

STEM Education Learning Report

Social Investments in Science, Technology, Engineering and Mathematics Education by BG Group plc



Evidence for
Excellence in
Education

BG GROUP'S INVESTMENTS IN STEM EDUCATION 2011-13

Science
Technology
Engineering
Mathematics

WHY STEM EDUCATION?

SUPPORTING GOVERNMENTS:

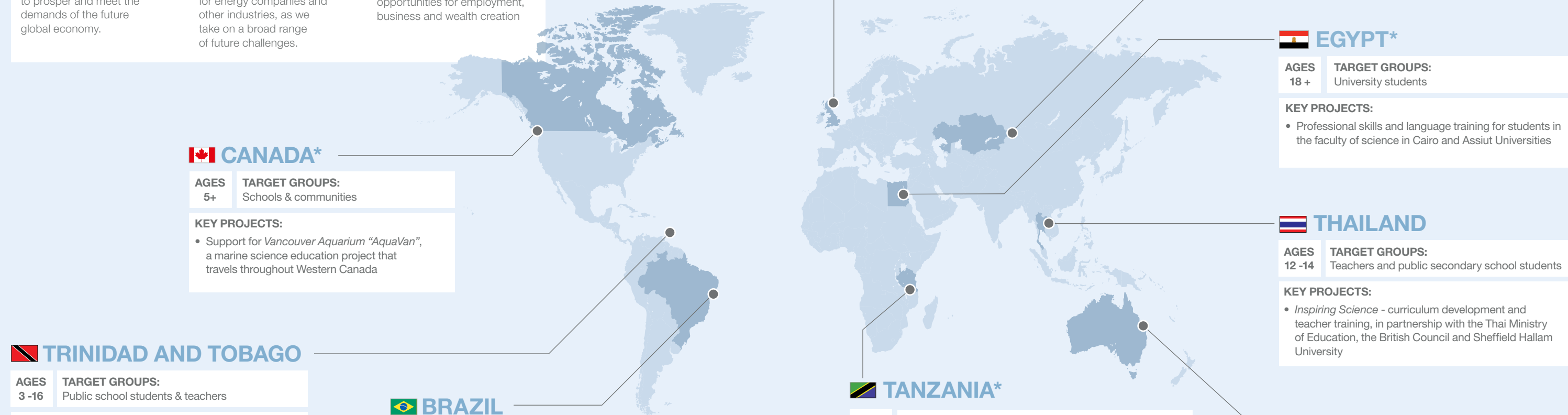
Developing a workforce with STEM skills and qualifications, to prosper and meet the demands of the future global economy.

DEVELOPING CAPABILITIES:

STEM-qualified professionals and technicians are crucial for energy companies and other industries, as we take on a broad range of future challenges.

DELIVERING ENDURING SOCIO-ECONOMIC BENEFITS:

Social mobility and opportunities for employment, business and wealth creation



CANADA*

AGES
5+

TARGET GROUPS:
Schools & communities

KEY PROJECTS:

- Support for *Vancouver Aquarium "AquaVan"*, a marine science education project that travels throughout Western Canada

TRINIDAD AND TOBAGO

AGES
3 -16

TARGET GROUPS:
Public school students & teachers

KEY PROJECTS:

- *BG Trinidad and Tobago Science Bus* – science learning outreach since 2000
- *STEMagination* - science teacher training in partnership with the University of the West Indies School of Education

BRAZIL

AGES
7+

TARGET GROUPS:
Public school students, teachers and university researchers

KEY PROJECTS:

- "End-to-end" investments from primary school science programmes through to university fellowships
- Targeting selected locations with a connection to the oil and gas industry (Rio de Janeiro, Angra dos Reis, Rio Grande)

UK

AGES
10-18

TARGET GROUPS:
Students & teachers (focus on under-represented groups)

KEY PROJECTS:

Working with leading STEM education partners across the UK:

- Royal Academy of Engineering
- Science Museum London
- Aberdeen City Council
- Exscitec Ltd, Imperial College and the National Oceanography Centre
- Darwin Centre for Biology and Medicine

KAZAKHSTAN*

AGES
18+

TARGET GROUPS:
University students & researchers

KEY PROJECTS:

- Support for the *Nazarbayev University Research and Innovation System*
- Post-graduate scholarships in science, energy studies, and sustainability
- Support for Kazakh National Technical University (Society of Petroleum Engineers)

