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PRIME MINISTER'S OFFICE
SINGAPORE

Ministry of Education
SINGAPORE

SINGAPORE UNIVERSITY OF TECHNOLOGY AND DESIGN
Established in collaboration with MIT

SCIENCE CENTRE singapore

PRESS RELEASE

Thursday, 10 December 2015

43,000 students stepped out for science in Singapore's first National Science Experiment

1. Over 43,000 students from 128 primary schools, secondary schools and junior colleges took part in Singapore's first National Science Experiment (NSE) from September to November 2015 this year.

2. The NSE[1] is an island-wide outdoor science experiment to excite and interest young Singaporeans in science and technology. In this mass activity, students carried the SENSg device[2] over four days to collect data on their daily travel patterns as well as the environment. Data registered in the device was transferred wirelessly to a central online portal whereby students could log in to view their individual data and the combined data of participating students. Through this experiment, students were made aware of science and technology in their daily lives and surroundings, and learnt the concepts of Big Data and the Internet of Things.

3. These are the key findings of the NSE 2015:

- Students walked an average of 5,853 steps each day.
- Students spent an average of 1.1 hours outdoors each day.
- 87% of students walked to school or took public transport (bus and/or train).
- Secondary school and junior college students live two to three times further away from schools than primary school students.
- These students produced a total of 5.21 tonnes of carbon dioxide daily from transportation taken during NSE.
- More than 1.8 million unique Wi-Fi access points were detected during NSE.

4. Data collected from NSE can be used in many ways, for example by urban transport planners to plan more efficient travel routes. The data on Singapore's urban environment can be analysed and used for urban planning and simulation.

[1] The NSE was announced by President Tony Tan at the Closing Ceremony of the Global Young Scientists Summit in January 2015.
[2] The SENSg (pronounced "SENSE-SG") device is a compact, portable and multi-parameter "Lab on a Lanyard". It uses Wi-Fi signals to localise itself, and periodically uploads data to a secured database if it is in range of a known access point. The data is anonymous and stored securely in the cloud. Refer to Annex C for more information on the SENSg device.

5. These results were announced in conjunction with the launch of Science Centre Singapore's E3: E-mmersive Experiential Environments exhibition on 10 December 2015, which was officiated by President Tony Tan.

6. The NSE is organised by the National Research Foundation Singapore and Ministry of Education, in partnership with the Singapore University of Technology and Design, Science Centre Singapore, Agency for Science, Technology and Research, Singapore Land Authority, and OneMap Singapore. More information on NSE is available at www.nse.sg.

Encls:
Annex A – National Science Experiment 2015 Results
Annex B – National Science Experiment Factsheet
Annex C – SENSg Device Factsheet

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National Science Experiment 2015
Big Data Numbers

43,140 students

128 schools

Over 155,000 km travelled

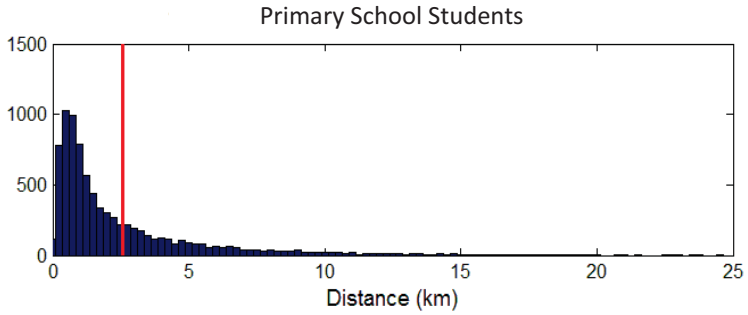
Over 59,000 active hours recorded

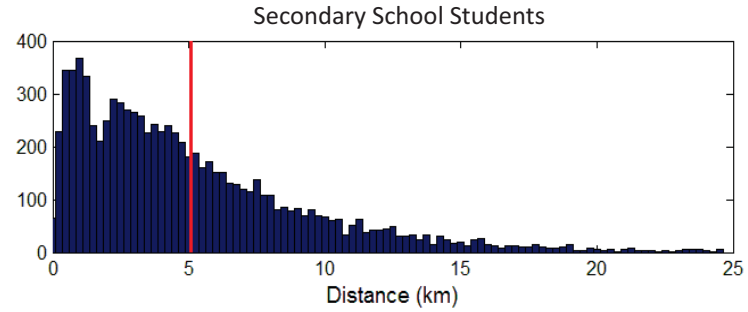
Over 2,700 hours spent exploring data on portal

