish an academy for Hands-On Science activities. I have a good experience in teaching kids and coaching Sc. teachers via inquiry & project-based learning.

Children are considered to be natural scientists, drawn to wonder, exploration, discovery, and analysis. In her book "*Science — Not Just for Scientists!*" Leonisa Ardizzone gives us simple ideas to open up the world of discovery to young children. Through open-ended explorations, you will discover how to cultivate children's natural curiosity by asking simple questions: *How? When? Where?* And the most famous of all children's questions: *Why?*

The hands-on science activities will empower children to question, experiment, and develop abstract reasoning skills (Leonisa Ardizzone, 2014).

From her point of view, as I used to deal with kids, I started *Tesla Hands-on Science Academy*.

Children in *Tesla academy* will explore patterns, cause and effect, size and scale, change and growth, energy, and how things work. Step-by-step activities lead children and their caregivers through a new world of discovery. It's simple and fun to investigate.

2. Why Tesla?

During celebration of Egypt's national day in the embassy in Tokyo, I have met Dr. Drago Stambuk who told me that he is a physician and poet, and he is the Croatian ambassador in Tokyo. When I told him that I am an Egyptian physicist and writer too, he asked me if I know Nicola Tesla. I said: Sure! Thereupon, he added with prideful: he was a Croatian physicist and Inventor. Hereupon, I started to read more about Nicola Tesla. Once I have just discovered that Tesla was an amazing scientist — not just a physical quantity unit! — I intended to write his biography and dedicate the book to Dr. Stambuk, who let me identify Tesla world of theories, applications and innovations.

So, Tesla is considered to be one of the greatest physicists, engineers and inventors in history. The unit of magnetic flux density was named in his honor in 1960. In 1916, he invented the first alternating current (AC) motor and developed AC generation and transmission technology. Though he was famous and respected, he was never able to translate his copious inventions into long-term financial success - unlike his early employer and chief rival, Thomas Edison!¹

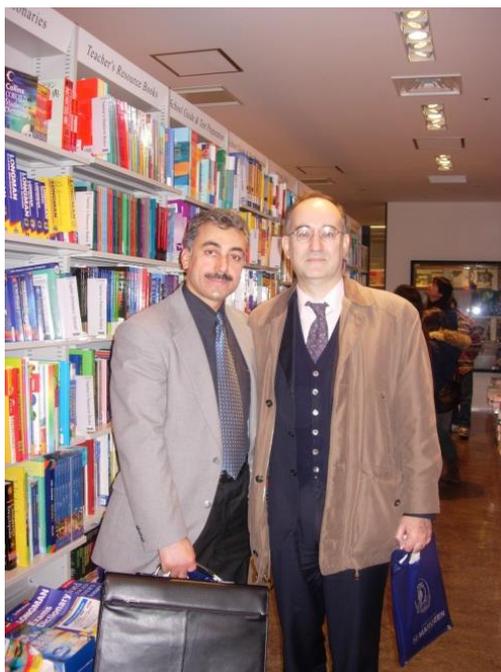


Figure1 The Writer With Dr. Drago Stambuk in Shiboya bookstore, Tokyo

2.1 Why Hands-On Science Academy?

In a bore and so passive educational environment, it is a fantastic opportunity for learners — boys & girls — to explore aspects of science that are always possible within the constraints of a normal school timetable.

The academy can stretch and challenge gifted and talented learners motivate and appeal to the interests of struggling learners.

In general, *Tesla Hands-On Science Academy* motivates and encourages learners of different ages and abilities.

¹ Available online at: <https://www.history.com/topics/inventions/nikola-tesla>.

The academy can enhance the positive experiences that boys and girls have with science by allowing them to explore their own ideas and interests as well as by exposing them to role models (*Scientists and Engineers*) who may encourage them to think of becoming scientists themselves.

It can also help to build confidence of the learners as well as change their attitudes towards science, technology and engineering. It can also help learners develop problem-solving skills. Further, learners can also develop social skills such as cooperative learning, communication and leadership.²

Members of the academy always have readily available projects and studies for their formative assessment. It can serve also as support base for learners participating in science expo, science Olympiads (as National/International Physics Olympiad) as well as science fairs in their schools

Tesla Hands-On Science Academy encourages links between, schools and science centers/museums as well as schools and science research institutes. It can also serve as links to other local/international communities and schools

3. Vision

Through the Hands-On Science Academy:

- 1) Pupils/Students will develop scientific attitude and use it in day to day life.
- 2) Pupils/Students enjoy science subject and related activities.

3.1 Mission

To establish a Hands-On Science academy, which not only help students in co-curricular and extra-curricular activities, but also provide highly support in routine teaching/learning process of science subjects through its activities and inquiry & project-based learning (PBL).

3.2 Strategies

- 1) Establishing shared vision and mission for Hands-On Science Academy with all colleagues — my team work — and the stake holders.
- 2) Making stake holders and community aware about the importance of the hands-on science activities for learners, especially for talented boys and girls by using Science Kits.
- 3) Developing projects in science using inter-disciplinary approach, participating in science contests (National/International).

3.3 Objectives of Tesla Hands-on Science Academy

To encourage curiosity and to create a thematic Hands-on learning experience.

3.4 Further Objectives

- 1) Publishing and distributing Popular Hands-on Science Books, and related literature.
- 2) Organizing field trips & story telling sessions about great scientists and their discoveries.
- 3) Organizing community services, as Mobile Science lab with no fees for kids in distant regions.

