The Structural Barriers to STEM Engagement
Final Report
for
Education Scotland

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ekosgen

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Executive Summary

Context: the STEM landscape

The context for the delivery of STEM education and professional learning in Scotland is complex, with a number of significant changes in the policy and strategy environment in recent years. The mix of structures is seen as challenging, with alignment across different organisations sometimes presenting issues.

From an operational perspective, there remain a number of challenges in supporting STEM education and professional learning. This includes supporting the transition of pupils through BGE into senior phase, and a need to better connect STEM to other parts of the curriculum, to help build scientific literacy and relate STEM to the real world and societal challenges.

The OECD Review of the Curriculum for Excellence (CfE) and the STEM Education and Training Strategy refresh acknowledge the dynamic nature of STEM education context, and the need to build curricular capacity, with greater clarity in Scotland's education institutional structures, to support effective implementation of CfE. Further, the Ken Muir Report and subsequent Scottish Government response establishes a renewed vision of education in Scotland, which places the learner at the centre of all education decisions.

Understanding structural barriers

Wider education landscape

There is a mixed level of commitment to the promotion of a STEM agenda in schools in Scotland. This is typically dictated by either scale of resource available within the local authority or level of activities being delivered. There is some positive evidence of increased commitment to STEM in some areas, such as through increased and dedicated staff resource, or proactive development of strategies and activities for STEM learning and development. Whilst there is appetite for commitment to developing STEM learning, knowledge sharing remains dependent on the enthusiasm of individuals and their personal networks. Further, the busy STEM landscape can make it difficult for practitioners and STEM leads to navigate the extensive range of support for STEM that exists.

The main issues within school processes and structures are a lack of teaching staff resource, timetabling processes and the accompanying restrictions on subject choice, curriculum requirements and in some cases, school departmental structures.

There is some evidence of creativity within timetabling resulting in successful inter-disciplinary learning (IDL) and more flexibility regarding STEM subject choice. However, the current view of CfE is that within the BGE phase, there is difficulty in making STEM more engaging and inventive to ensure a greater uptake of STEM subjects in the senior phase. Further, engaging all school departments in STEM project-based learning can be problematic where departments don't see the relevance of STEM to their teaching.

Different approaches taken within school clusters have had mixed success to overcome primary-BGE transition challenges, and there is general agreement that links between primary and secondary schools need to be made better and stronger. In contrast, STEM pathways from schools into colleges are generally considered to be strong.

LA STEM leads would like more time and resource to engage with schools and influence school improvement plans. Many have teaching experience, and are able to recognise and appreciate some of the key barriers to STEM learning within school settings. College STEM leads vary their approaches to schools, recognising the differences across schools in their approach and level of resources and commitment to STEM learning. This may be to focus on schools considered to be 'early adopters' of innovation in STEM education as influencers within a wider geography, or to work with DYW groups where schools are known to have limited resource. Others target careers advisors to counter challenges with outdated careers advice.

School environment

Recruitment of STEM teachers is a fundamental challenge impacting on learner throughput and STEM skills development. Issues in ensuring STEM skills and capabilities amongst STEM teachers, as well as staff turnover, also impact on STEM learning. Some schools are active in championing industry links to help bolster teacher understanding, and there are some good examples of projects delivering career-long professional learning as a way of delivering staff capability.

Curriculum delivery and assessment demands considerably reduce the scope to develop and deliver new or innovative STEM content in lessons, including in new, STEM-relevant areas of interest. This curriculum focus is also reinforcing a silo approach – though some schools are managing to overcome this and deliver more IDL through projects and cross-department collaboration.

STEM education does need to be resourced properly and many schools report that they lack these teaching resources or the ability to invest in them. Resource sharing and collaborative working across settings is one way to overcome this. More flexible teaching and STEM delivery spaces may also positively impact on delivery.

Support from senior management/leadership teams and headteachers is essential. Implementing STEM teaching ideas and projects without management team support can be very difficult. This support should be augmented by an effective school improvement plan that builds in STEM as an integral component.

There are many strong examples where cluster-led working is directly targeting the transition of STEM learners from primary and through BGE. In some instances, this incorporates dedicated courses targeting particular age groups (e.g. S1). Others use extra-curricular delivery such as STEM academies to stimulate greater uptake and deliver qualifications. However, staff confidence – particularly at primary school level – remains a barrier and much cluster working focuses on upskilling staff and building confidence.