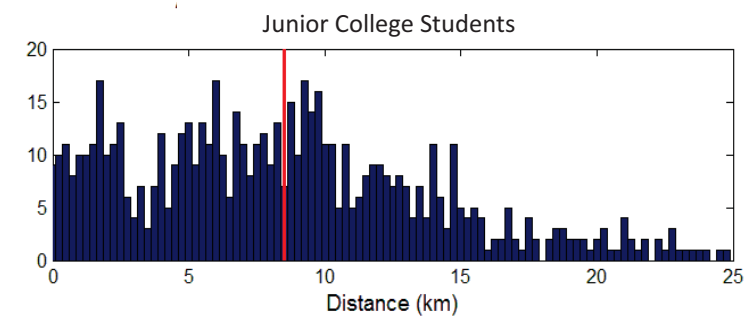
50,000 SENSg devices produced

National Science Experiment 2015

Average Home-School Travel Distance





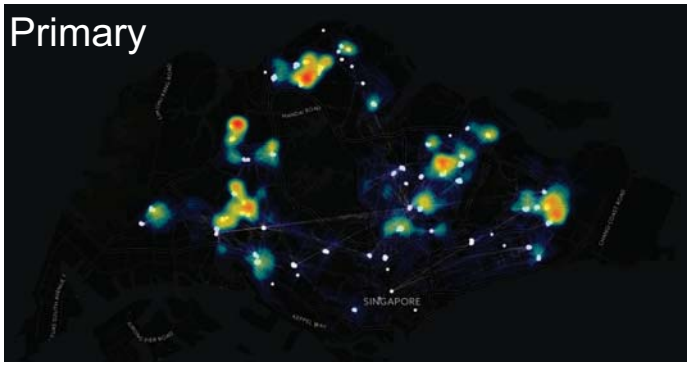


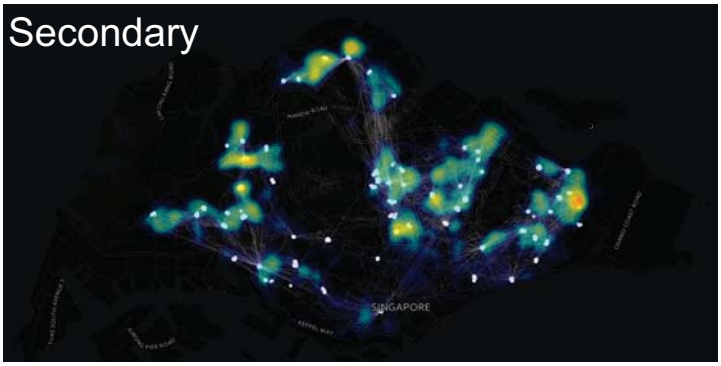
Average Travel Distance:

- Primary school students: 2.6 km
- Secondary school students: 5.1 km
- Junior college students: 8.5 km

- Secondary school and junior college students live two to three times further away from schools than primary school students.
- Student travel is synchronous, leaving home at 6.00 am and returning home between 3.00 pm and 6.00 pm.

Density of Homes around Schools:

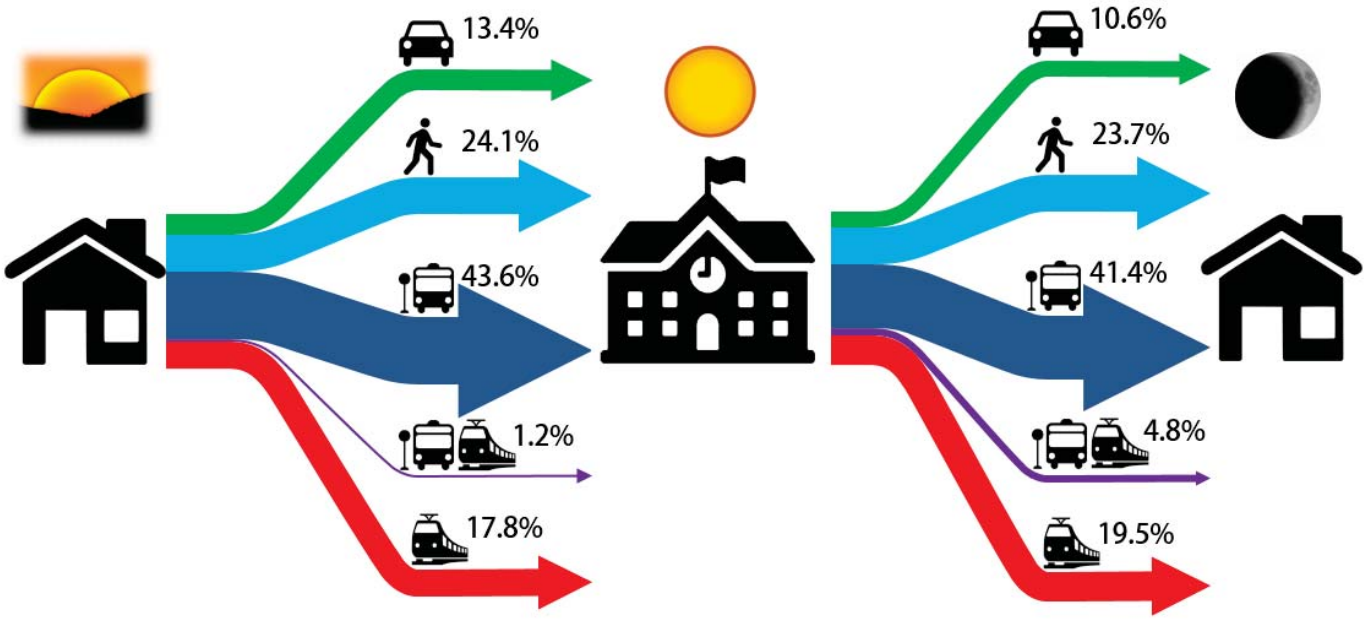


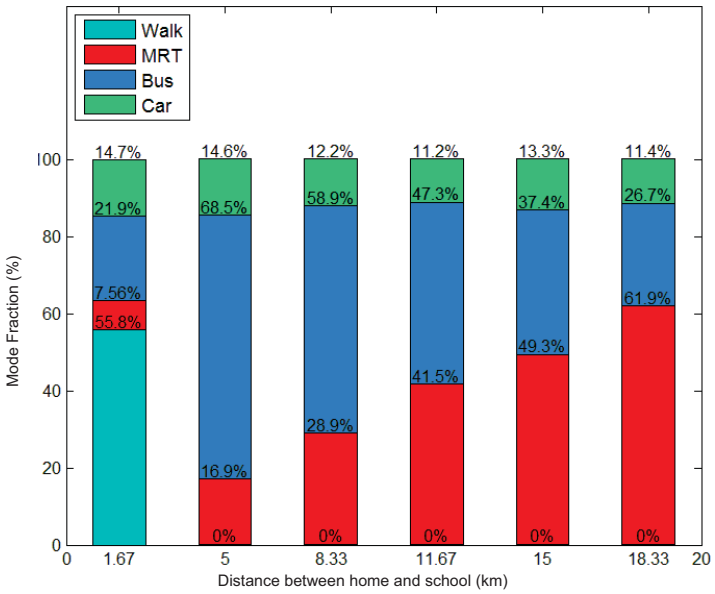


Legend:

White Spots – Schools
Red – Highest density of homes
Blue – Lowest density of homes

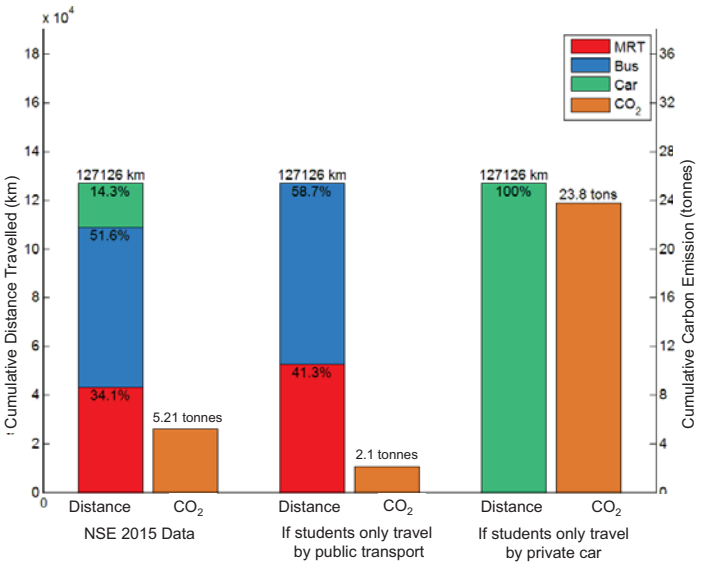
Modes of Transport





- Common modes of transport: Bus, Train, Walking
- Students who live within 2 km of their schools tend to walk to school.
- Students who live further from school are more likely to take the train or bus.

- Students produce 5.21 tonnes of carbon dioxide from transportation taken daily during experiment.
- If all the students were to take public transport, they will produce 40% less carbon dioxide.
- If all the students were to travel by private cars, they will produce 460% more carbon dioxide.