EGYPT*

AGES
18+

TARGET GROUPS:
University students

KEY PROJECTS:

- Professional skills and language training for students in the faculty of science in Cairo and Assiut Universities

THAILAND

AGES
12 -14

TARGET GROUPS:
Teachers and public secondary school students

KEY PROJECTS:

- *Inspiring Science* - curriculum development and teacher training, in partnership with the Thai Ministry of Education, the British Council and Sheffield Hallam University

TANZANIA*

AGES
11+

TARGET GROUPS:
School & university students

KEY PROJECTS:

- National and international university scholarship schemes (science and engineering)
- Science equipment and infrastructure for schools and universities
- *Young Scientists Tanzania* programme to promote science in secondary schools

AUSTRALIA

AGES
11 -16

TARGET GROUPS:
Students in Queensland public schools

KEY PROJECTS:

- *Wonder of Science* – supporting science and industry ambassadors in schools
- *Power of Engineering* – pupil workshops and site visits

BG GROUP HAS INVESTED APPROXIMATELY

\$6m

IN PROJECTS FOR SCHOOL STUDENTS AND TEACHERS, WORLDWIDE

BG GROUP HAS WORKED WITH MORE THAN

20

PARTNER ORGANISATIONS GLOBALLY

BG GROUP HAS DIRECTLY BENEFITED MORE THAN

30,000

SCHOOL STUDENTS WORLDWIDE

*Not covered in 2011-13 STEM Education Learning Report analysis because project was started recently and/or targets university students rather than school-aged students.

Find out more at www.bg-group.com

BELOW
STUDENTS PARTICIPATE IN THE "STEMAGINATION" PROJECT
DELIVERED
BY THE UNIVERSITY OF WEST INDIES SCHOOL OF EDUCATION, WITH
SUPPORT



In this report

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OVERVIEW

Introduction

This summary report presents the key findings from a consolidated assessment of BG Group's global social investments in STEM education (science, technology, engineering and mathematics) from 2011-13.

The assessment was designed and delivered by the National Foundation for Educational Research (NFER) to help BG Group learn and improve, and to identify learning that can be shared more broadly with other companies and education organisations.

The report is based on:

- a review of programme and project documentation
- 15 interviews with a range of BG Group staff including social performance managers within five countries in which BG Group is investing
- 18 interviews with staff from a range of organisations delivering STEM projects across these five countries as well as an external evaluator
- a small-scale rapid evidence review to explore best practice and factors for success in the delivery of STEM education projects in the UK and Australia.

BG Group overview

BG Group plc is an international energy business, active in more than 20 countries. The company focuses on exploration and production of oil and gas, with a specialism in gas and LNG (liquefied natural gas).

In 2011, BG Group adopted STEM education as one of three global themes for social investment¹ – although some projects go back further than 2011. The company has three stated objectives for focusing on STEM education:

- to support host governments: countries across the world recognise that they need a workforce with STEM skills and qualifications, to prosper and meet the demands of the future global economy
- to develop capabilities: STEM-qualified professionals and technicians are crucial for energy companies and other industries, as they take on a broad range of future challenges
- to deliver enduring socio-economic benefits: widening access to STEM education promotes social mobility and brings opportunities for employment, business and wealth creation.

The scope of this report is limited to STEM education projects targeting school-aged students in five countries (Australia, Brazil, Thailand, Trinidad and Tobago, and the UK). BG Group's support for STEM activities in higher education is not included in the report.

BG Group supports STEM education projects in a further four countries (Canada, Egypt, Kazakhstan, and Tanzania). These projects were not included for analysis in the report because they were started recently, or because they are targeting different beneficiaries (undergraduates or post-graduates), and so have limited scope for cross-learning with school-aged projects.

¹ BG Group global social investment themes are STEM education, vocational education and training, and livelihoods/enterprise development.

BG GROUP
HAS SUPPORTED
MORE THAN

25

PROJECTS
IN NINE COUNTRIES

FINDINGS

Learning Report findings for BG Group

Between 2011 and 2013, BG Group invested in 20 STEM education projects across five countries with the aim of improving STEM learning outcomes for school-aged children and young people, and supporting the professional development of STEM teachers.

