The Out-of-School STEM Ecosystem in Hong Kong Second Report 2016 – 2017

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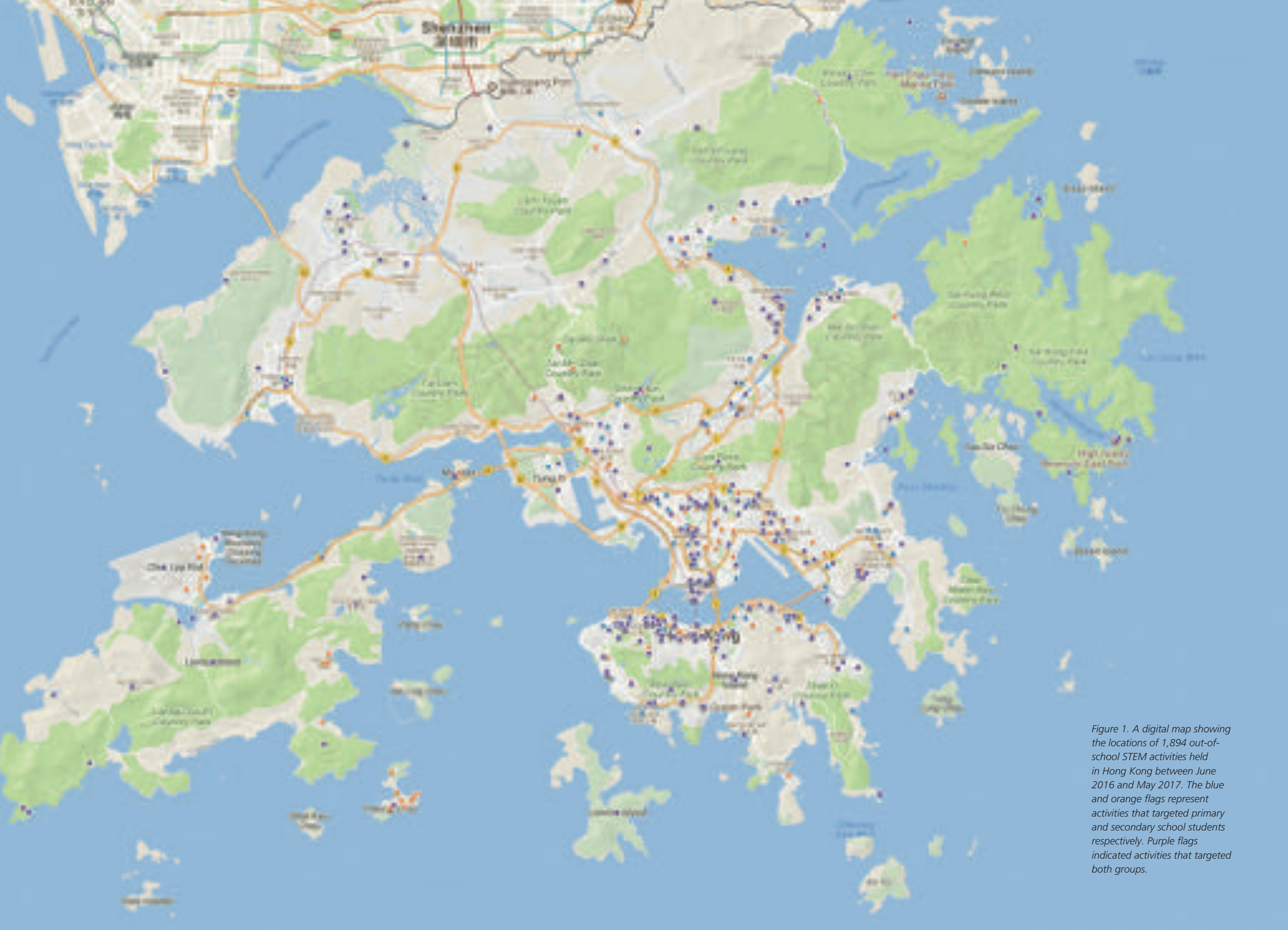

Figure 1. A digital map showing the locations of 1,894 out-of-school STEM activities held in Hong Kong between June 2016 and May 2017. The blue and orange flags represent activities that targeted primary and secondary school students respectively. Purple flags indicated activities that targeted both groups.

The Croucher Foundation

The Croucher Foundation is an independent private foundation established by the late Noel Croucher in 1979 to promote the standard of the natural sciences, technology and medicine in Hong Kong.

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Content

Introduction

In Hong Kong the landscape for out-of-school STEM learning is evolving. In 2016, to capture this change, the Croucher Foundation began a series of annual mapping exercises. This is the first multi-year study to focus on the out-of-school ecosystem for science learning in Hong Kong.

Our initial mapping exercise in 2016 identified over a thousand STEM activities including courses, workshops and exhibitions available to Hong Kong primary and secondary students. The study examined a twelve-month period from June 2015 to May 2016. It excluded tutorials and exam-orientated courses, and focused instead on activities designed to encourage an interest in science. We noted that a distinctive feature of informal science learning in Hong Kong was the number of activities taking place in our country parks, wetland areas and at Mai Po Nature Reserve.

In 2017 we launched our second mapping exercise:

- To create a map detailing out-of-school STEM learning programmes held in Hong Kong between June 2016 and May 2017 for students aged from 6 to 18;
- To explore the different modes of teaching and learning used in these out-of-school STEM learning programmes; and
- To evaluate the effectiveness, possible gaps and limitations of these activities at the individual, programme and community levels.

In addition to using desk research, surveys and in-person interviews, we added a new component to our methodology: focus groups to explore the experiences and perceptions of students and parents.

The resulting mapping document, with its online maps, is designed to provide a snapshot of all the out-of-school STEM activities that took place in Hong Kong within the period of the study.

We trust that this mapping document will be useful to students, parents and teachers as they plan extracurricular activities, and that in the longer term it will inspire more young people to follow their intellectual inclinations, and to try out curiosity-driven science.

From a policy perspective, the second exercise indicates extremely rapid growth in available out-of-school STEM activities compared to 2016. We examine the implications of this growth in the discussion section of the report.

Hong Kong STEM Network

In 2016, we discovered a vibrant community of people involved in running STEM activities in Hong Kong, but without much coordination.

To link this community together, so that people can share ideas and resources more easily, the Croucher Foundation has launched an informal gathering of STEM educators: the Hong Kong STEM Network.

Occasional meetings provide an opportunity for the board members and staff of local STEM organisers to get to know each other, to share ideas and experiences, and to discuss some of the common questions they encounter in their work.

In addition to providing a platform for general discussion, we will feature training seminars for STEM practitioners, and talks by invited speakers on topics of specific interest.

We are building an intranet site so that participants can post information about upcoming activities, advertise jobs and, where appropriate, work together on collaborative projects.

And we are using our digital mapping expertise to design a live map of upcoming STEM activities. Students, parents and teachers have pointed out that they are not always aware of available STEM activities and sometimes do not have enough advance notice. We hope that our live map will, over time, provide a useful channel for promotion of informal STEM learning.

The first meeting of the Hong Kong STEM Network was held in April 2017. The number of organisations which have participated in meetings of the Hong Kong STEM Network since April 2017 has increased gradually and currently stands at 50.

To gain a more complete picture, encompassing both in-school and out-of-school STEM learning, we recommend reading this mapping document in conjunction with a report on STEM education published in January 2017 by the Academy of Sciences of Hong Kong (Lun et al., 2016)

In future years, as we continue to survey the landscape, we hope that our annual mapping documents will become a useful resource, documenting the emergence of a robust and well-coordinated STEM ecosystem in Hong Kong, and a strengthened relationship between the school-based curriculum and activities taking place outside the classroom.

To identify out-of-school STEM activities held in Hong Kong over a twelve-month period, a team of five researchers carried out extensive desk research.

As in our previous study, extracurricular out-of-school STEM programmes were defined as those activities which were voluntary and which carried no academic credit towards graduation, and were held outside the school of the participants. As such, we included activities that took place inside schools but were open to students from other schools. The activities surveyed included competitions, exhibitions, talks, courses, workshops, field trips and camps.

Organisers completed an online survey and this year, to build a more comprehensive picture, we invited primary students, secondary students, and parents to complete surveys and to participate in focus groups.

Students and parents were recruited through schools and social media; organisers were invited by email. We received 102 survey responses from primary students, 359 from secondary students, 204 from parents and 62 from organisers. The research team applied validation criteria to verify responses before data analyses. Responses from primary and secondary students omitted were those with incomprehensible school names, when their age and level of study did not match by a difference of at most two years, and those with incomprehensible answers in open-ended questions. Furthermore, we disregarded incomplete paper survey responses from four parents and four secondary students. For organisers, duplicate responses from the same department of an organisation were removed and only the first submission was analysed.

After manual validation, the data comprised complete and valid survey responses from 92 primary school students, 335 secondary school students, 200 parents and 60 organisers (*Figure 3*).

In-person interviews and focus group discussions were conducted to understand the experiences, attitudes, opinions and motivation of different stakeholders. Formal invitations were sent to all schools in Hong Kong and 11 schools joined our study, four of which participated in our previous study and seven joined this year. In total, 25 principals and teachers met us for in-person interviews and we conducted 14 focus groups with 71 students and 4 focus groups with 19 parents (*Figure 3*).

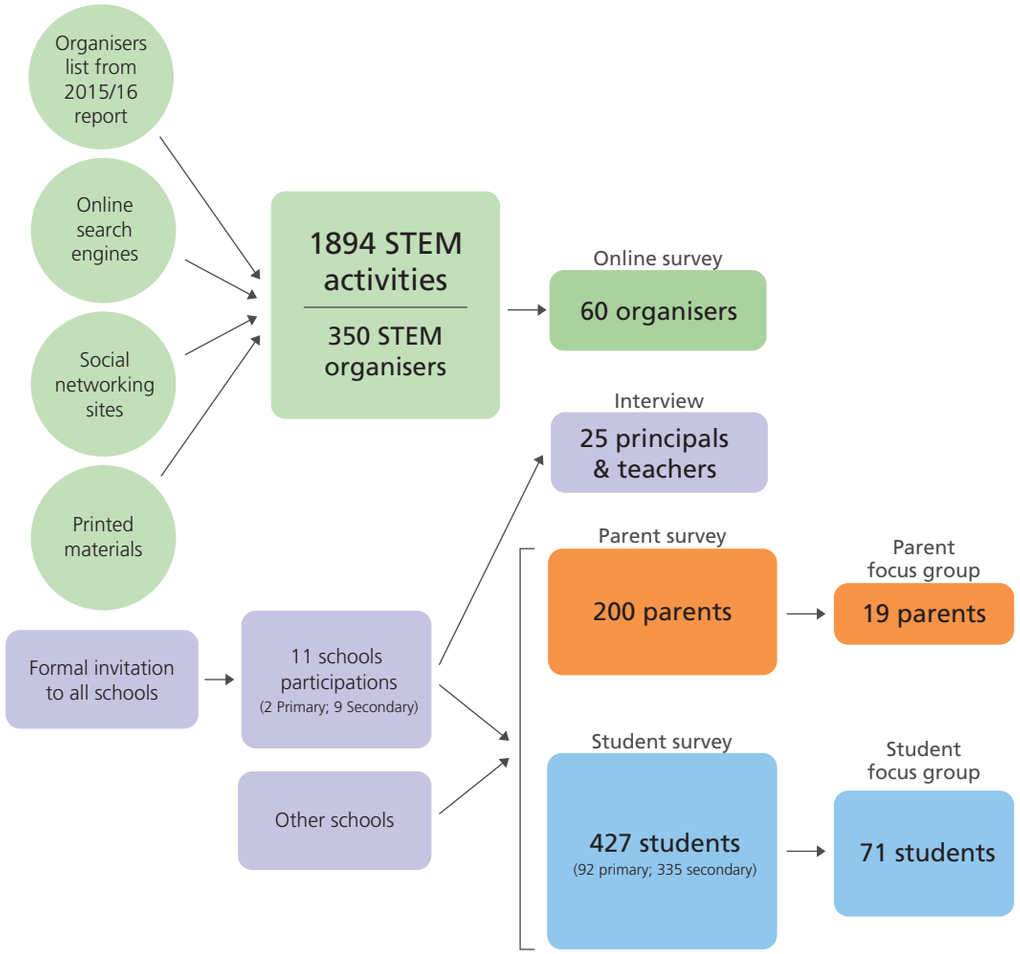

Figure 3. Research flow

Venues of out-of-school STEM activities

A digital map was generated to indicate the venues of the 1,894 STEM activities identified (*Figure 1*, inside front cover). For activities with multiple venues, all locations were mapped.

Out-of-school STEM activities took place throughout Hong Kong, with the main clusters found to be unchanged compared with 2016. Districts with a higher abundance of activities include Sha Tin and Tai Po in the New Territories, Yau Tsim Mong in Kowloon and Central and Western District as well as Wan Chai District on Hong Kong Island, where many organisers are located.