National Science Experiment 2015

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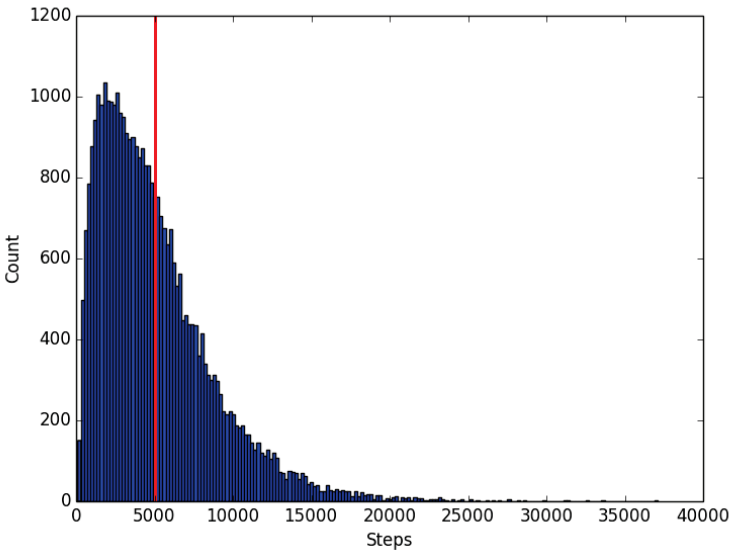
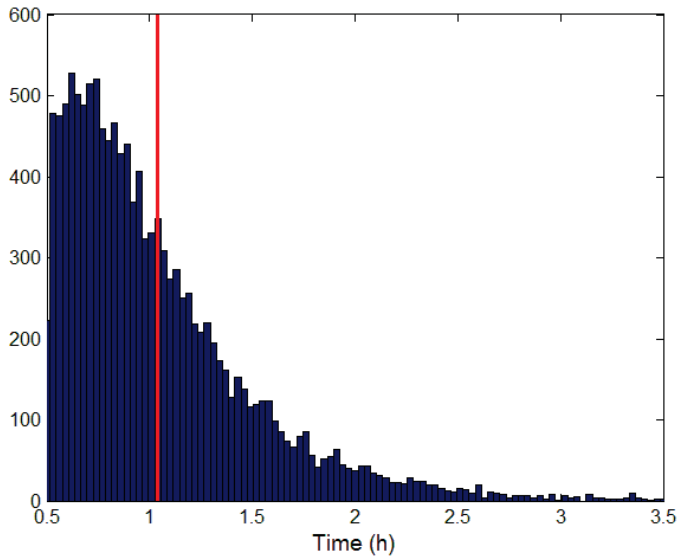
Student's Active Lifestyle

Step Count



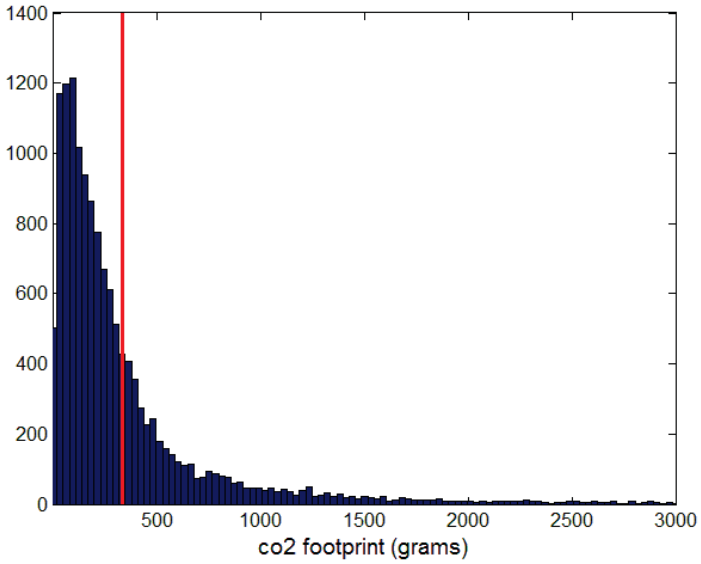
Average steps per day:
5,853

Time Spent Outdoors



Average time spent outdoors per day:
1.1 hours

Carbon Footprint



Average amount of carbon dioxide produced from travel per day: 333 grams

This is equivalent to:

- Driving a car for 2 km
- Running an air conditioner for 30 min
- Eating 25 grams or one forkful of steak