In total, more than 30,000 students benefited directly from these projects, and more than 1,300 teachers and 900 schools received training and support.

The programme has:

- supported new and existing projects that reflect the evidence base on which types of projects lead to enduring benefits for teachers and students – such as interactive, enquiry-based and contextualised activities aimed at young people, and professional development for teachers
- involved a large number of disadvantaged young people and teachers working within state-funded school systems and/or socio-economically deprived areas
- benefited large numbers of young people and teachers and led to many positive outcomes including increases in young people's interest, enjoyment, understanding and self-confidence in STEM subjects and the development of teachers' subject and pedagogical knowledge and access to resources
- facilitated strong partnerships with STEM education delivery organisations at a national, regional, local and project level with several examples of effective collaboration. Partnerships have worked best where partners have brought complementary knowledge relating to the delivery of education projects and the structure and needs of the national, regional or local education system. BG Group can draw upon the substantial goodwill of existing partners to build future strategic partnerships.

The assessment also highlighted areas where BG Group can further develop and improve the global STEM education programme, including:

- taking a more consistent approach to the monitoring and evaluation of project activity and impacts. Whilst most projects have monitoring in place, the introduction of a consistent project monitoring and evaluation process (which can be scaled up, or down, depending on the scope of project activity) will improve implementation, communication and strategy development. Projects should collect standard data at the time of project delivery. Larger, longer-term projects should be encouraged to design survey-based evaluations with a comparative element (such as pre- and post-activity surveys) and incorporate independent project evaluations

- defining an overall strategy for BG Group's STEM education programme that can be adapted to country-specific circumstances. This will enable individual projects to demonstrate clearly how they contribute to achieving both the programme and country-level strategies (for example, using a results-chain approach to show how activities lead to impacts). Country-level strategies help in the development of a portfolio of STEM partners and coordinated projects, bringing opportunities for wider impacts, scaling up of effective practice and avoidance of duplication
- further sharpening the focus on the types of young people it wants to target. As well as serving local communities close to its operations, BG Group's aim is to support young people from backgrounds that are disadvantaged and/or under-represented in STEM studies and careers. There are multiple country-specific barriers that need to be overcome and this is a key area for further innovation, in collaboration with delivery partners
- building on its current outreach and communications activities to share insights and learning from its STEM social investment programme with a wider group of external stakeholders within government, the private sector and professional STEM institutions.

BG GROUP
WORKED WITH
MORE THAN

20

PARTNER ORGANISATIONS
GLOBALLY

INSIGHTS

Insights from international research on STEM education

We reviewed the literature on STEM education to identify what works in delivering STEM education support projects for school-aged students.

BELOW
ANALYSIS OF ROCK SAMPLES DURING
THE BG GROUP EARTH AND MARINE
SCIENCE SUMMER SCHOOL (UK)



The insights from this review highlighted six elements that can make a positive impact on young people's engagement in STEM subjects. The elements below should be considered when designing STEM education activities, with several of these elements being reflected in BG Group's STEM education programme.

01

Students are most effectively engaged through the provision of practical learning activities which are stimulating and enjoyable and related to the world of work, daily life and their local context.

Students' engagement in STEM education is most effective when activities are related to their everyday life experiences, their local context and the world of work¹. Opportunities to experience STEM in real-life contexts have been offered to many young people taking part in BG Group's STEM education projects. Examples include: visits to companies working in STEM-related industries; summer school programmes offering practical science experiences; and classroom-based talks or workshops delivered by experts in STEM subjects.

02

There are clear impacts from engaging and challenging students through interactive scientific enquiry and problem solving.

Activities which are interactive and place an emphasis on scientific investigation and enquiry, and which allow students to take some control of their own learning, are of central importance to engaging and challenging students in STEM education². Enquiry-based activities are key features of several BG Group STEM education projects including those in Brazil (which have enhanced in-school science with investigative approaches related to the local environment) and in the UK (where outdoor field trips have been combined with curriculum-related workshops in school).

03

Engaging and challenging students through an enriched curriculum, including informal learning and extra-curricular activities, leads to positive outcomes.