Locations of STEM organisers

Figure 2 (inside back cover) shows the geographical distribution of the 350 organisers of the out-of-school STEM activities identified in this study. For organisers with multiple branches, only their headquarters or head office was mapped. To enhance visualisation, organisers in the same building were placed adjacently without overlapping.

Yau Tsim Mong district in Kowloon as well as Central and Western and Wan Chai districts on Hong Kong Island remained the areas with highest density of out-of-school STEM organisers.

Timing of the out of school STEM activities

We recorded a total of 1,894 out-of-school STEM programmes held during a twelve-month period from 1 June 2016 to 31 May 2017. Compared with 2016, this represents a 76% increase in the number of STEM activities held in Hong Kong.

Figure 4 provides an overall view of how the out-of-school STEM activities were distributed across the past two years (June 2015 to May 2016 in green; June 2016 to May 2017 in orange). The sum of activities across different months is more than the total number in the study period as some activities took place across several months or even throughout the year. These were counted separately.

The increase in the number of out-of-school STEM programmes can be observed as an upward transposition of the curve across all months in the study period (*Figure 4*). The shape of the curves was similar, with peaks and troughs in the same months. The peaks in the graph can be explained by a sequence of large-scale events including the Hong Kong Biodiversity Festival, InnoCarnival, HK SciFest and Maker Faire Hong Kong. The troughs in June and January correspond to the examination periods, and September is the start of the academic year.

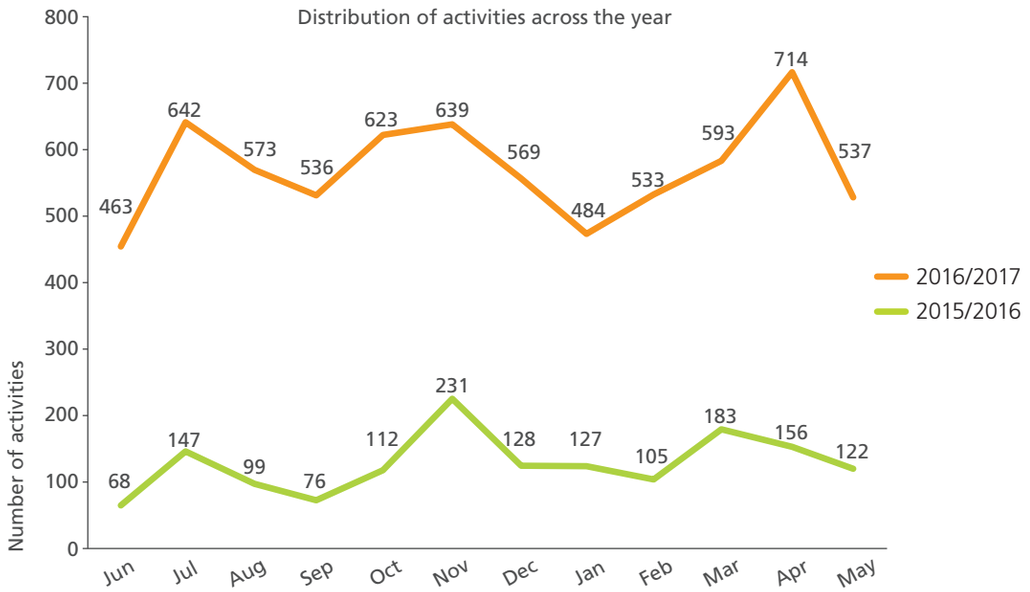

Figure 4. A graph showing the out-of-school STEM activities that occurred across the period of study (green: from June 2015 to May 2016, orange: from June 2016 to May 2017). Programmes that were conducted across different months were counted separately. We recorded 76% growth in STEM activities year-on-year.

Types of organisers and their extent of collaboration

In this study, we identified 350 organisers of out-of-school STEM programmes. Compared with the 144 organisers we identified using the same methodology in 2016, this represents a 143% increase.

There was significant growth in the number of non-governmental organisations (NGOs) and private companies involved in organising out-of-school STEM programmes (*Figure 5a*). More local schools were also identified as organisers as they provided STEM activities for students from other schools.

Among the out-of-school STEM programmes held between June 2016 and May 2017, 13.5% (255 out of 1,894 activities) involved two or more organisers when compared to 4.5% (48 out of 1,074) in the previous year (*Figure 5b and c*). There was more collaboration between government-related organisations and schools and NGOs than other combinations in both periods (*Figure 5b and c*). InnoCarnival 2016 and HK SciFest 2017 involved collaboration between government-related organisations and schools and private companies; Science Alive 2017, the STEM in mBot 2017 competition and the International IT Fest 2017 exhibition were large-scale events that involved collaboration between all three types of organisers.

In April 2017, to facilitate communication between STEM organisers and the sharing of ideas and resources, the Croucher Foundation launched the Hong Kong STEM Network.

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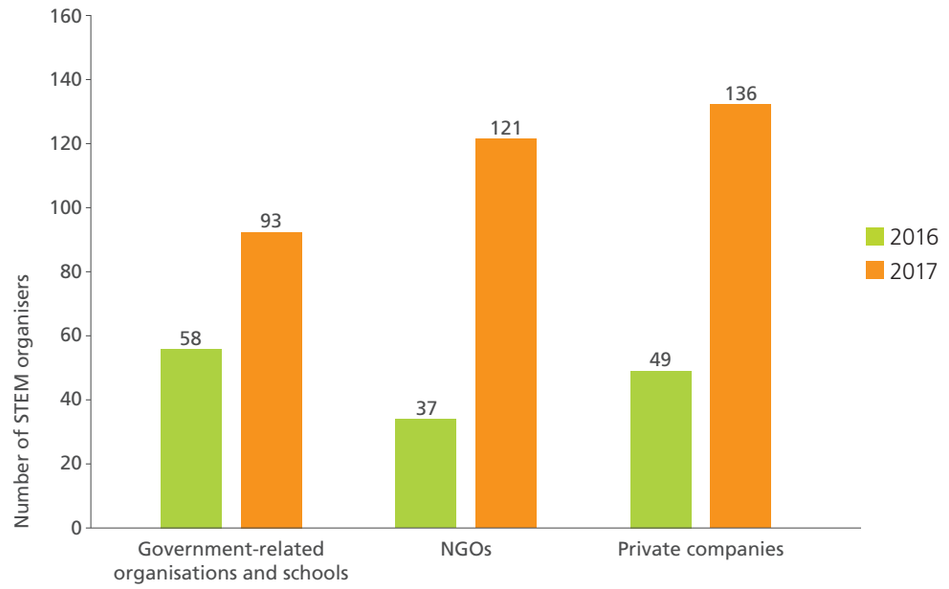
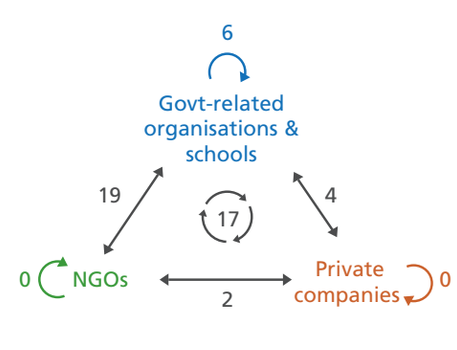


b 2016



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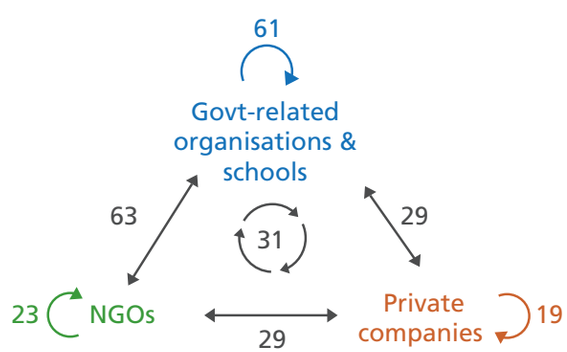

Figure 5. STEM organisers and their frequency of collaboration.
(a) The distribution of different types of STEM organisers in the previous study (green: 2015/16) and this study (orange: 2016/17). Primary and secondary schools and tertiary institutions have been grouped together with government-related organisations. Different departments and faculties of a tertiary institution were counted as one institution; different divisions and branches of organisations or private companies were counted as one organiser.
(b,c) A schematic diagram showing the extent of collaboration between different types of organisers in 2015/16 (b) and 2016/17 (c). The coloured arrows represent collaboration within the respective type of organisers.

Nature and types of STEM activities and their target participants

In this period of study between June 2016 and May 2017, we identified 1,894 out-of-school STEM programmes in subjects related to science, technology, engineering and/or mathematics. Activities were analysed according to their nature, type of activity and target age group.

Science remained the largest area of focus for STEM activities (*Figure 6a*) perhaps because of its very wide coverage from physics, chemistry, biology and medicine to environmental science, ecology, earth science and astronomy. Technology-related activities which include coding and programming, robotics and those involving cutting-edge technological applications, such as 3D printing, 3D modelling, virtual reality, augmented reality, drone photography and mobile app development increased compared with 2015/16.

The number of science- and technology-related activities nearly doubled whereas the number of engineering- and mathematics-related activities remained similar to 2015/16 (*Figure 6a*). Hence, the significant increase in the total number of activities this year was largely due to a surge in science- and technology-related out-of-school activities.

In this study, although the total number remained low, in 2017 we observed more out-of-school STEM activities that integrated all four areas of STEM (*Figure 6b*, 24 out of 1,894 compared to 9 out of 1,074 in 2015/16). There were also more activities that integrated at least two areas of STEM (269 out of 1,894 compared to 216 out of 1,074) although as a proportion of the total, the figure went down.

Engineering-related activities were those that involve a design process and which could include the application of technology. There was a significant overlap between engineering and other areas, particularly technology (*Figure 6b*). This is probably because engineering is not taught in the regular school curriculum so it was often integrated with other areas of STEM to aid its promotion to primary and secondary school students.

On the other hand, mathematics is an established subject and it was interesting to find that the majority of mathematics-related programmes were enrichment classes targeting students who are enthusiastic in the subject, so there is scope for more activities organised for all abilities and serve to arouse students' interest in mathematics.

The out-of-school STEM activities were categorised into competitions, exhibitions, talks, workshops, courses, field trips and camps (*Figure 6c*). Courses and workshops were classified according to the number of sessions: courses involved two or more sessions whereas one-off activities were defined as workshops. Exhibitions included theatres, films, drama performances and booths that were set up by different organisers, which let students watch with minimal or no hands-on experience. Talks included seminars and public lectures delivered by STEM professionals. The relative abundance of each type of activity remained similar to the previous study.

The target age groups of the 1,894 out-of-school STEM activities were categorised into primary (Primary 1 to 6; age 6-12), junior secondary (Secondary 1 to 3; age 13-15) and senior secondary (Secondary 4 to 6; age 16-18) levels (*Figure 6d*). Secondary was further classified into junior and senior levels due to a remarkable difference in the school curriculum. A count was added to all categories for activities that did not specify any target age group or those open to public. Over half of the activities identified targeted multiple age groups (*Figure 6e*).

