

A Holistic Approach to Promoting STEM Education

Diocesan Girls' School
20th June 2019

Outline of Sharing

1. Curriculum adjustment
2. Life-wide learning
3. Partnership with other stakeholders
4. Professional development of teachers



Departments Involved in STEM Education

- Major departments:
 - Computer, Mathematics and Science
- Partners of cross-curricular activities:
 - e.g. Visual Art, Technology and Living, Economics, Geography

1. Curriculum Adjustment - New Topics

	Science	Maths	IT
S1	Cell model Water filtration model Green Architecture Design (Heat)	Math Trail	3D modelling using Tinkercad
S2	Robotics Green Architecture Design (Sound)	Fractals	Maker education
S3	Green Architecture Design (Light)		Internet of Things (IoT) using electronic modules Virtual reality using Unity Technovation project using AppInventor

1. Curriculum Adjustment - Cross-curricular Activities

- Information Technology X Geography
Video project to produce a teaching video of “Tropical Rain Forest” or “Tropical Desert Plants”
- Information Technology X Economics
Technovation project to write the business plan of a startup company
- Mathematics X Visual Art
Tessellation and symmetry
- Science X Visual Art
Drawing of molecules
- Science X Technology & Living
Molecular gastronomy, Meal planning

1. Curriculum Adjustment - Methodology

- Examples of **mobile learning**
 - All teaching materials posted in Google Classrooms or Schoology
 - Apps such as Nearpod, EDpuzzle and Quizlet used for teaching and learning
- Examples of **self-directed learning**
 - Group projects allowing students to select problems to solve
 - EDpuzzle videos for students to learn at their own pace
- Examples of **authentic learning**
 - Technovation project of S3 IT to develop a mobile app and begin a startup company to address a problem in our community

1. Curriculum Adjustment

- Examples to illustrate our practices

1.1 Mathematics trail

1.2 Fractals

1.3 Robotics

1.4 Programming through apps development

1.1 Mathematics Trail

Target Students: All Secondary One

Objectives:

1. To explore the world from a mathematical perspective.
2. To work collaboratively in groups using apps and online learning resources.

1.1 Mathematics Trail

Planning:

1. Design a dynamic learning activity which connects the classroom lessons with the lives of surrounding, so that students can develop an appreciation of the beauty and usefulness of mathematics in everyday life.
2. Design tasks that incorporate students' STEM knowledge

1.1 Mathematics Trail

Implementation:

1. Teachers design a journey in the school campus which consists of a sequence of checkpoints.
2. Students discover mathematics and nature collaboratively on the campus.
3. Students use technological tools to think through a problem, test an idea, link with the real world, etc.

1.1 Mathematics Trail

Implementation:

4. Tasks included:

Properties of numbers (e.g. prime, composite, odd, even, square, triangular, Fibonacci and palindromic, etc.)

Geometry (e.g. symmetry, polygons, polyhedra, circumference and area of circles)

Patterns and Sequences

Counting, Estimation and Measurements

1.1 Mathematics Trail

Evaluation:

1. Students' work
2. Teachers' and students' feedback

Improvement:

1. Add / remove tasks
2. Activity time
3. New apps (e.g. CamMeasureLite, Clinometer-plaincode, Skitch)

1.2 Fractals

Objectives:

1. To Learn Fractals
2. To learn the intrinsic relationship between Science, Mathematics and Art

Planning:

1. Invite the Faculty of Science of HKU to conduct a workshop

1.2 Fractals

Implementation:

June 2016: SMArt Workshop - 7-metre Sierpinski tetrahedron

Lecture, make balloons, assemble the small balloons into a 7m mega-pyramid

Evaluation:

- Learn Fractals in more depth
- More models can be made

1.2 Fractals

When	2016 September (first term)	
Who	Students:	some S2 and S3 Math Team students
	Teachers:	Math teachers
What	Lecture, make a snowflake and some triangles	



1.2 Fractals

When	2017 September	
Who	Students:	some S2 and S3 Math Team students
	Teachers:	Math teachers
What	Lecture, make Paper Dodecahedron	

1.3 Robotics

Target Students: All Secondary Two

Objectives:

1. To raise students' awareness of applications and development of Robotics.
2. To strengthen students' analytical, logical thinking and problem solving skills through hands-on activities in Robotics.

1.3 Robotics

Planning:

1. External assistance from the Department of Computing, PolyU
2. Training of teachers
3. Devising lesson plans for Robotics in S.2 Science

1.3 Robotics

Implementation:

No. of lessons	Content
1	<ul style="list-style-type: none">- Introduction of Robotics- Building of a robot driving base
1	<ul style="list-style-type: none">- Introduction of the capacity of a robot with different sensors- Introduction of programming with a visual programming tool
2	<ul style="list-style-type: none">- Tackling missions with the robot

1.3 Robotics

Evaluation:

1. Students' work
2. Teachers' and students' feedback

1.3 Robotics

Improvement:

1. Relate with topics in Science curriculum, e.g. identify the similar structure between robot component and human body
2. Conduct a scientific investigation with Robots, e.g. investigate the relationship between motor power of the robot and the force generated
Use of tablets instead of computers for programming

1.3 Robotics

From 'STEM for all' to 'STEM for the talented' -- Electronics & Robotics Club & Team

1. General meetings & training workshops
2. Local, national & international Robotics competitions
3. Peer mentoring programme
4. Sharing with peers and DGJS students & exchange with other schools

1.4 Programming through Apps Development

Before apps development

- Students learnt programming using **Scratch** (<https://scratch.mit.edu>) and sensor board in S.3 IT lessons since 2007.