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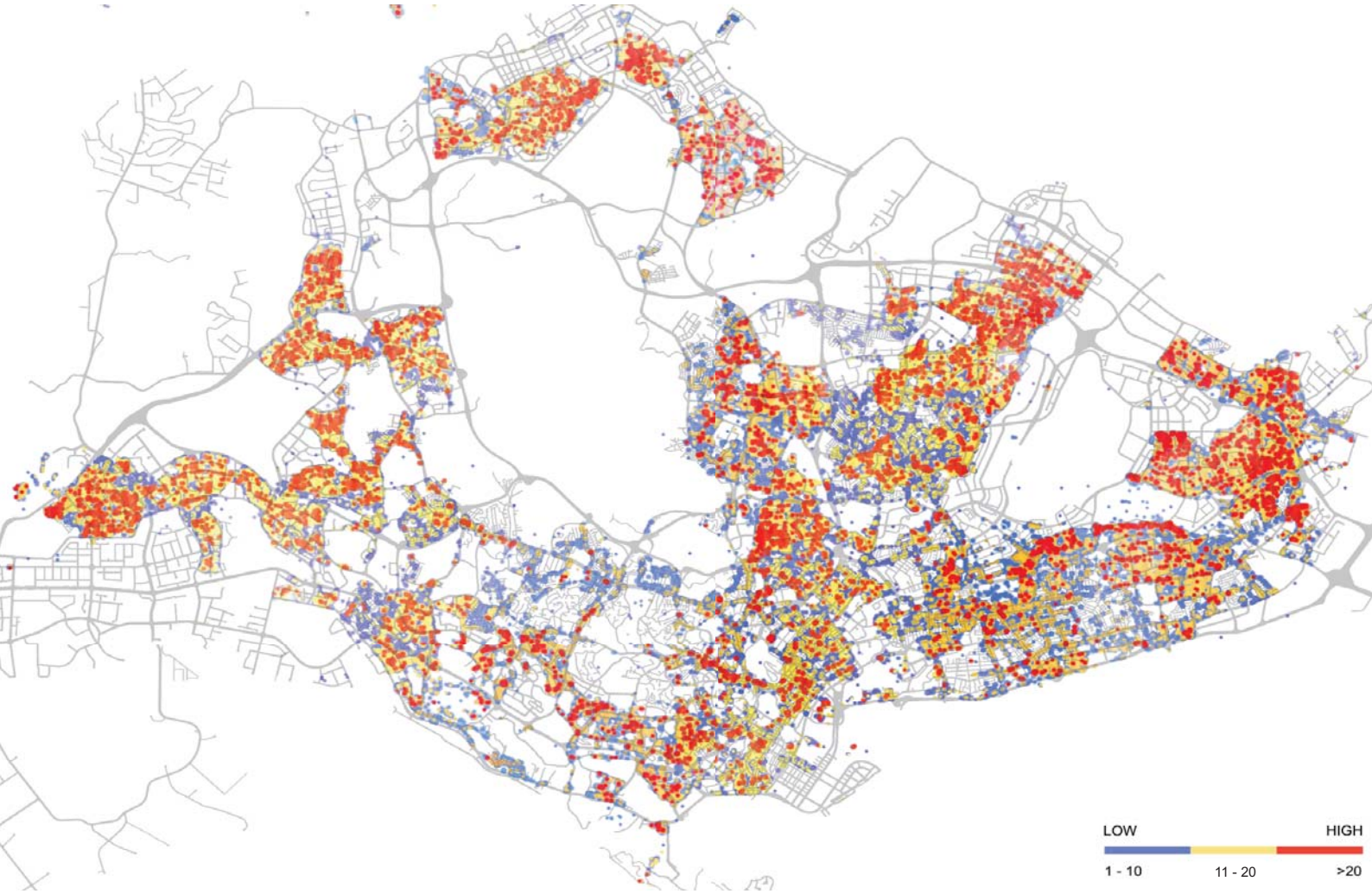
Wi-Fi Coverage



1.8 million

unique Wi-Fi access points detected

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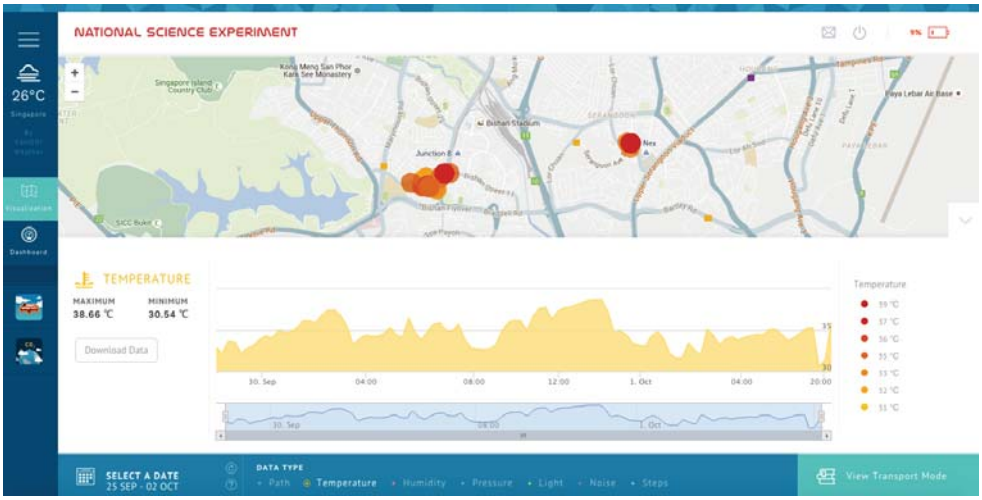
Visualisation and Interaction on Big Data Portal

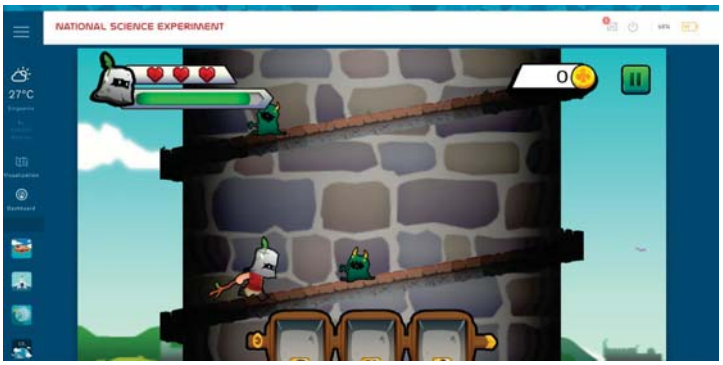
Student's Dashboard:



- Students can study their own big data on the web portal.
- Students can also learn their carbon footprint based on their travel choices.