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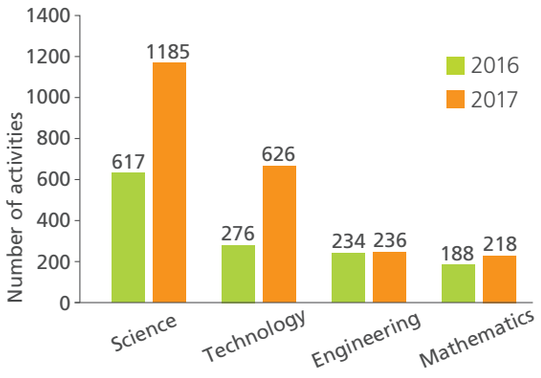

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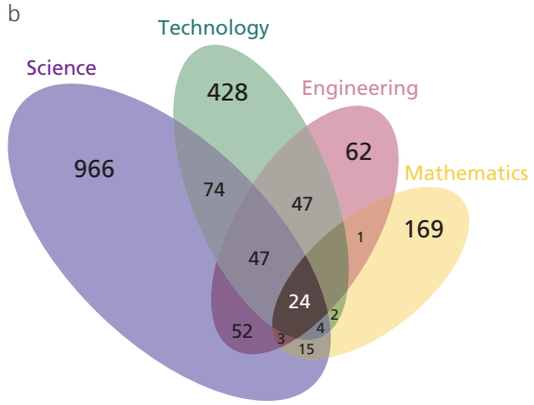

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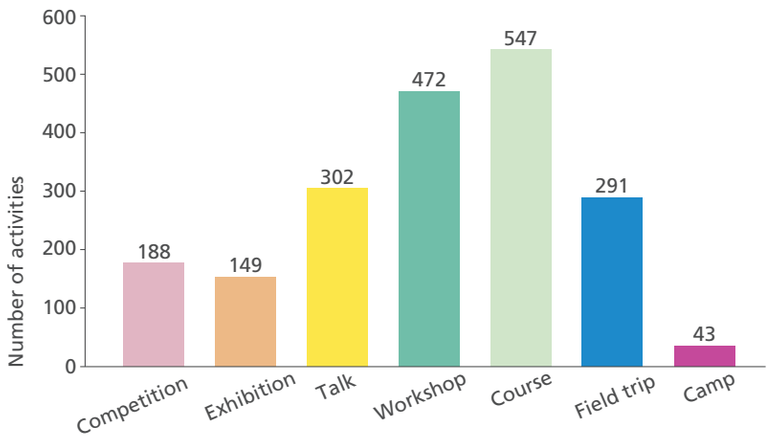

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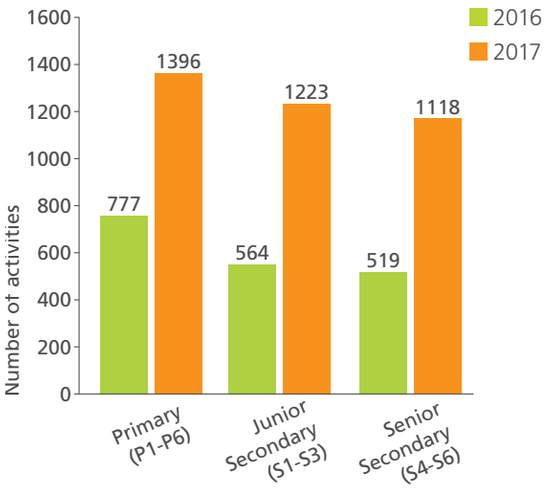

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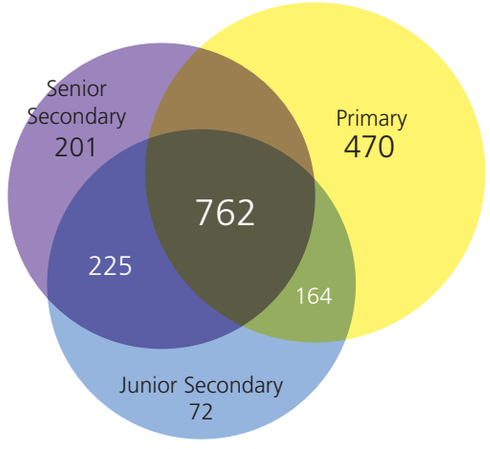


The dataset was explored further by looking at the type of activities that were organised for each area of STEM (*Figure 7*). Similar to the previous report, science-related workshops, courses and field trips were frequently organised. Except for mathematics, workshops with hands-on experience continued to play an important role in STEM education. Courses continued to dominate in the field of mathematics, an area with many competitions.

With respect to the promotion of STEM to different age groups, our dataset showed similar number of activities available to different age groups for each field (*Figure 8*). There were more science-related activities for senior secondary than junior secondary students. This could be due to a significant number of activities that specifically aim to complement the New Senior Secondary Science curriculum leading up to the Hong Kong Diploma of Secondary Education (HKDSE) Examination. For instance, there were science courses offered by tertiary institutions for extended learning.

In summary, this dataset showed a strengthened out-of-school STEM ecosystem when compared to the previous study period in the following aspects:

- There were more out-of-school STEM programmes available for primary school students, an increase from 777 in 2015/16 to 1,396 in 2016/17.
- There were more technology-related courses and exhibitions this past year, which was an area of improvement suggested in our last report.
- There were more activities that integrated at least two areas of STEM. This could encourage students to deepen their knowledge by relating concepts from different areas.
- There was more collaboration between different types of organisers. This is probably one of the most promising signs of a sustainable out-of-school STEM ecosystem in Hong Kong.

Figure 6. The nature and types of out-of-school STEM activities in our datasets and their target participants.

(a) The distribution of the nature of STEM activities in 2015/16 and 2016/17. Some activities engaged participants in more than one are of STEM hence each area was counted separately.

(b) A Venn diagram showing the number of STEM activities and the integration between different areas of STEM. The number of activities was indicated in each sector.

(c) The distribution of different types of STEM activities. Some of the out-of-school STEM programmes can be classified under more than one type of activity then each type was counted separately.

(d) The distribution of the target age groups of the STEM activities in 2015/16 and 2016/17.

(e) A Venn diagram illustrating the STEM activities that targeted one or more age groups. The number of activities was indicated in each sector.

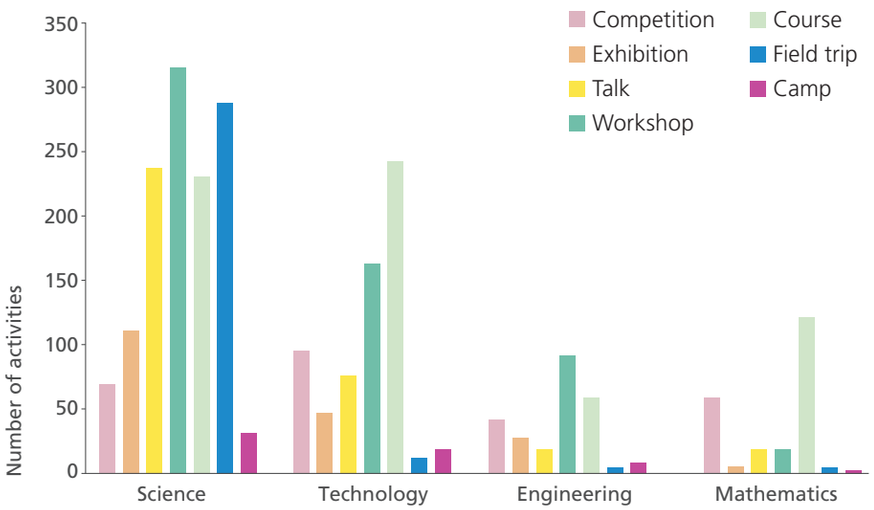


Figure 7. The distribution of various types of activities according to each area of STEM.

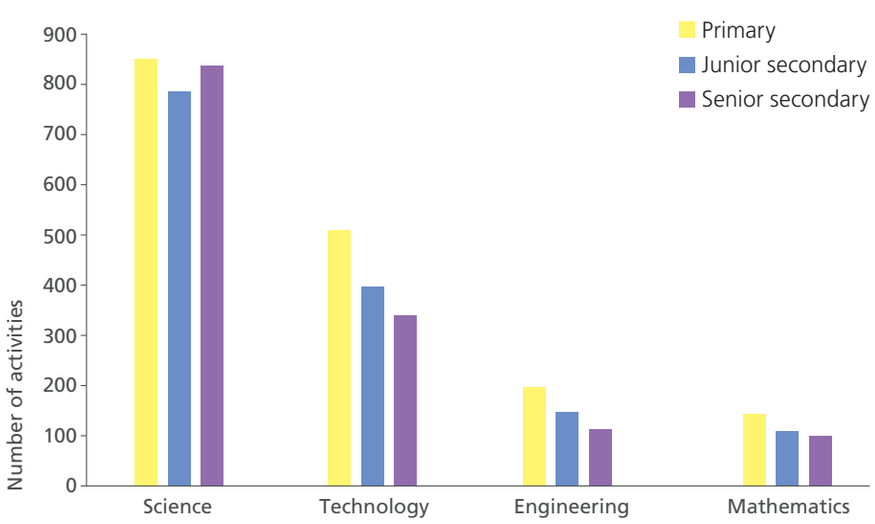


Figure 8. The distribution of the target age groups according to the nature of STEM activities.

Following data mining, the organisers were invited to complete an online survey. Its objectives were to collect more detailed information about the out-of-school STEM activities held by different organisers, such as their promotion and recruitment methods, programme structure, resource allocation, collaboration with others, as well as their experience in comparison with 2015/16. All the organisers in our dataset were invited and 60 complete and valid responses were received.

All of the survey respondents had heard of the term 'STEM' and had organised at least one out-of-school STEM learning programme in Hong Kong between June 2016 and May 2017 for students aged between 6 and 18 years. Among the 60 survey respondents, 26 of them (43%) were private companies, 22 (37%) were NGOs and 12 (20%) were government-related organisations, tertiary institutions or schools (*Figure 9a*).

Figure 9b illustrates that the most common type of STEM activity organised by the respondents was talks, workshops or courses. We grouped talks, workshops and courses into one category since they were indoor activities and were similar in nature. 56 out of 60 respondents (93%) conducted a talk/workshop/course between June 2016 and July 2017, while camp and field trip were the least common activity types with only 21 respondents (35%) conducted either of those types in the study period (*Figure 9b*). This could be due to the complexity of organising field trips and camps.

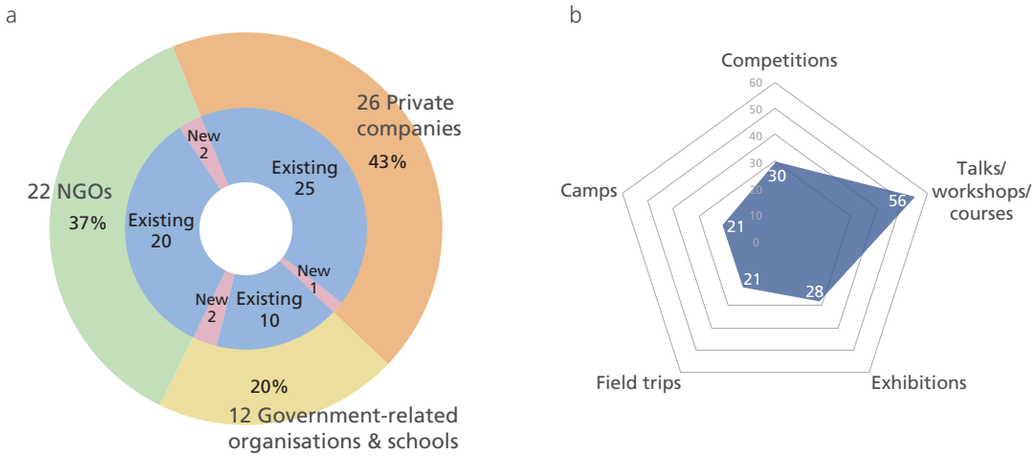


Figure 9. Out-of-school STEM activities organised by survey respondents.
(a) Summary of the 60 complete and valid survey responses. The outer circle shows the type of organiser and the inner circle indicates whether the respondents were new or had organised out-of-school STEM programmes before June 2016.
(b) Type of activities organised by the survey respondents between June 2016 and May 2017.

Promotion of STEM activities and recruitment of participants

The 60 STEM organisers who completed our survey used standard methods to promote their activities. *Figure 10a* shows the different promotion channels they used. 50 out of 60 respondents (83%) promoted their STEM activities on websites, while 49 respondents (82%) promoted through schools. Other promotional methods mentioned include newsletters and brochures.

Most of the organisers promoted their activities one to three months in advance (*Figure 10b*). Only two respondents (3%) promoted their activities more than six months in advance. Some principals and teachers requested earlier notification by organisers so they could have more time to recruit students and prepare for activities. Some school representatives also suggested that the best time for promotion would be at the start of a school year or before long holidays because teachers could pick and plan students' activities in the upcoming academic year or holidays respectively.

According to the organiser survey, most participants were recruited through schools, while individual application was the second most common application method (*Figure 11*).

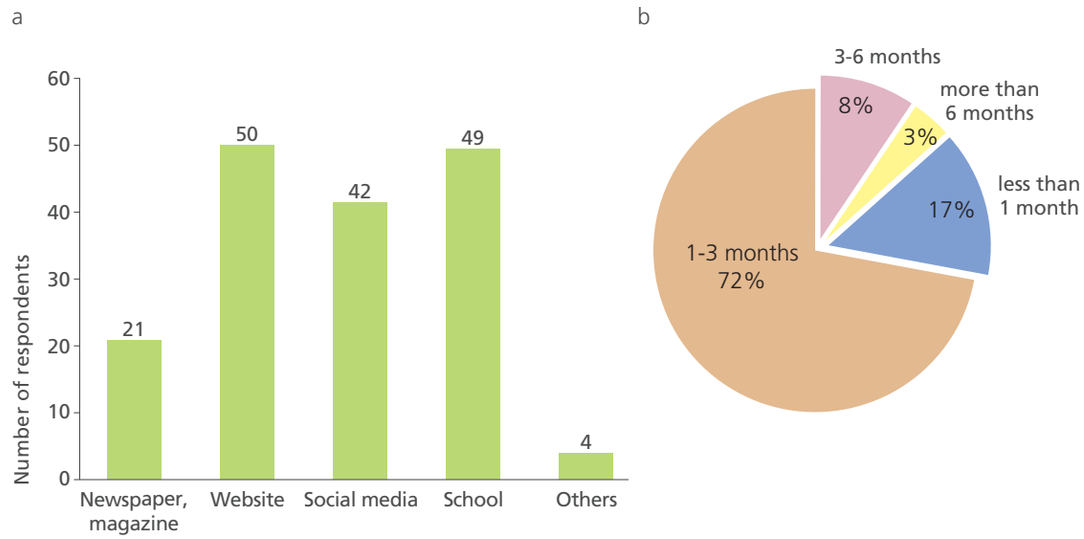


Figure 10. Method (a) and duration (b) of promotion of out-of-school STEM activities by survey respondents.