There are many factors impacting on the ability of learners to choose STEM subjects. This includes school links with colleges where good relationships can help to promote work placements, vocational pathways, employer engagement and extra-curricular activity to augment STEM learning. Staffing and timetabling constraints also impact on subject choice. Some schools are pursuing 'creative timetabling' of STEM subjects to maximise the opportunity to choose STEM subjects, whilst others are pursuing other approaches such as a 2+2+2 teaching model rather than the typical 3+3 BGE/senior split to increase exposure to STEM subjects through deep thematic teaching.

Many barriers in terms of equity and equality of access to STEM education still exist. Geographical inequality continues to reinforce inequity in STEM take-up, which is compounded by lack of equity to STEM teaching support, particularly in rural areas. Well-documented cultural and perceptual barriers also persist. Evidence suggests that tackling inequity and inequality is piecemeal, and change is slow.

The learner voice

Despite these challenges and barriers, there are positive findings from the learners themselves.

The reported confidence and capability of learners with regard to STEM is good, and perhaps higher than may have been anticipated, though confidence does vary along the learner journey, and also by gender and other protected characteristics. Also, the perceptions of STEM, amongst both boys and girls, are not as negative as anecdotal evidence may have reported.

However, there are some important issues and challenges arising. Whilst many of these are already known to Education Scotland and other strategic actors in the STEM education landscape, these findings go some way to confirming issues that may only have previously been identified through anecdotal evidence.

There is a clear demand for more engaging and more relevant STEM teaching amongst learners. There is also a particular issue with engagement of those in S1-S3 – it is at this phase where challenges around confidence, perceptions of STEM and decisions around (not) continuing STEM subject study arise. Thus there is a real need to ensure that STEM education being provided in schools is rooted in the real world.

There is also demand for increased flexibility in timetabling within schools. This will allow more learners to choose the STEM subjects they want to do, in instances where existing timetable requirements act as a constraint.

The role and impact of in-school influencers is also a clear challenge. Evidence would suggest that guidance staff, STEM ambassadors and young STEM leaders need to strengthen their impact to increase the positive influences around learners regarding continued pursuit of STEM education.

Tackling confidence and negative perceptions, particularly through transition to senior phase, and particularly for girls, is also important. Strengthening the role and impact of influencers is critical in this regard.

Priorities for addressing key challenges and structural barriers

The following priorities have been identified to tackle identified barriers to STEM education engagement.

Strategic aspects

1. RICs to have an explicit remit for STEM. This may take the form of explicit requirements for STEM actions to be built into improvement plans or better aligning STEM to existing priorities for example, literacy and numeracy in improvement plans.
2. Consideration to be given to introducing new and innovative qualification pathways which have potential to widen STEM learning and careers access for learners irrespective of their backgrounds or level at which they are working.
3. The visibility of STEM to learners should be increased, and consideration should be given to the best ways that learners can be 'hooked' into STEM through the BGE phase. This could include an increase in making more use of real-world STEM examples, or adopting flexible approaches to teaching and learning, including IDL, project/challenge-based learning or 2+2+2 teaching models.
4. Education Scotland and partners should consider ways in which schools can be supported to explore opportunities to plan and deliver IDL and joint lessons, as well as ways in which more flexible, effective teaching and learning spaces can be provided and created within schools.
5. Scottish Government and other strategic partners should give consideration to how best to develop a strategic approach to STEM teacher recruitment.
6. Greater collaboration between schools and colleges should be encouraged and facilitated to improve alignment
7. Scottish Government, Education Scotland and strategic partners should explore ways in which the strategic STEM education landscape can be harmonised to benefit the learner experience.

Operational aspects

Under local authority control or RIC influence

8. Education Scotland and RICs should continue to support local authorities, in particular smaller ones who lack resources, in achieving a more consistent and equitable distribution of STEM resources and professional learning support across schools and clusters.

9. Strengthening knowledge exchange through and across RIC areas through more formalised approaches, rather than relying on enthusiastic individual STEM practitioners, should be a priority.

Secondary school control

10. School improvement plans should have explicit priorities and actions for STEM, to ensure that STEM subjects have sufficient visibility at the school level, supported by adequate STEM representation on school leadership/management teams.