Games to encourage step count:

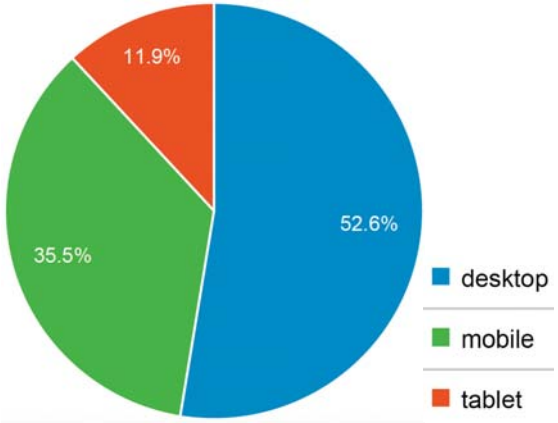
Step count determines the number of power-ups to assist the knight in his TowerQuest mission.



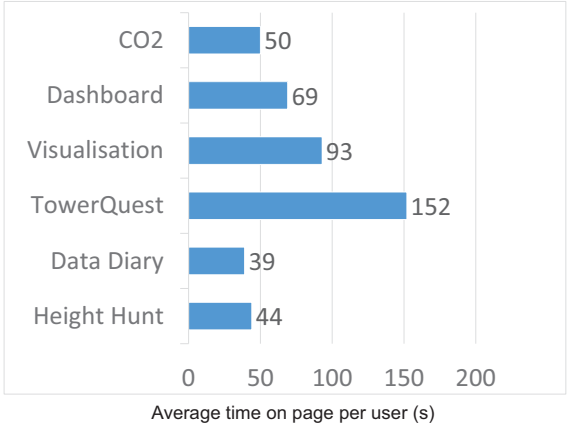
Data Diary and Height Hunt test students' understanding of statistics.

Web Portal Usage:

Almost half of the students visit the portal on the go.



Students spend the most time exploring their individual data and playing the games.



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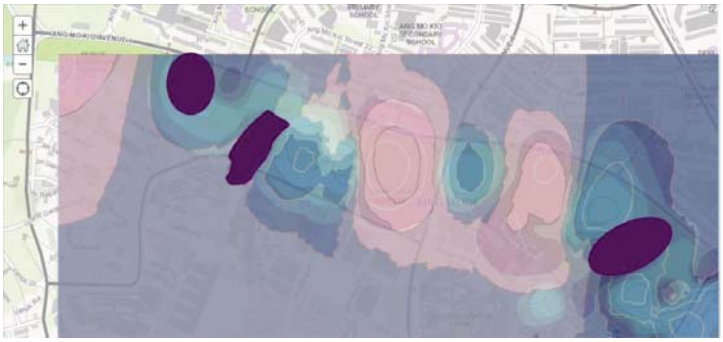
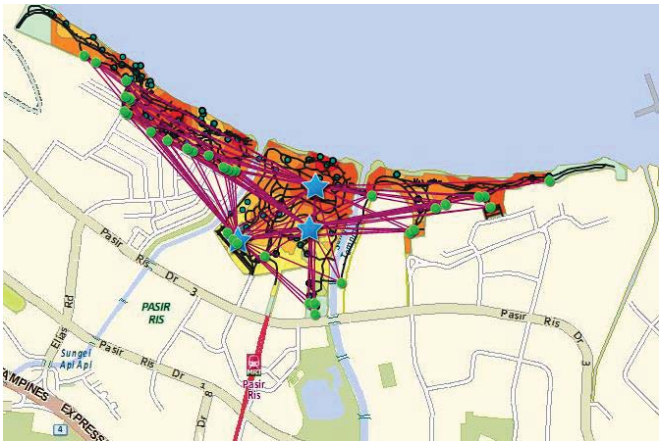
Student Projects from NSE 2015

Identifying locations for optimum growth of different species of flowering plants



Identifying dengue hotspots



Identifying ideal locations for LED lights or solar panels

Hong Kah Secondary School students comparing temperature and humidity in the Cloud Forest and outdoor Singapore

Students and staff of St Gabriel's Primary School took 7 million steps and raised 50,000 food packs for needy families

ANNEX B

National Science Experiment Factsheet

About the National Science Experiment

The National Science Experiment (NSE), themed “Step Out for Science”, is an island-wide outdoor science experiment carried out by Singapore students to track their carbon footprint, travel mobility patterns, and the amount of time they spend indoors and outdoors.