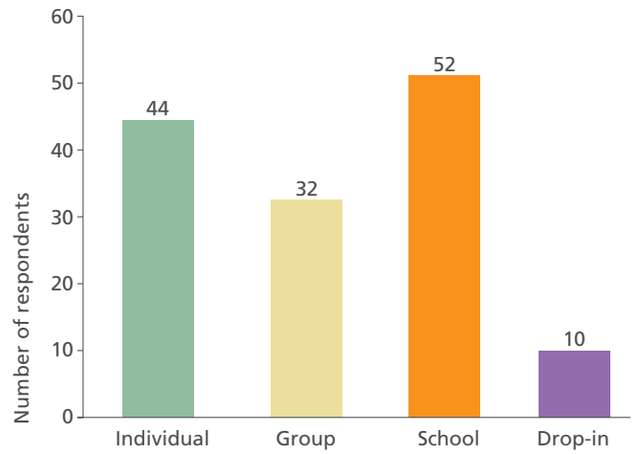


Figure 11. The application methods for the out-of-school STEM activities covered by the organiser survey.

Programme structure and cost subsidy

In focus groups, school representatives pointed out that briefing sessions and preparatory workshops held before out-of-school STEM programmes were very useful both for teachers and participants. We asked organisers about this.

The majority of the organisers offered pre-programme activities. Only nine out of 60 survey respondents did not provide any briefing or training session (*Table 1*). Over 50% of organisers offered training and briefing for participants before their STEM programmes, while 45% of them have offered training or briefing for teachers before their programmes (*Table 1*). This showed a high level of pre-programme support provided by the STEM organisers who completed our survey.

In terms of evaluation, 45 out of 60 respondents (75%) collected feedback from participants, 34 respondents (57%) collected feedback from teachers (*Table 2*). It is surprising that not all respondents evaluated the experience of participants, since customer feedback presumably allows organisers to know more about the needs of participants, and to identify areas of improvement.

In addition, only 25 out of 60 respondents (42%) promoted upcoming events to the existing participants (*Table 2*). This is perhaps a missed opportunity, since existing participants are usually good targets for promotion.

From our survey, 25% of the respondents offered some form of financial subsidy to participants, for instance to cover the cost of materials and equipment, application fee, and/or transport (*Figure 12*). It was not clear from our survey if these subsidies were sustainable.

Type of pre-programme activity	Number of organisers (n=60)
Training for participants	36
Briefing for participants	31
Briefing for teachers	27
Training for teachers	26
No pre-programme briefing/training	9

Table 1. Types of pre-programme activities offered by STEM organisers in the survey. Activities are arranged from most to least common.

Type of post-programme activity	Number of organisers (n=60)
Collection of feedback from participants	45
Collection of feedback from teachers	34
Promotion of upcoming events	25
Sharing session	20
Nomination of participants to other competitions/programmes	13
Overseas exchange tour	10
No follow-up activities	8

Table 2. Types of post-programme activities offered by STEM organisers in the survey. Activities are arranged from most to least common.

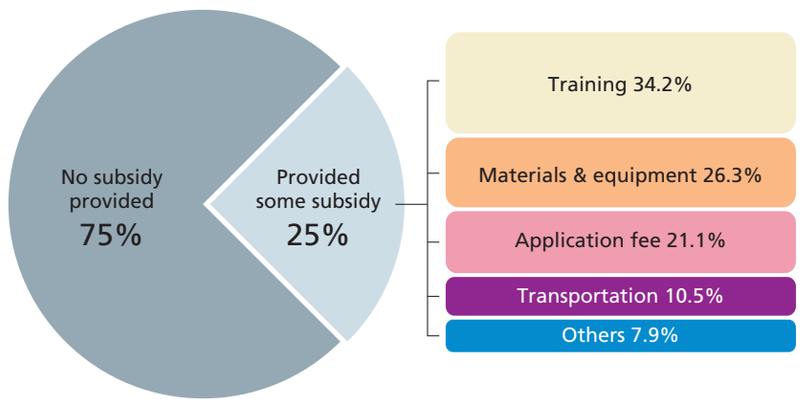


Figure 12. Provision of subsidy by organisers according to survey. Inset shows the types of subsidy offered.

Collaboration between different types of STEM organisers

When organising out-of-school STEM activities, most respondents had cooperated with NGOs (43 out of 60), private companies (35), tertiary institutions (34) or government-related organisations (30) (*Figure 13*). Only six of them did not collaborate with other organisers but all of them would consider collaborating in future, particularly with NGOs (*Figure 13 inset*).

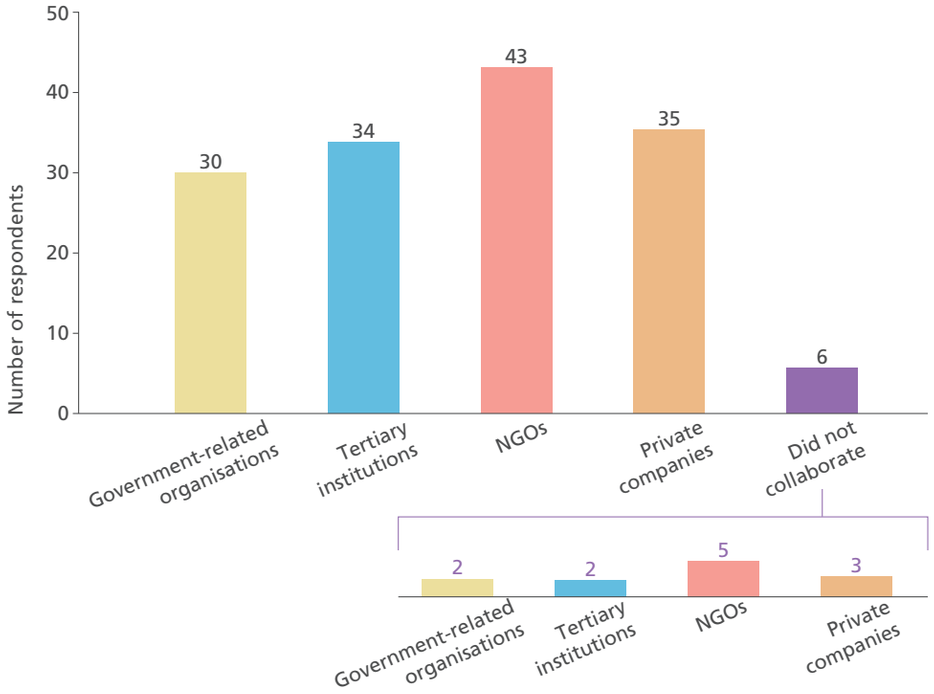


Figure 13. Collaboration between different types of STEM organisers by survey respondents. Inset: Considerations for future collaborations by respondents who had not collaborate with others before.

Significant changes compared to 2015/16

When asked to compare year-on-year, most 2017 respondents reported an increase in both the total number of participants in their STEM programmes and the number of STEM learning programmes they had organised (*Figure 14*). On the other hand, a small number of respondents were faced with dwindling numbers (*Figure 14*). On balance, despite concerns about the very rapid growth of this sector, this appears to be a healthy change.

In general, the challenges organisers faced were similar to last year. In relation both to the planning and execution of STEM activities, organisers reported a slightly more challenging operating environment, in particular in finding and retaining staff (*Tables 3* and *4*).

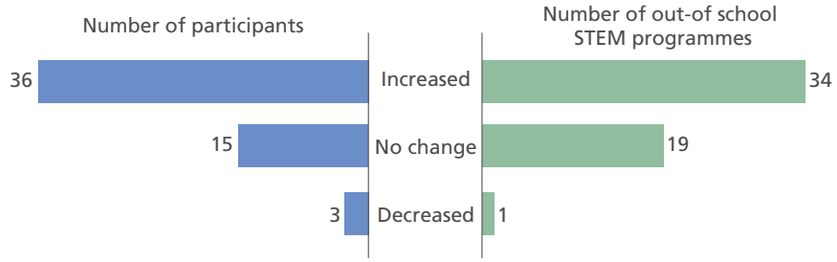


Figure 14. Changes observed by survey respondents in 2016/17 compare to 2015/16 in terms of the number of participants (left) and the number of out-of-school STEM-learning programmes organised (right).

Challenges faced by organisers when planning out-of-school STEM programmes	
Timing (n=43)	3.51 ± 0.67
Human capital (n=46)	3.49 ± 0.84
Venue (n=43)	3.26 ± 0.73
Content design (n=43)	3.25 ± 0.72
Financial resources (n=45)	3.22 ± 0.76
Promotion (n=46)	3.02 ± 0.73

Table 3. Challenges faced by STEM organisers when organising out-of-school STEM programmes. The 54 respondents who had organised out-of-school STEM programmes in 2015/16 and 2016/17 were asked if they faced challenges during design and preparation before the out-of-school STEM programmes over the past year and if so, rate the challenges faced using a 5-point scale (1 being easier than before, while 5 being more difficult). n indicates the number of respondents who reported facing that challenge while the mean rating ±1SD was calculated.

Challenges faced by organisers when executing out-of-school STEM programmes	
Human capital (n=47)	3.43 ± 0.77
Timing (n=42)	3.29 ± 0.64
Financial resources (n=47)	3.21 ± 0.66
Content delivery (n=44)	2.98 ± 0.76

Table 4. Challenges faced by organisers when conducting out-of-school STEM programmes. The 54 respondents who had conducted out-of-school STEM programmes in 2015/16 and 2016/17 were asked if they faced challenges while running and holding the out-of-school STEM programmes over the past year and if so, rate the challenges faced using a 5-point scale (1 being easier than before, while 5 being more difficult). n indicates the number of respondents who reported facing that challenge while the mean rating ±1SD was calculated.

This year representatives from two primary schools and eight secondary schools were interviewed in-person. These discussions enabled us to understand their perception of out-of-school STEM programmes and their rationale in choosing suitable out-of-school activities for students.

In March 2017, the Education Bureau provided a one-off grant of HK$200,000 to each public sector secondary school to facilitate their implementation of STEM, after the provision of a HK$100,000 grant to primary schools in 2016. Most schools used the grant to improve hardware, for instance, to buy new equipment to foster a better STEM learning environment for students. Several schools provided more training for their students and teachers in STEM areas. One school organised interschool STEM activities and overseas field trips to technology-oriented companies and schools so as to increase students' exposure.

It is difficult to estimate exactly how much of the very rapid year-on-year growth of the out-of-school STEM ecosystem was related to these extraordinary grants. From our interviews and focus groups, it does seem that there is a linkage, which raises questions about the sustainability of the current ecosystem.

Out-of-school STEM activities complement in-school STEM activities

Most schools acknowledged the importance of STEM education and that in-school and out-of-school STEM activities served different purposes such that they complement one another. In-school STEM activities target all students in school, and could increase engagement by exposing all students to STEM and providing students with fundamental knowledge.

Schools regarded out-of-school STEM programmes as opportunities to widen students' horizons: students not only meet STEM experts and other participants, but also encounter a wide range of topics outside the regular school curriculum. These opportunities could spark curiosity, reveal students' potential and help them to develop their talent in STEM. Interviewees stated that they invested time in looking for suitable out-of-school activities for students.

Schools consider programme content and nature and students' needs as the main factors in selecting out-of-school STEM activities

Most schools faced challenges in choosing appropriate out-of-school STEM activities for students. Representatives from nine out of the ten schools interviewed studied the nature and content of out-of-school STEM programmes. School representatives stated that both teachers and students preferred to participate in activities that were aligned with the curriculum and/or the school's strengths because of a perception that less time and effort would be required for training and preparation. The format of activities was also considered, as individual-based programmes would allow students to challenge themselves and polish their problem-solving skills, while team-based programmes could encourage participants to work together and learn from each other. Some schools preferred competitions that require students to create a product impromptu within a specified time, where students' problem-solving skills were tested with minimal assistance from teachers and parents. Besides, some schools preferred organisers that could provide training and resources for teachers and participants.

Representatives from seven schools said that student interest was another factor for selection, since intrinsic interest would enhance engagement and achievement in an activity and help to make learning more sustainable. Some schools looked for activities with evidence of a high level of student engagement.