1.4 Programming through Apps Development

Evaluation of Scratch programming

- Students regarded their programming experience not authentic, therefore not useful.

Switching from Scratch to AppInventor in 2013-2014

Objectives of apps development

- Provide **authentic programming** experience.
- Familiarize with the program development cycle.
- Develop creativity and problem-solving skills through programming.

1.4 Programming through Apps Development

Planning

- Teachers learnt AppInventor from online tutorials (<https://appinventor.mit.edu/explore/ai2/tutorials.html>) and collaborative lesson planning.
- To compare the two programming platforms, students were asked to develop a specific game using both Scratch and AppInventor. Students' feedback was then collected to fine-tune the new curriculum.

1.4 Programming through Apps Development

Implementation

- 8-10 lessons of apps development using AppInventor in S.3 IT
- Live testing by **emulator** in the first year, and then by **tablets** gradually

1.4 Programming through Apps Development

Improvement

- Integration with Technovation Challenge (<https://technovationchallenge.org>) since 2017-2018
- The Technovation curriculum takes students through 4 stages of launching a mobile app startup, inspired by the principles of **design thinking**:
 - **Ideation** -- Identify a problem in the community
 - **Technology** -- Develop a mobile app solution
 - **Entrepreneurship** -- Build a business plan to launch the app
 - **Pitch** -- Bring the business to market

1.4 Programming through Apps Development

From 'STEM for all' to 'STEM for the talented' -- DGS Programming Team

- Weekly training of apps development
- Joining local and international apps competitions
- Developing apps for the school community, e.g. Mini-Bazaar, DSE Countdown
- Sharing experience with peers and DGJS students

2. Life-wide Learning

2.1 Life-wide Learning Activities organised by teachers

- After-school activities
- Other Learning Programme (OLP) Days
- Post-exam activities
- Overseas camps

2.2 Life-wide Learning Activities organised by ECA groups

- General Meetings during Other Learning Experience (OLE) lessons
- Theme Weeks
- Competitions

2.1 Activities organised by teachers

- Taster Programmes

Taster Programmes for S.1 students in

- Python programming
- Graphic design
- Drone
- Robotics
- Designing and building a Roller Coaster

2.1 Activities organised by teachers - Workshops

Workshops

- Introduction to Engineering and Robotics
- Discover Engineering Workshop
- Rocket Car Workshop
- Bridge Making Workshop
- Forensic Science Workshop
- Exploring Pick's Theorem
- Eulerian cycle / Eulerian path

2.1 Activities organised by teachers - Talk

- Visit to theme park to learn about environmental friendly initiatives
- Mathematical Modelling Talk - modelling disease outbreaks

2.1 Activities organised by teachers

- Overseas Camps

- Girls participated in the Youth Camp in Shenzhen and had the chance to learn new technologies with students from Hong Kong, Macau and Shenzhen.
- VR/AR Experiential Summer Camp - Visiting Fujian VR Experiential Centre
- Singapore Mathematical Modelling Forum & Challenge

2.2 Activities organised by ECA groups

Technology-related ECA groups run general meetings, theme weeks, workshops and taster programs to promote innovation and technology.

- Mathematics Team
- Computer Club
- DGS Programming Team
- Science Club
- Electronics & Robotics Team/Club

2.2 Activities organised by ECA groups

- General Meetings during OLE lessons

- AR Workshop
- 3D Printing Workshop
- Robot demonstrations by external speakers
- Visits (Virtual Reality Lab, Student Project Lab and AI technology company)

2.2 Activities organised by ECA groups - Theme Week

Theme Week of the DGS Programming Team

- Robot Obstacle Race

Theme Week of the Electronics & Robotics Team/Club

- Station games
- Laser Cutting Workshop

2.2 Activities organised by ECA groups - Theme Week

Mathematics Theme Week

- Inter-class competition
- Whole-school challenge
- Game booths
- Board display

2.2 Activities organised by ECA groups - Competitions

- FIRST Tech Challenge Asia Pacific Invitational 2016, 2017
- FIRST Tech Challenge World Championship 2018
- International Mathematical Modeling Challenge (IM²C)
- China Girls' Mathematical Olympiad
- Technovation Challenge 2017
- 47th International Exhibition of Inventions of Geneva

2.2 Activities organised by ECA groups - Sharing

- Student Education Fair on STEM organised by EDB in Jan 2016
- Direct Subsidy Scheme Schools Council STEM Fair in Sept 2018
- Members of the Electronics and Robotics Team shared their experience in robotics competitions with other local teachers and students.
- Our mathematicians received a group of teachers and students from Singapore. They had an opportunity to exchange their knowledge and learning experiences. The highlight of the day was the workshop on “Knot Theory” conducted by our student. The mathematicians learned from one another and enjoyed the session very much.
- Robotics Workshop for the Elder Academy during the Mini-Summer Term
- Smart Phone Workshop for the Elder Academy during the Mini-Summer Term

2.2 Activities organised by ECA groups - PIE cycle at the Student Level

- Google Site for every ECA group to publish their plans and reports
- Year plan, Term reports and Annual reports of ECA groups
- PIE in competitions

3. Partnership with Other Stakeholders

DGJS

- Electronics and Robotics Team introducing robotics to DGJS students

Old Girls

- Old Girls who work in different sectors share their experiences with students at the Careers Fair

4. Professional Development of Teachers

Workshops

- Teaching tools, e.g. learning platform, apps
- Flipped Classroom
- International teacher conferences, e.g. Schools With Innovative Future Technology Roundtable Forum

Formats

- External teacher conferences
- Staff Development Days
- Teacher sharing sessions
- Workshops