² Available online at: <https://www.edutopia.org>.



Figure 2 The Writer With Science Staff in a Weekly Meeting Discussing Hands-on Science Topics



Figure 3 Doing Some Hands-on Science Activities With My Kids in a School Science Club



Figure 4 Using Physics Kit in Hands-on Science Activities

4. Activities Alignment

Tesla Hands-On Science activities align with the outcomes of National Science Curriculum in Egypt, and blend with both IGCSE and IB Primary Years Program (PYP).

4.1 Lessons From the Past

In fact, I used to teach science and physics lessons using inquiry teaching strategy; guided inquiry (80% teacher and 20% student), then directed inquiry (20% teacher and 80% student), eventually full inquiry (100% student's attempt) as a Hands-on science project or a scientific model by the end of each chapter or unit.

Kids were enjoying science topics and were curiously looking for science periods. It was so funny periods as I was exploring natural phenomena and science concepts with kids.



Figure 5 Samples of the Hands-on Science Kits (Biology & Physics) and Some Kids With Hands-on Science Explorations

4.2 The Selected Activities

We selected the hands-on science activities from science books, edited in bilingual activity books/booklets (English- Arabic) to suit both national and international curricula as well. Children are classified to two levels; level-1 for 5–8 years kids (Junior Explorer), and Level-2 for 9–15 years pupils (Junior Scientist).

The main course duration is three months, 3 sessions weekly, 120 min/session, includes 30 min for a lecture + 90 min for Hands-on Science activities/projects. The kids will be given related assignments to complete further tasks (at home activity).

After the child passes level-1 or level-2 and has got skills and has the ability to complete studying at lab zone, he/she will be asked to start an advanced course.

4.3 Strands of Science

- 1) Life Science
- 2) Physical Science
- 3) Earth & Environmental Sciences
- 4) Energy & Mechanics
- 5) Space & Technology

Here are some instructions /inquiries regarding to physical science;

- The kids will investigate energy transformation and transference using electrical circuits.
- Understand how electricity is generated and which methods are most sustainable.
- Discuss prior knowledge of energy/electricity.
- Predict and test materials as conductors or insulators of electricity.
- Using electromagnets in toys.
- Examine broken and working motors and follow the energy transformations taking place.
- Observing a solar panel working (Glen Singleton, 2010).

4.4 Science Project Topics

Here are suggested Science project/activity topics for kids to approach inquiry; guided, directed and full inquiry.

4.4.1 Life Science

- 1) Bacteria: Does reusing water bottles increase their bacterial content?
- 2) Bacteria: How clean are the tops of soda cans, and what is the most effective way to clean them?
- 3) Ionizing Radiation: How does ionizing radiation affect the germination and growth of plants?
- 4) Yeast: How does the amount of carbon dioxide generated by yeast depend on temperature?

4.4.2 Physical Science

- 1) Chemistry: Which plants and vegetables make the best dye?
- 2) Electrochemistry: How do the levels of salt and vinegar affect the amount of gas produced by electrolysis of water?
- 3) Magnetism: How does temperature affect a magnet?
- 4) Solar Cells: How does temperature affects solar cell energy production and storage?

4.4.3 Environmental Sciences

- 1) Acid Rain: How does acid rain affect algae and bacteria?
- 2) Air Pollution: What effect does sulfur dioxide have on lichens?
- 3) Lead: What is the lead content of drinking water at home and at school?



Figure 6 Some of my talented Students who participated in National Physics Olympiad, and 6th Cairo International Exhibition of Innovation

- 4) Water Pollution: Does pollution affect oxygen production in aquatic plants?

4.4.4 Earth and Space Science

- 1) Greenhouse Gases: How does the concentration of carbon dioxide affect plant growth?
- 2) Rocks: Does age affect the hardness of sedimentary rock?
- 3) Weather: Is there a relationship between the phases of the moon and the weather?

4.4.5 Mechanics & Energy:

- 1) Solar Cells: How does temperature affect the efficiency of a solar cell?
- 2) Wind Energy: Can wind power be stored compressed air?

Wind Energy: What factors affect the generation of electricity by wind turbines (Stephanie Lerner, 2007)?

5. Conclusion

We started Tesla Hands - On Science Academy as an intensive summer course (3 months, 12 sessions monthly, with 4 strands: physical science, life science, Earth science then simple knowledge of space and technology.

Actually, we are still in the beginning and surely we will update the academy by fruitful discussions, and exchanging experiences with successful academies and professionals. I admit that I have got benefits from the past papers of HSCI conferences “Handbooks”³.

Eventually, I hope to see teaching/learning science in all schools to be based on STEM (Science, Technology, Engineering & Mathematics). And to see children use not only “*Science Textbook*” but also “*Science Kits*” as well.

Surely, every student can acquire and effectively apply the knowledge, attitudes, and skills necessary to thrive in his/her studies, career, and will enjoy adult life.

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References

- Leonisa Ardizzone (2014). *Science — Not Just for Scientists!* Easy Explorations for Young Children, Lewisville-Texas, Gryphon House.
- Glen Singleton (2010). *365 Science Experiments*, Heatherton-Australia: Hinkler Book.
- Stephanie Lerner (2007). *Kids who Think Outside the Books*, New York, Amacom.
- Available online at: <https://hands-on-science.co.uk>.

³ Available online at: <http://www.hsci.info>.