Six schools valued the reputation of an activity and/or the organiser. Some school representatives mentioned that they were more inclined to refer students to recurring and/or large-scale activities, because they were more confident in renowned and experienced organisers.

Three schools also mentioned the importance of rewards, such as visits to renowned companies, shadowing and overseas exchange experiences. These rewards were considered to be more experiential and sustainable for learning, hence more beneficial to students, compared to trophies and certificates.

Two schools discussed the role of teachers in these out-of-school STEM activities. Though teachers might not directly participate in these activities, they play an essential role in teaching related knowledge and guiding students along. Thus, activities were selected based on the availability and qualification of teachers, provided they have sufficient time in their busy schedule on a regular school day.

Students are the customers of out-of-school STEM programmes and a major stakeholder in this STEM ecosystem. We conducted a survey to find out why students joined out-of-school STEM activities. We attempted to gauge their preferences, typical levels of participation, and exposure to different activities. 427 complete and valid responses were collected (*Figure 3*). We also conducted focus group discussions with 71 students to examine their experiences, preferences and reasons for participating in out-of-school STEM activities, and their thoughts on essential elements of a meaningful STEM activity.

Students enjoyed both in-school and out-of-school STEM programmes

61.8% (264 out of 427) of survey respondents knew about STEM education. 64.2% (274 out of 427) joined at least one STEM activity in school in the past year, while 38.9% (166 out of 427) joined at least one STEM activity outside school (*Figure 15*).

Survey respondents who joined STEM activities in the past year had a positive attitude towards the activities in general (*Figure 16*). Some students who participated in focus group discussions reflected that events in school were more popular as they could join with their classmates. Nevertheless, some students believed that their schools had insufficient STEM resources at school. They noted that they often needed to share apparatus and/or equipment. Most students reported that the STEM activities outside their classroom were mainly exhibitions and small-scale competitions with limitations on venue and scale but that these activities did arouse their interest.

On the other hand, students found that the location and timing of out-of-school STEM activities offered more flexibility, with more diversity of activities and more attractive rewards compared to in-school ones. Students thought large-scale activities were more competitive and challenging and promoted knowledge exchange between participants from other schools. Out-of-school STEM activities were perceived to serve as a ladder for students to progress to STEM learning at more advanced levels.

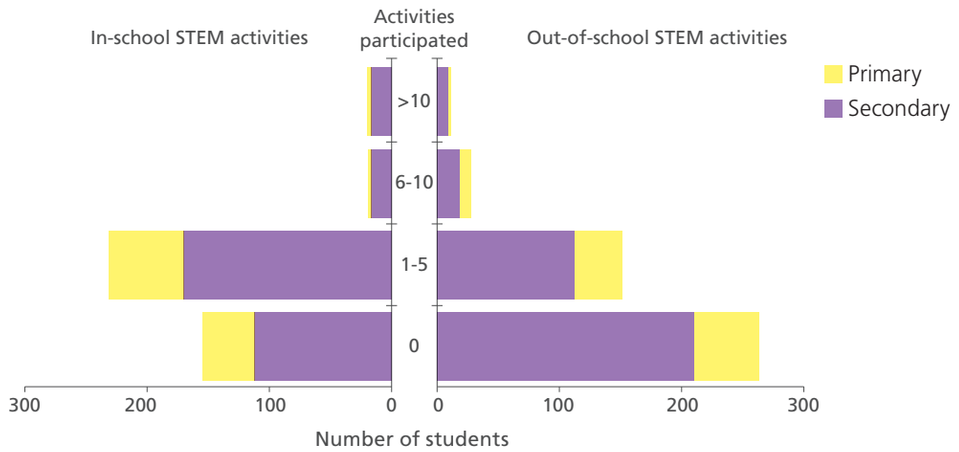


Figure 15. Student participation in in-school and out-of-school STEM activities in 2016/17.

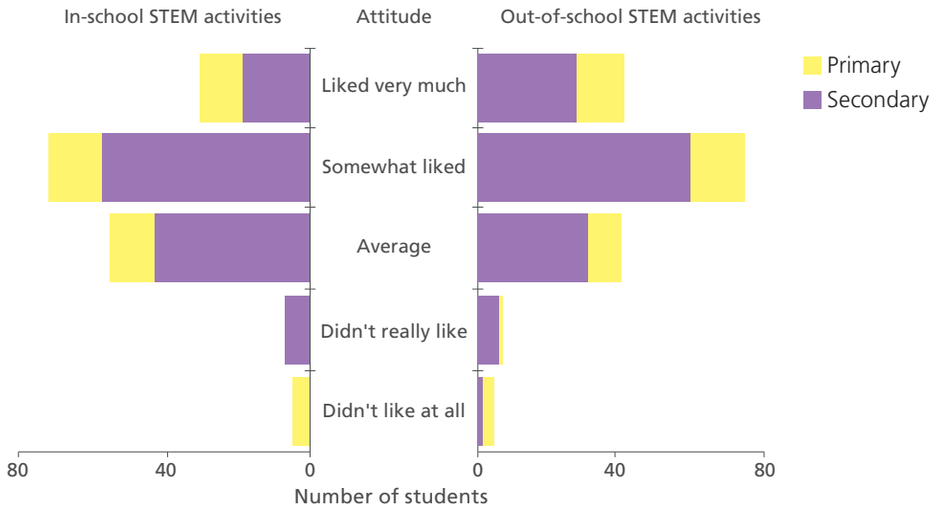


Figure 16. Student's attitude towards STEM activities in-school and out-of-school. Survey responses from 42 primary and 142 secondary students who joined out-of-school activities in the past year were displayed.

Students' personal interests motivated their participation in out-of-school STEM activities, through which they hoped to gain new knowledge and skills

The survey results revealed that students' personal interests were the most decisive factor for both primary and secondary students wishing to join out-of-school STEM activities (*Table 5*). Focus group participants noted that they would be prepared to go to great lengths, overcoming obstacles and barriers, if they were very interested in the activities. This underlines the importance of conducting proper market research, including customer surveys, to determine the particular interests of students.

Students also hoped to gain new knowledge and skills not covered in school (*Table 5*). Secondary school students were often considering applying for undergraduate places in universities, as well as their future career paths, and hoped to join out-of-school STEM activities to gain more experience and enrich their academic portfolios. For instance, some focus group participants said they selected courses and competitions organised by universities because such experience might be taken into account during the application process.

Among the top three expectations of secondary students were to gain new knowledge and skills, and to apply knowledge from the school curriculum (*Figure 17*). These expectations reflected their eagerness to learn, and to put what they know in practice.

Another top expectation was to prepare for their future career (*Figure 17*). They valued more hands-on opportunities and more in-depth understanding about STEM-related industries. Thus, out-of-school STEM activities that gave students practical experience would be more appealing to them. It was encouraging to see that 65.8% (281 out of 427) of all survey respondents would like to study STEM-related subjects in future (*Table 6*). However, only 43.8% (187) were considering STEM-related careers (*Table 7*).

In addition, focus group participants mentioned that encouragement from school, friends and parents served as another source of motivation. The survey revealed that most students participate in out-of-school STEM programmes on their own (*Figure 18a*). Primary students preferred parents' company when they participate in out-of-school STEM activities, in contrast to secondary students' preference (*Figure 18b*).

Motivating factors	Primary (n=92)	Secondary (n=335)
Interest in Science / Technology / Engineering / Mathematics	60.9% (56)	49.3% (165)
Gain knowledge and skills outside the school curriculum	32.6% (30)	40.6% (136)
Enriching portfolio, fulfilling Other Learning Experience (OLE) requirements	32.6% (30)	34.9% (117)

Table 5. Motivations for joining out-of-school STEM activities. Survey respondents had to pick the top three most motivating factors.

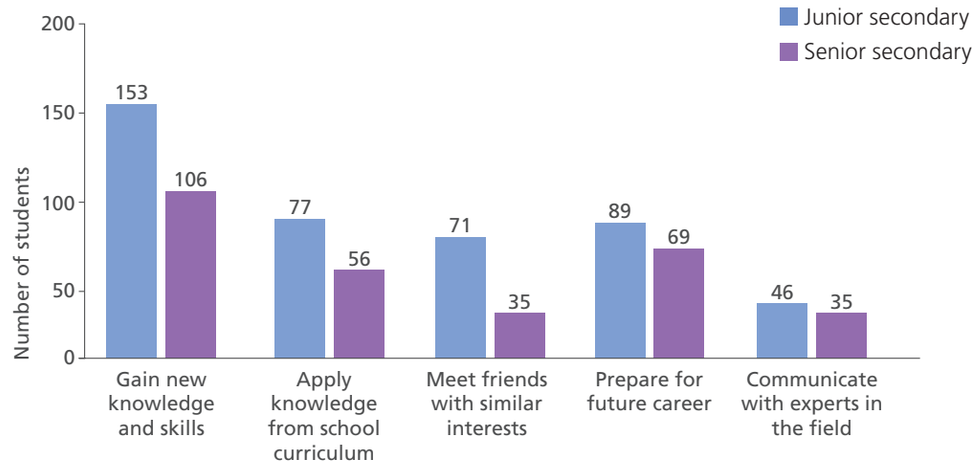


Figure 17. Student's expectations on out-of-school STEM activities. Only secondary students were asked and they were allowed to choose all applicable options.

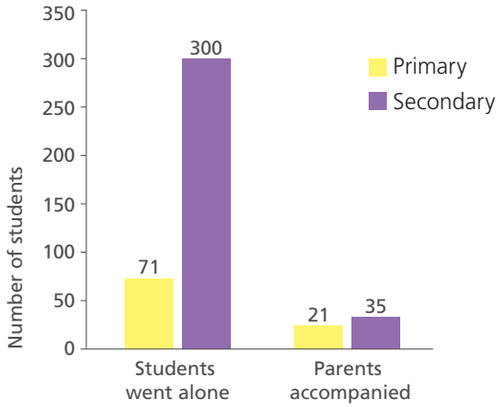
	Primary (n=92)	Secondary (n=335)
STEM-related subjects	68.5% (63)	65.1% (218)
Non-STEM-related subjects	31.5% (29)	34.9% (117)

Table 6. Students' inclination on future subject choices.

	Primary (n=92)	Secondary (n=335)
STEM-related jobs	68.5% (63)	37.0% (124)
Non-STEM-related jobs	31.5% (29)	63.0% (211)

Table 7. Students' future career outlook. Respondents typed out their choice of occupation, which were classified as either STEM-related or non-STEM-related.

a



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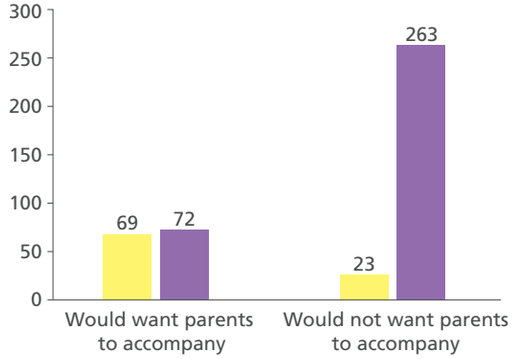


	Primary (n=92)	Secondary (n=335)
Students went alone	77.2% (71)	89.6% (300)
Parents accompanied	22.8% (21)	10.4% (35)
Respondents would want parents to accompany	75.0% (69)	21.5% (72)
Respondents would not want parents to accompany	25.0% (23)	78.5% (263)

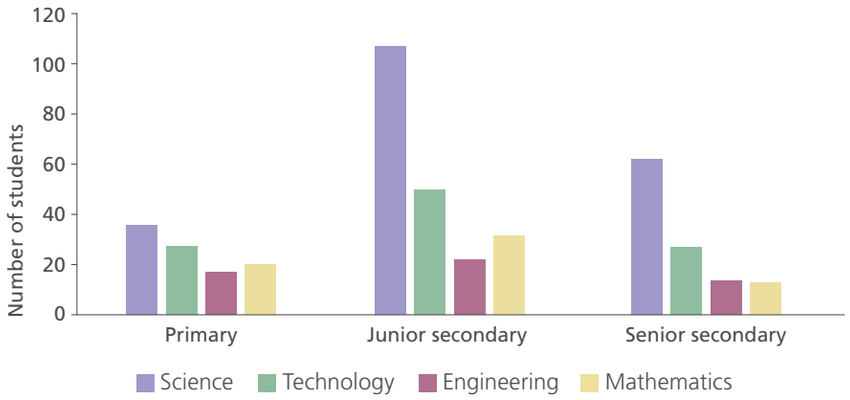
Figure 18. Parents' involvement in student's participation of out-of-school STEM activities and students' preference.
(a) Parents' company in out-of-school STEM activities according to student survey.
(b) Students' preference for their parents' company according to survey.

48.5% (207 out of 427) of the survey respondents preferred science-related activities most, followed by technology, mathematics then engineering (*Figure 19a*). This resembles the pattern of available activities offered by STEM organisers, suggesting that STEM organisers are aware of market demands and are responding in an appropriate way (*Figure 6a*).