Students benefit from a curriculum enriched by STEM extra-curricular activities and informal learning³ and evidence suggests that they gain much of their understanding and knowledge outside of the classroom⁴. Other benefits include the development of more positive views towards, and greater enjoyment of, STEM subjects as well as improved achievement and performance³. BG Group's STEM education projects have supported schools to enhance their STEM education in a variety of ways. Examples include: practical science activities delivered through 'Science Bus' visits to school sites in Trinidad and Tobago; opportunities for students to visit Rio de Janeiro's Museum of Geodiversity in Brazil; and workshops at the Science Museum, London.

1] Ofsted, 2013; Ofsted, 2011; Australia Industry Group, 2013; Universities Australia, 2012 and Harlen, 2010.
2] Ofsted, 2013; Ofsted, 2011; Harlen, 2010; Davies, 2006 and Royal Society, 2010.
3] OECD, 2012; Ofsted 2011; Ofsted 2013; Davies, 2006; Lloyd et al., 2012 and Feng, 2012.
4] Falk et al., 2012.



ABOVE
ENQUIRY-BASED SCIENCE LEARNING THROUGH THE
"SCIENCE AND TECHNOLOGY WITH CREATIVITY" PROGRAMME
IN ANGRA DOS REIS, SUPPORTED BY BG BRASIL

04

Supporting young people to develop their confidence and self-belief in STEM subjects is beneficial, particularly for disadvantaged groups.

Research demonstrates positive links between students' self-belief in STEM subjects, and their actual achievement⁵. Higher self-belief also impacts on the likelihood that students will choose to study STEM subjects post-16⁶. Disadvantaged students' belief in their ability to succeed in education, and the amount of time they spend studying STEM subjects, has a positive impact on their educational outcomes. Summer schools support disadvantaged students to close the achievement gap and have a positive impact on their social and emotional well-being⁷. Through summer schools and bursary projects, BG Group has provided young people from more disadvantaged backgrounds in the UK with positive out-of-school STEM learning experiences as well as the support they need to develop their belief in their ability to succeed and to progress into higher education.

05

It is important that STEM teachers are supported to continuously update their knowledge and skills and to maintain their passion for teaching.

STEM teachers (and technicians) benefit from continuing professional development (CPD) to update their subject knowledge and skills as well as maintain their passion for teaching and their confidence in using a range of pedagogies such as scientific enquiry. This can ensure that they effectively engage and enthuse young people⁸. Several projects within BG Group's STEM education programme have aimed to develop and update STEM teachers' expertise and enthusiasm in delivering STEM subjects as well as improve their access to up-to-date resources. Examples include: specialist science teachers training a wider group of 'teacher trainers' to use curriculum resources and then cascade this learning in their own schools (in Thailand); developing a national STEM teacher network to support STEM teachers (in the UK); and teacher training workshops to help them teach critical and creative thinking in science (in Trinidad and Tobago). As these projects have proceeded, they have demonstrated that certain factors are required to support schemes which aim to develop STEM teachers. Of key importance is the commitment of schools' senior leadership teams to staff undertaking CPD as well as the provision of sufficient time for teachers to undertake CPD and make changes in their practice. Without these supporting factors, a project focused on providing CPD to STEM teachers is unlikely to be successful.

06

It is important that young people, and their families, are provided with good quality information and advice on STEM study and career options and the value of STEM qualifications.