11. Consideration should be given to how to support clusters and local authorities to ensure effective progression in learning from early learning and childcare through to primary and secondary and from secondary school to post-college within STEM subjects. Teaching materials grounded in the real world and in contemporary industrial, sectoral and societal contexts should be maximised.

12. The development of practitioners through CLPL and industry exposure should be supported and maximised, to build confidence and capability within the STEM teaching cohort. Partners should capitalise on the need for protected time for STEM CLPL for staff, and pursue opportunities to build greater staff development time into timetabling

13. Local authorities, schools and RICs should explore opportunities to plan and deliver IDL and joint lessons, potentially in partnership with colleges. Teaching 'silos' between subjects inhibits the potential for effective IDL and cross-subject learning/teaching. Ways in which more flexible, effective teaching and learning spaces can be provided and created should also be explored.

14. Skills Development Scotland, in conjunction with, RICs, local authorities and schools, and other partners should explore ways in which guidance staff can be supported to improve their effectiveness and reach, and equipped with the resources and intelligence necessary to deliver an effective guidance function, and better influence learners in their choices regarding STEM subjects. This should include training on the effect of unconscious bias and gender stereotypes when advising young people.

15. SSERC with input from Scottish Government to give further consideration to the effectiveness of STEM ambassadors and young STEM leaders, including by drawing upon the findings from the recent Young STEM Leader Programme Annual Report and Programme Evaluation.

16. Greater innovation and flexibility is required in timetabling amongst schools and across clusters. Solutions may include longer time periods to allow for IDL, and using more project- or challenge-based learning. This may also extend to pathway development in partnership with colleges, subject to the scope for greater alignment in planning cycles between schools and colleges.

1 Introduction

Introduction

1.1 Education Scotland appointed ekosgen in partnership with Context Economics in January 2019 as evaluator of aspects of the STEM Education and Training Strategy, including the STEM Grants Programme (SGP). The aim of the STEM Strategy is to build Scotland's capacity to deliver STEM learning and to close equity gaps in participation and attainment in STEM.

1.2 ekosgen evaluated Year One (financial year 2018/19) of the SGP which reported in April 2019. The evaluation found that the £187k programme of funding had improved access to STEM professional learning by removing barriers to CLPL. A number of recommendations relating to further rounds of the SGP were made and implemented by Education Scotland around: targeting and engagement, project scalability and innovation, project complementarity and project and programme level monitoring and evaluation. In Year Two of the SGP (financial year 2019/20), £1.95 million in grant funding was awarded to projects continuing with Round 1 activity and also to projects that had successfully bid for Round 2 funding.

1.3 The scope of the Year Two evaluation was widened to gain an understanding of the wider regional and national STEM landscape and the actors therein. This included the impact of Education Scotland's regional support and other wrap-around support provided through the STEM Strategy. Evidence was gathered via a comprehensive stakeholder consultation programme conducted over the course of the period November 2020 to March 2021. This focus was deemed particularly important given the additional demands imposed on schools and practitioners and, in turn, the Education Scotland Teams during the course of the COVID19 pandemic.

1.4 Following up on this exploration of the wider STEM landscape, the consultant team's Year Three evaluation activities have included: an evaluation of the benefits and impacts of the SGP on learners and practitioners over the course of its three years' delivery to date, and an extensive consultation programme with those involved in the operational delivery of STEM education. The findings of the latter are the focus of this report.

1.5 The consultation programme, conducted between January and May 2022, sought to identify and better understand the structural issues and barriers which exist in the school and wider education system and how these help or hinder the levels of STEM engagement in schools.

Study methodology

1.6 The study methodology has consisted of the following elements:

- A comprehensive consultation programme with a sample of individuals from the following groups across all geographic areas:
  - 59 primary and secondary school teachers, headteachers and depute headteachers, and career and guidance staff
  - 7 college STEM leads
  - 10 local authority STEM leads
- An online survey with learners which achieved 1,309 responses and an online survey of parents which received 542 responses (see Chapter 4 for a detailed respondent profile).

1.7 A mixed method approach was adopted in order to secure engagement from as wide a range of practitioners and other individuals as possible. Online focus groups were conducted with teachers and guidance staff and one-to-one online interviews with local authority STEM leads, college STEM leads and school senior management. A random sampling approach was taken across all groups.