Survey respondents were also asked to rank their preference for various types of activities, and their ranking was converted to scores. Camps were found to be most popular among students, whereas talks, courses or workshops had the least relative popularity (*Figure 19b*). Focus group participants preferred activities that took place outside the classroom, and reflected that talks, courses and workshops often took place indoors and resembled regular school lessons, which were considered to be more instructional, with less student interaction, and hence less interesting.

Secondary students were further asked about their preference of activity type for each specific field of STEM. The most popular type of science-related activity was camps, followed closely by competitions; technology-related exhibitions and competitions were ranked top two places in popularity; engineering-related camps and mathematics-related competitions were most popular in these respective fields (*Table 8*). Focus group participants said they like to test and apply the knowledge they acquired at school by joining out-of-school competitions. Meeting and competing with participants from other schools facilitate knowledge exchange, allowing them to learn from each other and improve themselves. They also value opportunities where they could find out about their weaknesses, especially through advice from judges and STEM experts, as well as comments from other participants in competitions.

a



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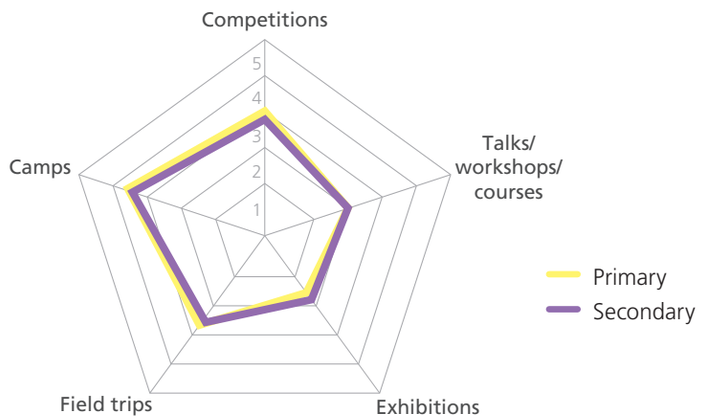

Figure 19. Student's preference for different out-of-school STEM programmes.
(a) Student's preference according to the nature of activity.
(b) Student's preference according to the type of activity. The average scores for competitions, talks/courses/workshops, exhibitions, field trips and camps are 3.01, 2.41, 2.73, 3.23 and 3.62 respectively, calculated with 5 being the top and 1 being the bottom.

STEM area (n=335)	Science	Technology	Engineering	Mathematics
Talks/courses/workshops	16.4% (55)	14.9% (50)	19.1% (64)	22.7% (76)
Competitions	**26.0% (87)**	**23.3% (78)**	17.9% (60)	**34.6% (116)**
Exhibitions	17.6% (59)	**24.5% (82)**	20.9% (70)	10.7% (36)
Field trips	12.8% (43)	16.4% (55)	16.1% (54)	12.8% (43)
Camps	**27.2% (91)**	20.9% (70)	**26.0% (87)**	19.1% (64)

Table 8. Student's preference according to the type of activities for each area of STEM.
Only secondary students were asked.

Students' busy schedules prevented participation in more out-of-school STEM programmes

When asked about the barriers they encountered in joining out-of-school STEM activities, primary and secondary respondents selected the same top four barriers: almost half of the respondents reported that insufficient time as an obstacle, followed by lack of interest, lack of confidence in STEM subjects, and cost (*Table 9*).

Many focus group participants, especially senior secondary students, hesitated when asked to join out-of-school STEM programmes due to their busy learning schedules and the pressure of preparing for public examinations. Some students commented that in cases when schools nominated candidates (for example for competitions), priority was given to students with better academic performance, rather than those who had interest or talent in the subject.

Just as interest was a motivation (*Table 5*), it was also a barrier. A lack of genuine interest could affect whether students enjoyed these activities. Cost was also a consideration as about 30% of student respondents commented that they were not able to afford to join activities and/or looked for low-cost activities.

Most survey respondents reported that they heard about out-of-school STEM activities from their school or teachers (*Figure 20*). Although some students mentioned that they would search for activities on their own, many relied on their schools as their only information channel. Some of them said that they were unable to join certain activities because they missed important details like application deadlines. Respondents suggested that schools could help by providing timely information on suitable activities.

Barriers	Primary (n=92)	Secondary (n=335)
Insufficient time	48.9% (45)	46.0% (154)
Not interested	32.6% (30)	33.4% (112)
Lack of confidence in STEM subjects	32.6% (30)	29.3% (98)
Cost	31.5% (29)	27.5% (92)

Table 9. Barriers encountered by students in participating in out-of-school STEM activities.

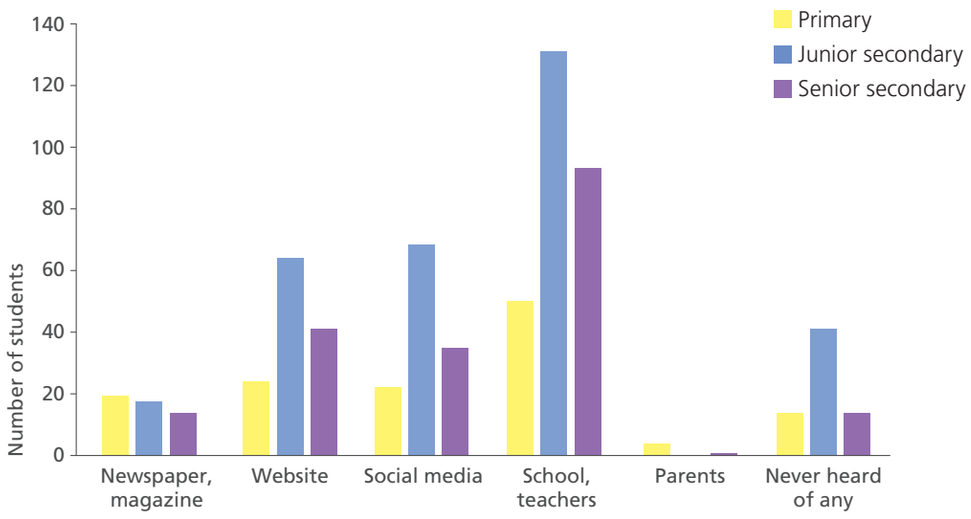

Figure 20. Sources of information about out-of-school STEM programmes according to student survey.

Students were concerned about their language proficiency and content of the out-of-school STEM activities

Some focus group participants reported that they faced difficulties during out-of-school STEM programmes, namely in the language medium of instruction, level of content and a lack of support. Activities conducted in English only posed a significant challenge for some students who felt that they could not perform their best when they did not fully understand the rules, guidelines and instructions. In this regard, students suggested that bilingual education would help.

Other than language proficiency, some found that the knowledge required in certain out-of-school STEM activities did not match their own level of competence. Students pointed out that some activities were too advanced, even for their teachers. Hence, they could neither relate the tasks with their prior knowledge nor acquire new knowledge.

Some students who encountered difficulties during activities commented on a general lack of responsiveness among STEM organisers. The action taken by organisers, after being informed by participants of difficulties, was not specific enough and in some cases not timely. This suggests that STEM organisers should from time to time review their customer relationship management processes.

Students' ideas of meaningful and enjoyable STEM activities

Theme

Students preferred a wide range of topics and the integration of different areas of STEM. They noted that the application of knowledge in daily life often requires knowledge from multiple disciplines. When students encountered an appealing theme, they would work hard to overcome other difficulties such as time and academic pressure.

Timing

Students preferred activities to be held during the summer holidays or at the start of a school term, when they were less busy. Some students suggested that it would be helpful to receive information about the activities before the long summer holiday, so that they could use their time more effectively once the academic year started.

Format

Students preferred diverse and interactive pedagogical approaches to monotonous presentations, especially in mathematics- and technology-related fields. They noted that hands-on and experiential formats facilitated their learning. In order to gain more knowledge, some students said they would like to join a series of talks or courses rather than one-off activities.

Programme

Many students placed emphasis on orientation sessions and preparatory workshops. They noted that these could help them to understand the content of the activity and how to prepare. Some students suggested that, for a typical activity, the ratio between instructors and students should be smaller. Sharing sessions and communication platforms could be set up during the activity to foster the exchange of ideas and to allow participants to stay in touch with each other. These recommendations reflect the emphasis placed by students on the continuous support of the organiser before and throughout the activity and during the period after the activity.

Rewards

Students appreciated activities with opportunities to go overseas, visits to renowned companies or shadowing experiences at universities because these rewards were much more inspiring and valuable than merely cash rewards or certificates.

We conducted a survey to find out about the attitude of parents towards STEM education, their level of involvement in selecting activities for their children and their criteria for selection. 200 complete and valid responses were collected (*Figure 3*). We also conducted focus group discussions with 19 parents from four primary and secondary schools to examine their role and level of engagement in STEM education, as well as their expectations in out-of-school STEM activities.

53.5% (107 out of 200) of the survey respondents knew about STEM education. Parents received information about out-of-school STEM programmes mainly from school (*Figure 21*). It was noted by parents that some schools have e-platforms with promotional information on activities including STEM activities. Some parents also reflected that they heard about STEM from their children. Those who had never heard about STEM claimed a lack of access to information about STEM and related out-of-school activities.

51.5% (103 out of 200) of the parents surveyed did not regularly get involved in making decisions about out-of-school activities for their children, but let children and teachers decide (*Figure 22*). Focus group participants stated that often they were not familiar with the content of activities or the underlying knowledge. Nonetheless, they wanted their children to participate in more out-of-school STEM activities. Some parents relied on teachers to provide guidance and assistance to students. Many parents said they would discuss and choose activities with their children but would not force them to join unless they had a genuine interest.

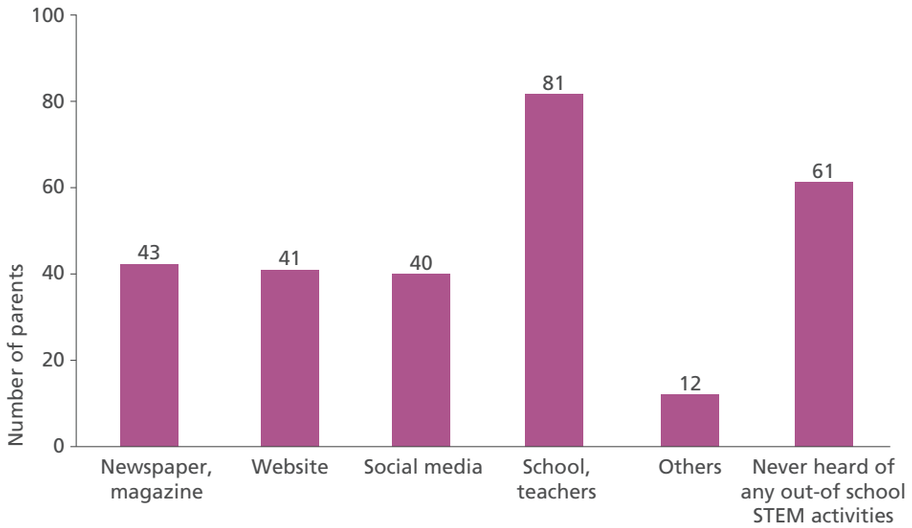

Figure 21. Sources of information about out-of-school STEM programmes according to parent survey. Parents were allowed to select multiple options.

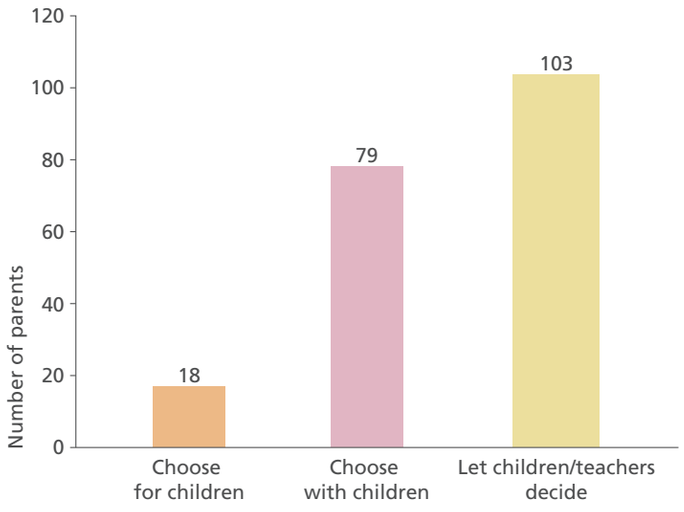

Figure 22. Parents' involvement in choosing out-of-school STEM activities for their children.

Many parents considered out-of-school STEM programmes to be important to their children

69.5% (139 out of 200) of the survey respondents thought that out-of-school STEM activities were important to their children. Parents ranked STEM just below languages, among other out-of-school activities (*Table 10*).