The experiment involves Singapore students carrying a specially designed device to collect data on their daily travel as well as data from the environment. This data is transferred wirelessly to a central online portal from which these students (and their teachers) can log in to view the results, including the aggregated data of students from all over Singapore who are taking part.

Through this experiment, students learn about the Internet of Things and Big Data as the portal will provide the knowledge and tools to teach them to read and analyse the information, create graphs, interpret visualisations, and compare trends. Teachers will also be able to leverage the data to develop interesting physics lessons and teach concepts such as humidity, linear kinematics and pendulum motion through hypotheses testing and hands-on experiments.

The NSE experiment is organised by the National Research Foundation (NRF) Singapore and Ministry of Education (MOE), in partnership with the Singapore University of Technology and Design (SUTD), Science Centre Singapore (SCS), the Agency for Science, Technology and Research (A*STAR), the Singapore Land Authority and OneMap Singapore to excite young Singaporeans in science and technology, and to celebrate 50 years of science and technology in Singapore, as part of our Jubilee celebrations.

Technology sponsors of NSE include A*STAR’s Institute of High Performance Computing, the Infocomm Development Authority of Singapore, Wireless@SG, NVIDIA, SAP, Dassault Systemes and Skyhook. The logistic sponsor of NSE is Singapore Post Limited.

Schools' Participation
The NSE targets to involve more than 250,000 Singapore students from Primary 3 to Junior College 2 levels from across the island.

Time Span of NSE
The NSE will take place over three years, from 2015 to 2017. The first experiment will start in the second half of 2015 and the first set of results is planned for release by the end of 2015. The experiment will be carried out with different objectives and experiments in the subsequent years to sharpen interest and provide meaningful challenges for the participants.

Duration of Experiment (September to November 2015)
Students will conduct the experiment in the weeks of 28 Sep, 5 Oct, 12 Oct or 2 Nov (schools can choose any week). The experiment entails each student carrying a device over four days during the week.

Measurements of the National Science Experiment 2015
The SENSg device measures and tracks the following activity levels:

- Daily walking activity of each student, that is, the number of steps taken during a day;
- Time spent indoors and outdoors;
- Travel mode, that is, commuting via walking, cycling, riding in a bus or train, or travelling in a car.

Learning Points for Students
Participating students will be provided with user IDs and passwords to access the NSE web portal to view their data. They will be able to compare their activity levels against their peers (peers' data are anonymous to them). The portal will provide the tools to teach students how to read and analyse the data, create graphs, interpret the visualisations, and compare their findings against their cohort.

Teachers' Use
The compact, portable and multi-parameter SENSg device allows students to carry a "lab on your lanyard" for their own science experiments. Teachers can use the SENSg device to write science lessons and teach concepts through hypotheses testing and hands-on experiments. A set of experiments, complementing existing science curriculum and syllabus, will be developed by the SCS as enrichment lessons for schools.

NSE Results
A series of national data visualisations will be produced at the end of the experiment. These data, collected from each student contributing to a larger pool of big data, will be aggregated (combined) to yield insights into how mobile our Singapore's youths are and their mobility patterns.

In summary, the experiment would make available some of the following insights:

1. How active are our young Singaporeans?
2. What are the travel patterns of young Singaporeans?

3. What does Singapore's heat map look like? Where are the hot spots located?
4. How is Wi-Fi connectivity spread across Singapore? Which areas have higher connectivity?

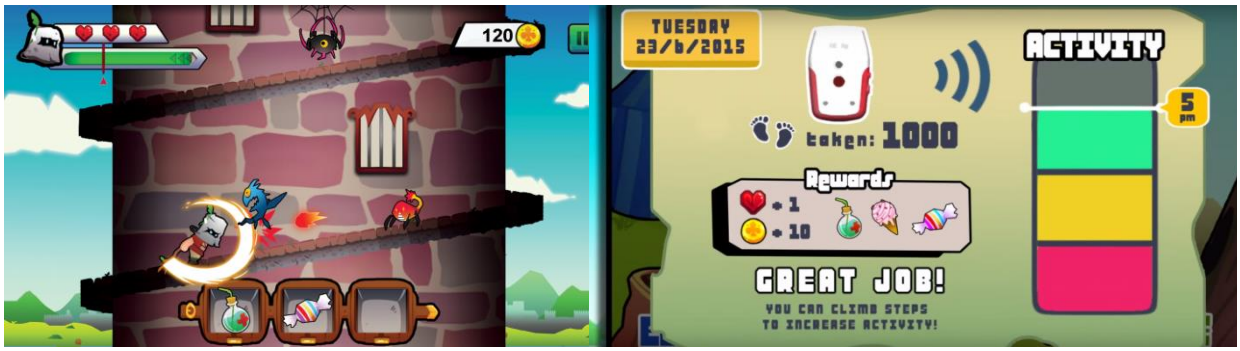
Data outcomes from the NSE will also be used to support ongoing research programmes such as the Land and Liveability National Innovation Challenge, the Virtual Singapore as well as the Smart Nation initiative.