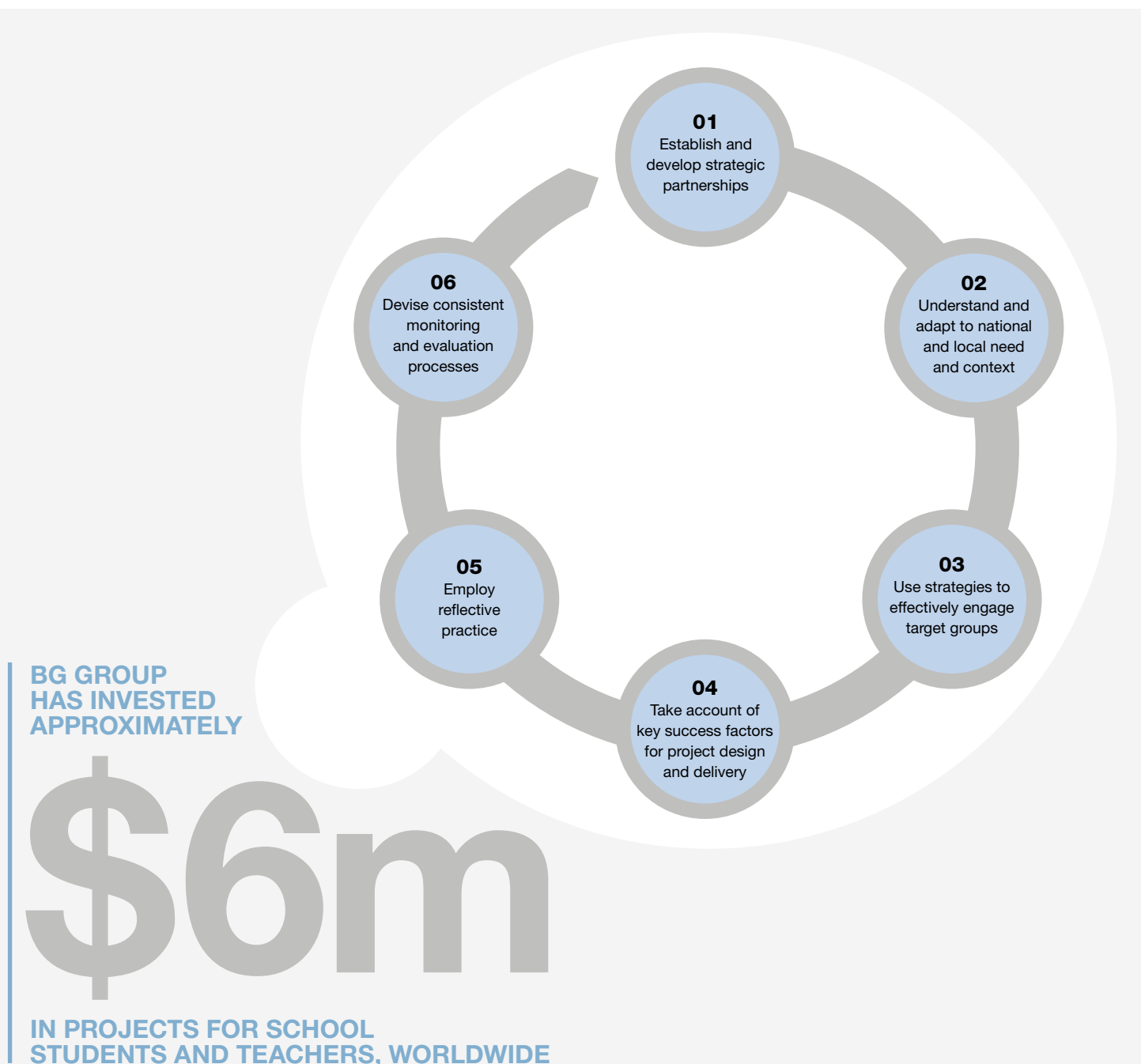
It is important to raise the awareness of young people and their families of the available progression routes into STEM study and careers post-16, as well as the value and transferability of STEM qualifications⁹. Research shows that families exert a considerable influence on students' aspirations¹⁰. A small number of BG Group's partnership projects have provided young people and their parents with information about STEM study options and career pathways. However, there is an opportunity for BG Group to increase its emphasis on providing advice on STEM study and career options in its future education projects and to increase its focus on involving families.

5| OECD, 2011; JRF, 2010; DfE, 2011; Hoare et al., 2012; Martin et al., 2013 and Sutton Trust, 2011.
6| Ibid.
7| Ibid.
8| Ofsted, 2013; Ofsted, 2011; Universities Australia, 2012; NSLC, 2012 and Royal Society, 2012.
9| Ofsted, 2011 and ASPIRES, 2013.
10| ASPIRES, 2013.

LEARNING

Learning from implementation

Since 2011, the implementation of BG Group's STEM education programme has generated a wealth of knowledge and insights. The diagram below illustrates the key learning points which are described in more detail [overleaf].



The following learning points are shared for others that are supporting, designing or implementing STEM education programmes and policy.

RIGHT
HANDS-ON SCIENCE DURING THE STEM FAMILY DAY – PART OF THE BUILDING BRIDGES SCIENCE PROGRAMME AT THE SCIENCE MUSEUM, LONDON

BELOW
GEOLOGY FIELD WORK DURING THE BG GROUP EARTH AND MARINE SCIENCE SUMMER SCHOOL



01

Establish and develop strategic partnerships

Partnerships are the foundation of BG Group's approach to supporting STEM education – both in terms of strategy, design and delivery of projects as well as plans for wider dissemination/replication of success.