Parents believed that out-of-school STEM activities could enhance critical thinking, analytical and problem-solving skills, and arouse interest in STEM-related subjects (*Table 11*). The content of an activity was considered to be the most important selection criteria, followed by location and duration of the activity (*Table 12*).

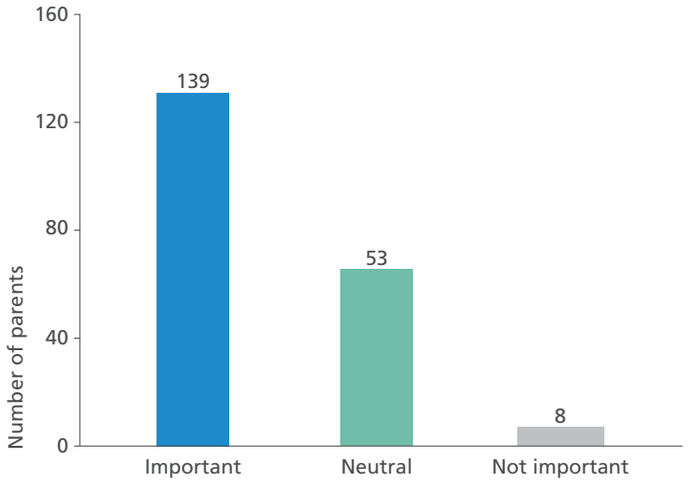

Figure 23. The importance of out-of-school STEM activities from parents' perspective according to survey respondents.

Ranking	Activities	Score (Mean ± 1SD)
1	Languages	3.76 ± 1.44
2	**STEM**	**3.61 ± 1.14**
3	Sports	3.09 ± 1.25
4	Music	2.31 ± 1.31
5	Arts	2.24 ± 1.19

Table 10. Parents' ranking of out-of-school activities in survey. The 200 parents were asked to rank five types of activities according to importance (Most important: 5, least important: 1).

Benefits	(n=200)
Enhance critical thinking and analytical skills	**71.5% (143)**
Arouse interest in STEM-related subjects	**60.5% (121)**
Enhance problem-solving skills	**56.0% (112)**
Strengthening communication skills	40.0% (80)
Enrich portfolio	37.0% (74)
Improve academic results in STEM-related subjects	25.5% (51)
Enhance parent-child relationship	17.5% (35)

Table 11. Benefits of out-of-school STEM activities from the perspective of 200 parents. Survey respondents were allowed to select up to three options.

Criteria	(n=200)
Content	**72.5% (145)**
Venue	**55.5% (111)**
Duration	**51.5% (103)**
Cost	46.0% (92)
Enrich portfolio	46.0% (92)
Reputation of activity/organiser	34.0% (68)
Complement with in-school curriculum	40.0% (80)

Table 12. Selection criteria of out-of-school STEM activities according to 200 parents in survey. Survey respondents were allowed to select multiple options.

Many parents wanted their children to join more out-of-school STEM activities and can do more to motivate them

93.5% (187 out of 200) of the parents said they wanted their children to join more out-of-school STEM activities (*Figure 24*). However, only 57.5% (115 out of 200) actually encouraged their children to join more, and even fewer (46.6%) accompanied them to the activities (*Figure 24*).

The parents who did not accompany their children explained that activities were often not designed for parents' participation, that sometimes their children preferred to go on their own, and that, as parents, they lacked time, related knowledge or interest in the activities (*Table 13*). Some parents who participated in focus group discussions commented that the only involvement they could provide was emotional support instead of physical participation. Some also mentioned that they were not aware that parents could join children in activities, and only found out after the event.

The survey revealed that a higher proportion of parents accompanied their children to the activities if their children were at primary school compared to those at secondary school (*Figure 25*). This matches the findings from the student survey where primary students preferred parents' company more than secondary students, who did not want their parents to accompany them (*Figure 18*).

74% (43 out of 58) of parents had held discussions with their children to learn about the activities after they had taken place.

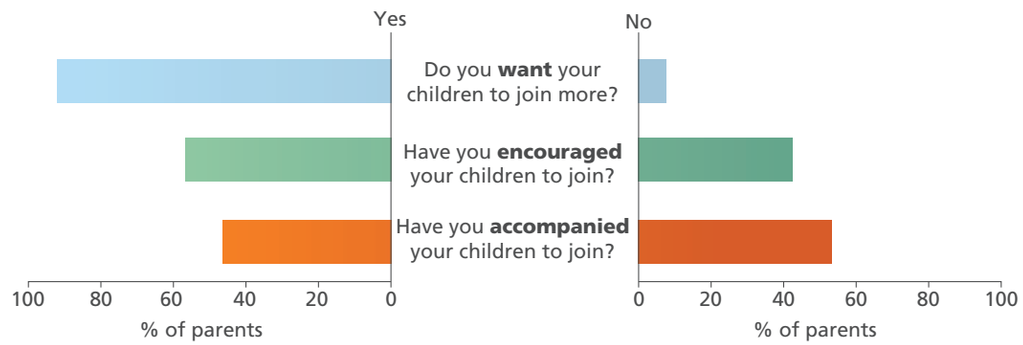

Figure 24. Parents' stance and actions taken in regards to their children joining out-of-school STEM activities. 187 survey respondents wanted their children to join more out-of-school STEM activities and 115 encouraged their children to do so (n=200). Only 58 survey respondents' children had participated in out-of-school STEM programmes in 2016/17 and 27 of them accompanied their children to the programmes.

Reasons	(n=31)
Activities not designed for parents' participation	51.6% (16)
Child/children prefer to join alone	22.6% (7)
No time	19.4% (6)
No related knowledge	16.1% (5)
Not interested	6.5% (2)

Table 13. Reasons why parents did not accompany their children to out-of-school STEM activities, according to survey respondents. Survey respondents were allowed to select multiple options.

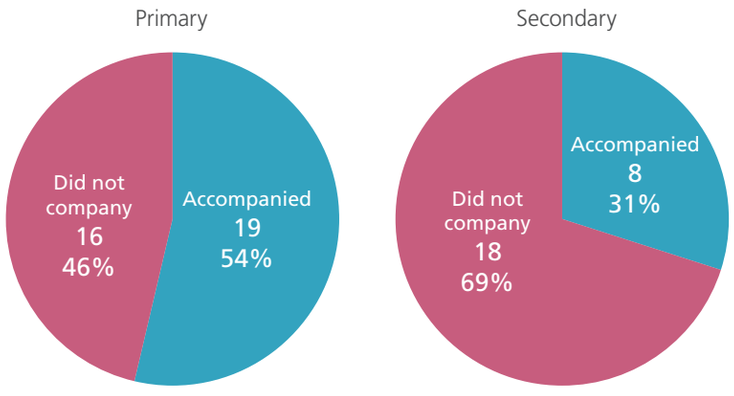

Figure 25. The percentage of parent company in children's participation of out-of-school STEM activities, among students who participated in out-of-school STEM activities over the past year.
(a) Parents of primary students accompanying their children to out-of-school STEM activities (n=35).
(b) Parents of secondary students accompanying their children to out-of-school STEM activities (n=26).

In summary, we have taken a twelve-month period from June 2016 to May 2017 and produced a map of the out-of-school STEM ecosystem in Hong Kong. This is the second annual mapping exercise conducted by the Croucher Foundation, using the same methodology, allowing us to make some comparisons.

The study covers the nature, type, and target age groups of these out-of-school STEM activities, as well as the extent of collaboration between different organisers. Digital maps generated from this dataset show the geographical distribution of these activities and their organisers.

In addition to conducting extensive desk research, to obtain views from different stakeholders, namely the organisers, schools, parents and students, online surveys and in-person focus group discussions and interviews were conducted.

The following sections aim to provide a comprehensive overview of the findings.

Out-of-school STEM activities were highly valued by students and parents

This study finds that students and parents had similar expectations on out-of-school STEM activities: students hoped to gain new knowledge, apply what they learnt and prepare for their future career (*Table 5 and Figure 17*); parents believed that children could be equipped with critical thinking, analytical and problem-solving skills via the activities (*Table 11*). These views are supported by research which suggests that physical experiences enhance STEM learning as they often facilitate active learning, make learning more relevant and allow participants to acquire new knowledge and experience with on-the-spot investigations (Kontra, Lyons, Fischer & Beilock, 2015).

School representatives and students noted the usefulness and importance of briefing and preparation, in particular for STEM competitions. It is likely that such pre-programme support enhances learning and the performance of participants in the programme.

There were more technology-related courses and exhibitions as well as mathematics competitions offered in this study period, which indicates that organisers are working effectively to anticipate and meet student needs (*Table 8*).

Students generally prefer camps and field trips (*Figure 19 and Table 8*) but very few STEM-related camps and field trips were held in 2016/17 (*Figure 6c*). This indicates a possible area of focus for STEM organisers in future.

Collaboration between organisers has strengthened compared to our previous study period (*Figure 5b*). Many organisers have worked in partnership and others have stated that they would consider collaborating in the future (*Figure 13*). Coordination between different stakeholders enhances knowledge exchange and the sharing of resources and expertise.

Parents could actively and significantly contribute to students' STEM learning

Although parents value out-of-school STEM activities, some parents reflected that they had a relatively passive role in helping their children in the activities as they might not possess relevant knowledge or did not have sufficient time to accompany their children. Parents believed that few activities are designed to allow them to join in, and were concentrating on providing emotional and financial support. In contrast, this study revealed that students, especially primary students, would prefer parents to participate if possible. Parental involvement is especially important for primary students (Jeynes, 2005) and can directly influence students' academic motivations and achievement (Simpkins, Fredricks & Eccles, 2012).

Many parents relied on their children's school to select activities (*Figure 21*) but parental involvement could motivate students to join out-of-school STEM activities. For instance, parents could bring students to visit exhibitions and museums or join parent-child workshops associated with STEM.

It is recommended that parents actively communicate with students before and after the activities even when they could not participate with them. Besides, parents could help establish a home environment with STEM elements by encouraging students to observe, ask questions and formulate hypotheses and when possible, test their hypotheses. Simple encounters and childhood experiences have a strong influence in the relationship of a student with STEM subjects (VanMeter-Adams, Frankenfeld, Bases, Espina & Liotta, 2014).

Schools play an essential role in promoting out-of-school STEM programmes

This study showed that schools provide the main channel through which both students and parents learn about out-of-school STEM programmes (*Figure 20* and *Figure 21*). Organisers are aware of this channel and promoted out-of-school STEM activities through schools (*Figure 10a*). Schools could help by providing more timely information on suitable activities to students and parents.

Teachers who support and select suitable STEM education activities could influence students' commitment and motivation in pursuing STEM subjects and ultimately a STEM-related career (Subotnik, Tai, Rickoff & Almarode, 2009). Teachers' knowledge, experience and encouragement could also stimulate students' interest in joining out-of-school STEM activities (Sjaastad, 2012).

Teachers from some schools formed a STEM team in order to utilise the knowledge and expertise of teachers with different specialisms. This allows teaching personnel to share their workload. With the packed teaching schedule, care should be taken to minimise resources and extra workload.

Peer influence could also be a motivating factor for students in deciding whether to join an out-of-school STEM activity (Albert, Chein & Steinberg, 2013). Some students preferred group-based competitions and they would join events together upon friends' invitation or encouragement. Meeting new friends was another driving force (*Figure 17*). Students probably regarded these out-of-school programmes as opportunities to meet friends with similar interests and expand their social circle.

The study reveals once again a rich and vibrant ecosystem for out-of-school STEM education in Hong Kong with almost 2,000 discrete activities covering a very wide range of scientific disciplines.

Students continue to have excellent access to online resources and can easily keep up-to-date with the latest news and developments in STEM. Hong Kong has a tradition of manufacturing, and is geographically close to some of the world's most advanced research and manufacturing facilities. Compared with their peers in the region, and internationally, Hong Kong students achieve excellent academic results in STEM-related subjects (Lun et al., 2016).

The Hong Kong SAR Government has allocated significant new resources and, on 11 October 2017 in her policy address, the Chief Executive Mrs Carrie Lam reiterated the commitment of her administration to the development of STEM education in Hong Kong.

The Hong Kong STEM Network, an informal gathering of STEM providers was launched in April 2017. From the inaugural meetings of the network, and the findings of the mapping exercise, it is clear that STEM organisers are open to collaboration and are enjoying finding new ways to share information and resources.

Sustainability of the out-of-school STEM ecosystem in Hong Kong

The STEM learning ecosystem in Hong Kong has experienced a period of significant growth. From 2016 to 2017, we observed a 76% increase in the number of activities available to school students, and an even larger increase - from 144 to 350 - in the number of organisations offering out-of-school STEM activities in Hong Kong.

This extraordinary period of growth appears to have been driven in part by special one-off grants offered to schools by the Hong Kong SAR government, and must raise questions about the sustainability of the ecosystem in its current configuration.