The SENSg Device

The device, named "SENSg" (pronounced "SENSE-SG") measures and stores the step count and environmental data, which are correlated to the device's location. The device uses Wi-Fi signals to localise itself, and periodically uploads data to a secured database if it is in range of a known access point. The data is anonymous, and stored securely in the cloud. It is designed and developed by researchers from the SUTD.

Read and watch video about the SENSg device and the kinds of data it can collect, such as humidity, temperature, pressure, sound, light, and step count. These can be used to deduce whether a student is indoors or outdoors and the travel pattern.

TowerQuest Game



(Photos of the TowerQuest game)

Students can access the TowerQuest game via the NSE web portal, which challenges players to assist a knight in clearing levels and rescuing a princess at the top of the tower. The game draws inputs from the SENSg device and environmental data collected, which determines the number of power-ups (benefits or special abilities) awarded to assist the knight in his mission.

Watch the TowerQuest game trailer.

ANNEX C

SENSg Device Factsheet

The SENSg device (pronounced “SENSE-SG”) is a compact, portable and multi-parameter “Lab on a Lanyard”. It uses Wi-Fi signals to localise itself, and periodically uploads data to a secured database if it is in range of a known access point. The data is anonymous, and stored securely in the cloud.

The SENSg device collects data based on nine parameters:

Parameter	**Explanation**
Relative humidity	Relative humidity is the percentage of the amount of water vapour in the air compared to the maximum amount of water vapour the air can hold. The SENSg device contains capacitive humidity sensors to measure relative humidity. The accuracy of the relative humidity reading is highly dependent on temperature, hence the SENSg device is designed with multiple holes to increase ventilation. The humidity sensor is also mounted in a way to minimise heat transfer from other electronic sensors.
Pressure	The SENSg device’s pressure sensor consists of a piezo-resistive sensor. The measured pressure can be used to estimate the altitude, or the height above sea level.
Temperature	The SENSg device contains an infrared (IR) thermometer that measures the temperature of an object by sensing the infrared radiation emitted. The lens covering the IR thermometer sensor uses special materials to minimise reflection and absorption by the lens material.
Sound	The microphone in the SENSg device converts sound pressure waves to electrical signals, and provides the sound pressure level readings in decibels. It uses special capacitive micro electromechanical systems (MEMS) microphones to measure sound pressure level for measuring city noise.

Light	The SENSg device contains a photodiode to measure light. When the light shines through a specially designed filter, it generates a small amount of current which is used to measure light.
Inertial measurement	The SENSg device contains a MEMS Inertial Measurement Unit which combines an accelerometer, a gyroscope and a magnetometer. An accelerator measures acceleration force (i.e. increase in speed) which can be the gravitation force, or a force generated through motion. A gyroscope is a spinning wheel or disc in which the axis of rotation is free to assume any orientation. It uses Earth's gravity to help determine the position. The magnetometer detects the earth's magnetic field.
Step count	The SENSg device comes with an in-built pedometer to measure the number of steps taken while carrying the device. The accelerator (see inertial measurement) measures the magnitude of acceleration along a particular axis. If the acceleration is greater than a specific programmed amount, a step is registered.
Indoor / Outdoor time	The SENSg uses differences in relative humidity and light between indoor and outdoor spaces to differentiate between time spent indoors or outdoors. The time is also taking into consideration when measuring differences in light. Examples of indoor spaces include air conditioned spaces (e.g. offices, malls and hospitals) and covered indoor spaces with ventilation (e.g. classrooms with ceiling fans and underground carparks). Examples of outdoor spaces include open air spaces (e.g. open air carparks, above-ground MRT stations)
Travel pattern	The SENSg device is can determine the mode of transportation, such as whether a person is walking, in a motorised form of transport (e.g. car or bus) or on the MRT train. Walking, taking the bus and riding in a car can be separated from one another based on their distinctive travel patterns. Taking the MRT train can be determined as trains have special magnetic signatures. The SENSg device uses sensor readings to determine the mode of transportation. Once these readings are uploaded onto the secure cloud database, algorithms further refine the readings based on geospatial data.

Some guidelines on how to carry the SENSg device accurately:

Do's	**Don'ts**
Wear it on the move – whether you are indoors or outdoors, climbing stairs, travelling in a vehicle or walking	Put it in your bag or pocket while on the move – this could affect accuracy of the results
Carry it around your neck using the provided lanyard, or clip it to your belt loop	Submerge it in water, or wear it while bathing. Try and also protect it from getting wet when it rains
Charge the battery before it runs out, especially when you see the light blinking red	Carry it when you are doing vigorous activities, for example, during sports or physical education
Check your data at app.nse.sg/app to learn big data and carry out exciting experiments	Hit it against hard surfaces or throw it around, as it is a sensitive measuring device
	Lose the device. Keep it in a safe place when it is not in use