1.8 The online surveys were promoted by Education Scotland's STEM and other teams to their various school contacts, and local authority STEM leads.

How the report is structured

1.9 The report is structured in the following way:

- **Chapter 2** presents a brief overview of the wider STEM landscape and provides the operational context for STEM in the school and wider education setting;
- **Chapter 3** presents feedback from the primary research with teachers and other stakeholders with respect to identifying and understanding the structural barriers to STEM engagement in schools; and
- **Chapter 4** sets out the findings of primary research with STEM learners and parents of STEM learners to understand barriers to engaging with STEM education from their perspective; and
- **Chapter 5** presents the study's conclusions and priority areas for consideration to feed into the Scottish Government's current reform of education in Scotland.
- **Appendix A**: List of consulted organisations

2 The wider STEM landscape

Introduction

2.1 The context for the delivery of STEM education and professional learning in Scotland is complex, with a number of significant changes in the policy and strategy environment in recent years. This chapter summarises the STEM landscape from a strategic and operational perspective, and provides an overview of the emerging policy context.

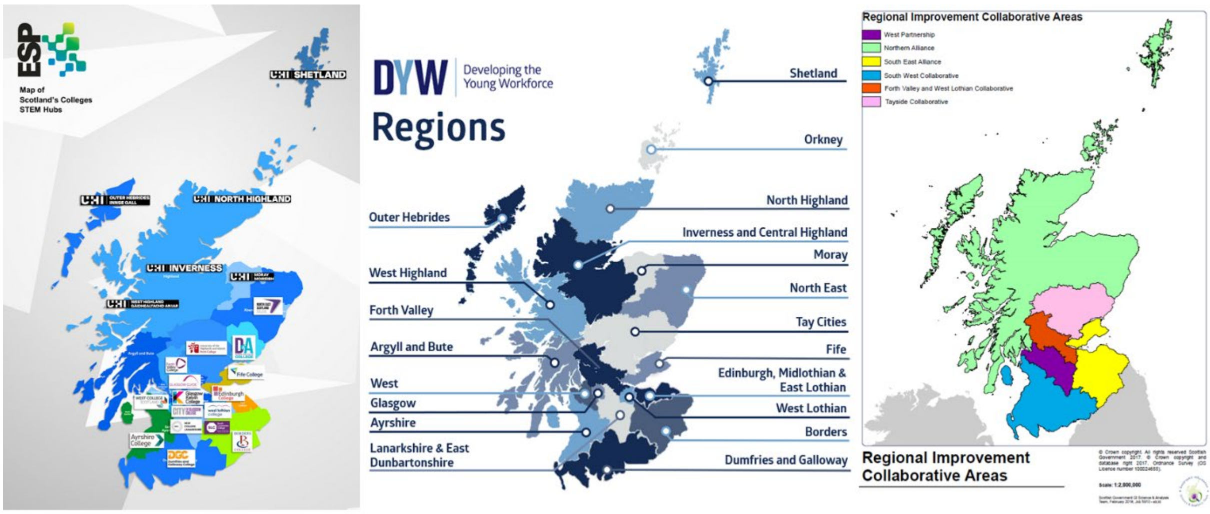
The strategic STEM landscape

2.2 Education Scotland through its STEM and Improving Gender Balance and Equalities (IGBE) teams plays an important role in the STEM education and training landscape in Scotland, positioned at the interface of national, regional and local structures. They are well established actors providing support, networking, co-ordination, integration of activity and provision of professional learning. They are also seen as engaging and influencing widely in addressing equity and equality issues in STEM education and professional learning, at all levels of STEM-related activity. Through this activity, they have driven efforts at a strategic level to facilitate the improvement and development of STEM professional learning, and in turn STEM education.

2.3 In response to feedback from stakeholders, Education Scotland established a STEM Partners Forum in March 2022. This helped to take more strategic, co-ordinated approach to engagement with different stakeholder groups, and maximise the benefit of capacity and capability in their wider strategic partnerships. It also contributed to overcoming the limits of the STEM and IGBE teams' respective capacities with regard to partner engagement. This clearly demonstrates Education Scotland's understanding of the need to play the role of connector, and provide leadership in co-ordinating amongst STEM partners. Nevertheless, the STEM landscape consists of potentially hundreds of partners nationally, and partner engagement is a constant process for the Education Scotland regional teams, which demands a significant investment of time.