The findings of this most recent mapping exercise suggest some positive steps which STEM organisers may consider taking to sustain and further strengthen the ecosystem in future years:

More systematic promotion

Our findings suggest that both schools and STEM organisers could benefit by adopting a more systematic framework for the promotion of out-of-school STEM activities.

Simple improvements suggested by teachers, students and parents include:

- aligning promotions to the school timetable
- promoting to existing participants
- ensuring that each course is evaluated by participants with a view to identifying compelling new topics and themes
- making use, where possible, of e-platforms operated by schools.

The Hong Kong STEM Network, launched by the Croucher Foundation in 2017, is building its own promotional platform, including a live digital map, which may in future years become a useful resource.

Affordability

61% of students surveyed took part in no out-of-school STEM activities during the period of the mapping exercise. 30% cited cost as one of the major barriers to participation. There is perhaps space, within the ecosystem, for innovative low-cost strategies.

Business strategy and improvements in design of products

The findings of the mapping exercise point towards several practical steps which STEM organisers could consider taking to improve the design of activities:

- offer more complex events, including camps and field trips, rather than classroom-based activities (may require forming partnerships and strategic alliances)
- work with teachers and government to align activities with the school curriculum
- build in simple experiential rewards (these do not need to be expensive or elaborate)
- where possible improve the instructor to student ratio
- teach bilingually or in Cantonese
- use social media and other communication platforms to build communities of participants which endure beyond the end of the activity
- use better customer relationship management systems and processes
- advertise more emphatically opportunities for parents to become involved
- design activities for all levels of ability, not only the academically gifted

Under very strong growth conditions, such as those experienced over the past two years, some of these measures may not appear to be necessary. Nonetheless, it would be prudent to plan for a future consolidation, and in any case the comments and suggestions of students, teachers and parents should provide a valuable point of reference.

Untapped demand

The vast majority of the parents we surveyed (94%) would like their children to participate in more out-of-school STEM activities. Although there has been very rapid growth in provision over the past year, there is nothing in the findings over mapping exercises to suggest that demand for out-of-school STEM activities in Hong Kong has been exhausted.

Building human capital

According to our findings the number of organisations providing out-of-school STEM activities increased by almost 150% from 2016 to 2017. Our most recent mapping exercise identified 350 STEM organisers in Hong Kong. It is therefore not surprising that STEM organisers have found it difficult to recruit suitably qualified facilitators, and cited this as one of the main challenges they face in delivering out-of-school STEM activities. Our mapping exercise excluded organisations offering tutorials and exam-orientated courses, which may also be competing for staff within this segment.

The Hong Kong STEM Network is an informal gathering of STEM organisers launched by the Croucher Foundation in April 2017. The Croucher Foundation is building an intranet site for the Hong Kong STEM Network. This will include a jobs section, allowing members of the network to advertise available positions, and discuss human resource issues more generally. In 2017, the University of Hong Kong, in partnership with the Australian National University, launched a part-time Master of Science Communication. Other countries have reasonably well developed networks of science communicators, including museum staff, with professional backgrounds in either science or education.

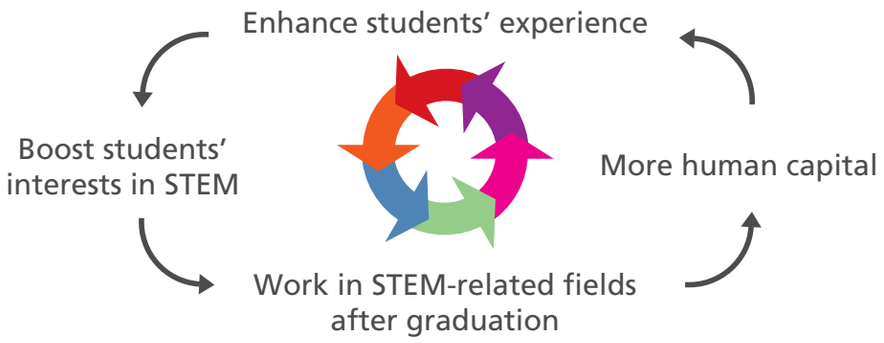

Figure 26. Positive feedback cycle for strengthening the out-of-school STEM ecosystem in Hong Kong.

Set against this, the use of social media in Hong Kong, and a growing network of co-working spaces, maker spaces, and incubators, appears to have simplified the process of running out-of-school STEM activities with programmes including, for example, #GirlsMakeTech and Café Scientifique placing Facebook pages and/or YouTube channels at the core of their operations. In the longer term, as students experience well designed STEM activities, and develop a love of science, it is likely that more of them will study STEM subjects at a higher level and may eventually consider a career in science communication (*Figure 26*).

Towards a stronger, more coordinated, out-of-school STEM ecosystem

The Croucher Foundation trusts that this snapshot of the out-of-school STEM learning ecosystem, with its associated digital maps, will be a useful resource for students, parents, teachers, STEM programme providers and education policy makers in Hong Kong. It is encouraging that, our second mapping exercise revealed more systematic collaboration between providers of STEM learning activities. Future versions of the mapping document will enable us to chart the STEM ecosystem as it evolves and, through the concerted effort of the STEM education community, as it strengthens over time (*Figure 27*).

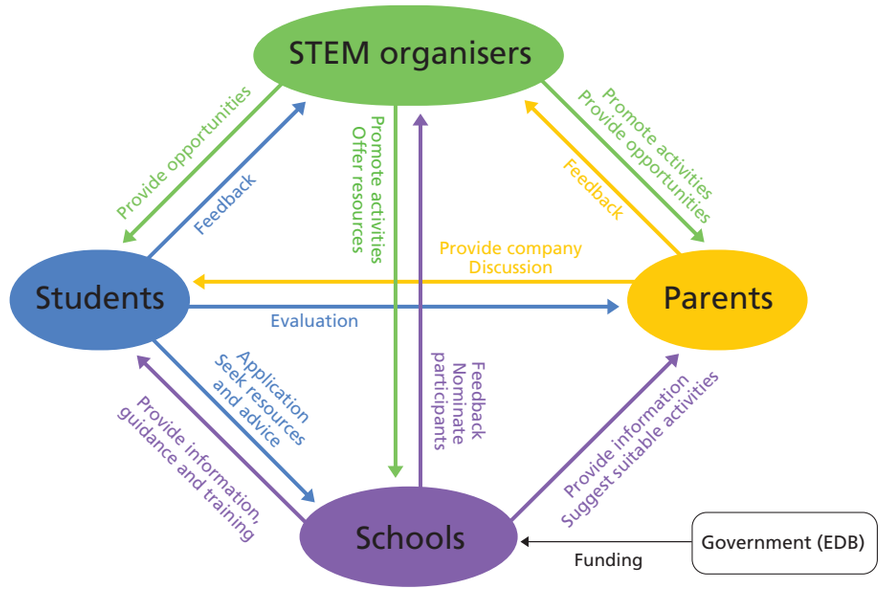

Figure 27. The roles of different stakeholders in the out-of-school STEM ecosystem in Hong Kong.

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King's College
Lions College
Pui Ching Middle School
Sai Kung Sung Tsun Catholic School (Secondary Section)
St. Bonaventure Catholic Primary School
St. Paul's Co-educational College

3C Thinkers Foundation Ltd
3D Roundhouse Ltd
A Star Coding Ltd
Binary Creation Ltd
Creative Coding HK Ltd
CreativeKids
Discovery Technologies Ltd (DTSL Group)
EduCoach
Electronic Technology (Int'l) Co. Ltd
Environmental Association Ltd
ETC Educational Technology Connection (HK) Ltd
Everbest Technologies Ltd
Fatbars Ltd
Firefly Conservation Foundation
First Code Academy
FLYHI Education Ltd
Future Leaders Academy
Galaxy Scientific Group
Hong Kong Association for Science and Mathematics Education
Hong Kong New Generation Cultural Association Science Innovation Centre
Hong Kong Science and Technology Parks Corporation
Hong Kong Wetland Park
i-education
ICT-in-PE Foundation
Institution of Engineering and Technology Hong Kong
Kapok Classroom
Outdoor Wildlife Learning Hong Kong
Pigeon City Technology (HK) Ltd
Plastic Free Seas
Popular Science Education Foundation Ltd
Sai Kung District Community Centre
Science Workshop
Science World Ltd
Semia Ltd
Sik Sik Yuen Biotechnology MobileLab Program
Smart Kiddo Education Ltd
Sunny Talent Education HK
The Chinese University of Hong Kong
The Genius Workshop
The Hong Kong Academy for Gifted Education
The Hong Kong Association for Computer Education
The Hong Kong Polytechnic University
The Hong Kong University of Science and Technology
The International Society of Arboriculture Hong Kong Chapter
The University of Hong Kong
WEWALab
World Class Arena
World Wide Fund For Nature Hong Kong

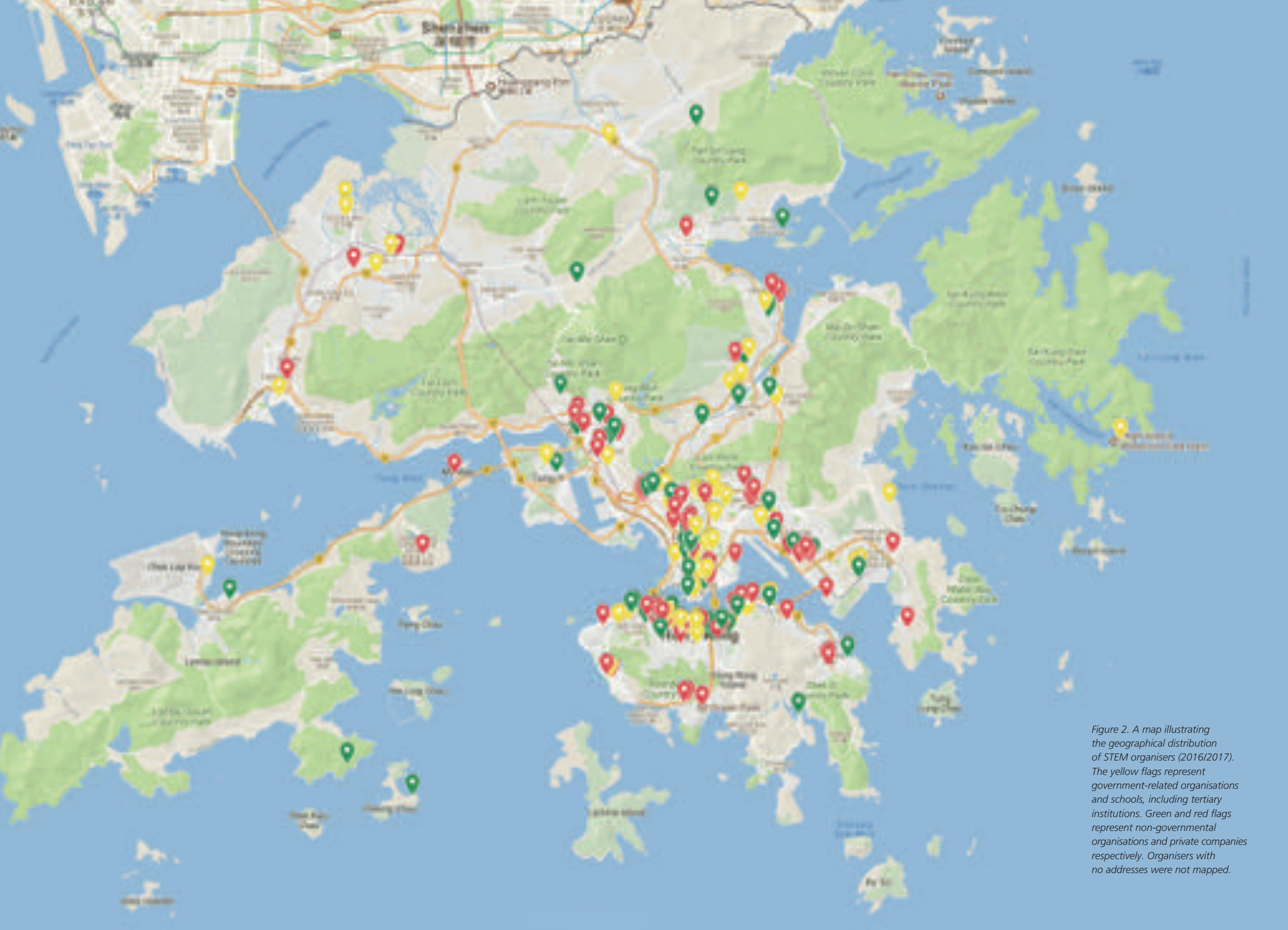

Figure 2. A map illustrating the geographical distribution of STEM organisers (2016/2017). The yellow flags represent government-related organisations and schools, including tertiary institutions. Green and red flags represent non-governmental organisations and private companies respectively. Organisers with no addresses were not mapped.