The partnership strategy needs a clear focus in its own right and attention needs to be given to engaging and effectively collaborating with the right partners. Partners bring different strengths and expertise and it is rare to find partners that can do everything.

In some places (for example the UK), there are large numbers of established organisations working in STEM education and hence a choice of partners. In contrast, in other countries (e.g. Brazil), education organisations tend to support education more broadly and few specialise in STEM education. BG Brasil has worked with a smaller STEM-focused organisation and supported their scale-up, as well as working with broad education-focused organisations and supporting their development and delivery of STEM-specific programmes.

Effective partnership is a two-way relationship that requires a commitment to agreeing and working towards shared objectives and working collaboratively. The Learning Report asked partners about their experiences of partnering with BG Group – most were good.

An example of success can be found in Thailand where the Inspiring STEM project supported by BG built a strong partnership between the Ministry of Education, private sector funders and government/development agencies. In Queensland, QGC (a BG Group company) is collaborating with other energy companies in a partnership with the state government, to support new STEM projects informed by government priorities.

02

Understand and adapt to national and local need and context

An international STEM education strategy needs to recognise the political and educational context and particular challenges in each country and adapt approaches accordingly. Within the UK, where there is a plethora of organisations working on the STEM education agenda, BG Group's approach has been to collaborate with organisations with an established track record who are aware of gaps and needs in their local area.

In other areas, BG Group has collated baseline evidence and information, drawing on existing research in addition to commissioning its own. For example, BG Brasil commissioned a scoping study from an education think tank. Part of the study set out the management structure of Brazilian education at municipal, state and federal levels which enabled them to better understand the educational landscape and the key players it would be necessary to engage with. In assessing the country context, it is important to identify which stakeholders are critical for successful approval of projects, and the challenges that might be faced if stakeholders are not supportive of private sector investment in public education.

03

Use strategies to effectively engage target groups

Engaging disadvantaged groups can be particularly challenging in the UK where significant effort is often required to engage lower-performing schools and where there is a multitude of widening participation initiatives targeting young people –with a risk of “initiative fatigue”. Where UK STEM partners have been successful in engaging schools, they have: a track record of successful delivery; allowed significant time to recruit schools prior to delivery; and gained senior leader commitment. They have achieved the support of senior leaders through demonstrating the benefits of engaging, e.g. how activities will link to the curriculum and impact on students' progress and achievement.

The programmes in Queensland and Trinidad and Tobago have both targeted students in more remote locations close to BG Group operations and away from major cities. Whilst this brings logistical challenges, it provides benefits for students who generally have less access to educational enrichment activities.

In the emerging economies covered by this report, public education performance continues to be a challenge – Brazil was 59th and Thailand 48th out of 65 countries in the 2012 Programme for International Student Assessment (PISA), carried out by the Organisation for Economic Co-operation and Development (OECD). In this context, educational challenges exist across the entire public school system. This provides less of a need to strategically target disadvantaged students, compared to other countries. However, education authorities may have less of a focus on performance in STEM subjects specifically when general education performance is lagging. In countries where regional or local government has significant influence, achieving their approval has been an important first step to engaging schools and some projects have been unable to get off the ground without it.

04

Take account of key success factors for project design and delivery

It is too early to make definitive statements about the educational outcomes from the projects supported by BG Group. However, a range of likely success factors were identified during the research:

- prior to project delivery, sufficient time needs to be factored in for relationship building and engaging schools
- prior to rolling out large-scale projects, a pilot phase of delivery is beneficial, so that any challenges and issues can be tackled early before significant funds are invested
- interactive, contextualised and practical activities are particularly engaging for young people although there needs to be an increasing emphasis on theory as students get older
- for extra-curricular projects, activities that include problem solving, investigations, teamwork and giving presentations can allow students to develop transferable and employability skills that they have less time to focus on in school there needs to

be a balance between fun and engaging activities and activities which have clear learning outcomes and which will develop knowledge, understanding, skills and confidence

- drawing on STEM professionals and role models helps to place activities within the local context and raise awareness of, and enthusiasm for, STEM subjects and careers – however, the volunteers need to be properly briefed to ensure their input is pitched at the right level
- projects benefit from building in an element of teacher professional development even where the main target group is students – actively engaging teachers in activities and modelling delivery can build their capacity to deliver and sustain activities in school
- the 'Train the Trainer' model of professional development can be effective in cascading effective practice and resources to large numbers of teachers where the trainers are effectively supported and have the relevant experience, credibility and access to teachers
- an element of flexibility needs to be built into project design to enable activities to be adapted to changing needs and schools' particular circumstances
- ideally, activities should be developed which have direct link to the curriculum which will support schools to embed them in lessons, as well as convince schools to engage in the project
- to achieve a significant impact on students, activities need to be sustained over time and incrementally build on prior learning.

However, it is important to recognise barriers which can be country-specific. For example, teacher training is often seen as the most effective and high-impact intervention. Although this is true in many cases, it cannot always be easy to implement in certain countries due to the need for multiple approvals at government level. In some countries and regions, it can be opposed on political grounds. In others, it can be difficult to achieve due to the many other pressing priorities and demands on teachers' time or particular changes occurring during that period. For example, BG Trinidad and Tobago has found it challenging to engage teachers in one of their STEM projects due to the time requirements already placed on teachers during roll-out of a new science curriculum.



LEFT
STUDENT PARTICIPATION DURING THE
2013 "POWER OF ENGINEERING" EVENT
IN QUEENSLAND, PART-FUNDED BY QGC
(A BG GROUP COMPANY)

NEXT STEPS

The way forward

Together with NFER, and based on the findings from the 2011-13 Learning Report, BG Group has identified the following points for further development within its STEM education programme:

- further definition of the company's global strategy for STEM education investments, that can be adapted to country-specific circumstances
- adapting country strategies to build on strengths and address key challenges at the country level – this may include investment in partner organisations' capabilities and support for innovative approaches to target "hard to reach" students that are under-represented in STEM subjects
- adoption of a more consistent approach to the monitoring and evaluation of project activity and impacts – based on a simple results-chain approach that shows how activities link to impacts. The scale of investment in monitoring and evaluation will be appropriate for the scale of projects, and where possible it will include data gathering at the "point of intervention" rather than after the event
- building linkages with a wider group of funders, delivery organisations and other STEM education stakeholders within government, the private sector and professional STEM institutions, to look for opportunities for cross-learning, leveraging of funds, and scale-up of successful STEM education projects.

05

Employ reflective practice

Key to successful delivery is reviewing on an ongoing basis what has worked well and what requires enhancement. This includes deliverers allowing themselves the time to reflect on delivery but also gathering and acting on feedback from beneficiaries. The best projects are those which are continuously enhanced and improved as a result of reflective practice and proactively responding to feedback.

For example, in the second year of delivery, BG Group's partnership project with the Science Museum in the UK has been adapted based on learning from year one – including the creation of a new booklet with activities for students and their families, to build a stronger connection and maintain continuity between different project activities.

06

Devise consistent monitoring and evaluation processes

Looking across the projects within the five countries has highlighted variations in the amount and quality of monitoring and evaluation data being collected – in part because BG Group has aimed to avoid putting new demands on partners who already report data to multiple funders. Some projects are collecting good quality monitoring and evaluation data, with a small number of external evaluations being undertaken. However, the data gathered by others is patchy and, in a number of cases, important data, such as a gender breakdown of beneficiaries, has not been gathered. This makes it difficult to gain a programme-wide picture of progress.

A key learning from implementation is that the "point of intervention" is the easiest place to collect monitoring and evaluation data (for example, during or immediately after a STEM education session). Projects that have attempted to collect data through surveys after the fact have generally not had good response rates, particularly from teachers, who typically have busy timetables. This poses a challenge for collecting long-term impact data – such as exam results or study destinations – and innovative ways of tracking students may be needed.

In addition, the country context may limit the scope of monitoring and evaluation. Up to now, Brazil has not had a common public examination in science and so exam results cannot be used to compare student success after STEM education activities.

BG GROUP
HAS DIRECTLY
BENEFITED MORE THAN

30,000

STUDENTS
WORLDWIDE

MORE THAN

1,300

TEACHERS HAVE RECEIVED TRAINING AND SUPPORT
THROUGH BG GROUP PARTNERSHIPS AND INVESTMENTS

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**Evidence for
Excellence in
Education**