2.4 Nationally and regionally, the landscape is complex. There are six RICs, as well as 13 regional STEM partnerships (previously college STEM hubs). There are also 20 regional DYW groups. The previous three STEM ambassador hubs have now been consolidated into one co-ordinated by SSERC.[1] Informal sub-regional partnerships also exist.

Figure 2.1: College STEM Hubs, DYW regions and RICs in Scotland



[1] https://www.stemambassadors.scot/

Source: DYW/ESP/Scottish Government, 2022

2.5 This mix of structures is seen as challenging, with alignment across Education Scotland and RIC structures, STEM Ambassador Hubs and Regional STEM partnerships sometimes presenting issues. RICs in particular are seen as being too far removed from the local level, and too disconnected from the issues that they have a remit for as reported in the recent Ken Muir report on Scottish Education: *Putting Learners at the Centre: Towards a Future Vision for Scottish Education* [2]. The result is a lack of clarity on roles, functions and responsibility, and a potential disconnect between the different structures. Previously, it was identified that there is a need for clearly defined remits of each actor in the STEM landscape, including that of Education Scotland's STEM team. Fewer and better fora and groups, with less overlap was also suggested by some stakeholders, to address structural issues and help to streamline agendas.

Operational considerations

2.6 From an operational point of view, the work of Education Scotland's Regional Officers in raising the profile of STEM in educational settings can be considered successful. The team's work is contributing to increased engagement of teachers and practitioners, and a growing appetite to take up professional learning opportunities. Their activity is perceived to be complementary to that of SSERC and the RAiSE programme, amongst other initiatives. The RAiSE programme has also demonstrated a degree of sustainability as a result of the number of local authorities choosing to self-fund Primary Science Development Officers (PSDOs) beyond the lifetime of the initial RAiSE funding.

2.7 However, a number of challenges in supporting STEM education and professional learning have been identified.

2.8 A greater degree of support generally is required in supporting the transition of pupils from primary, through the broad general education (BGE) phase delivered in S1-3 into the senior phase of secondary school. This is required to sustain the engagement with STEM subjects that is increasing in primary school and retain pupil participation in STEM subjects at the senior phase.

2.9 There is also a gap in terms of headteachers and their knowledge of STEM, and their ability to champion it. This is particularly important for smaller (primary) schools where the number of STEM teachers is limited.

2.10 It has previously been recognised that there is a need to connect STEM education to other parts of the curriculum: bringing other subjects into STEM, and also in bringing STEM into other subjects. This is to help build scientific literacy, and ensuring that scientific understanding could be readily applied and related to the real world, and to societal challenges – developing an interest in the impact of science on society, and critical engagement in thinking about science, rather than teaching of science in a more abstract way. This could be achieved through provision of increased support for work-based learning, or through inter-disciplinary learning and project- and challenge-based team working. Such approaches would help to develop cross-cutting and meta-skills (e.g. analytical capability, critical thinking, problem-solving, collaboration, etc.), which are central to scientific enquiry.

2.11 There is a wide range of STEM education and professional learning support provision, with providers often engaging and competing for a common audience. This busy landscape is in part due the wide-ranging nature of STEM.

2.12 Education Scotland has made some progress through its position as a public sector body to enable greater access to available support and resources via the development of resources such as the

[2] https://www.gov.scot/publications/putting-learners-centre-towards-future-vision-scottish-education/

National e-Learning Offer (NeLO)[3] online directory, and the STEM Nation online resource.[4] In addition, in response to requests from practitioners, Education Scotland's STEM Team worked with BBC Bitesize, Napier University and other key partners in 2021/22 to produce a further 230 practical sciences videos for National Qualification Sciences. However, significant resource is required to keep this up-to-date and relevant, and ensure that it taps into alternative/supplementary approaches, and maximises the learning potential for wider benefit to settings and practitioners.

2.13 The response to the COVID-19 pandemic greatly accelerated online engagement and delivery of professional learning for STEM practitioners. It is likely that there will be no return to the same level of face-to-face professional learning delivery, with the use of digital platforms for professional learning delivery likely to continue in future. This can support an increase in professional learning uptake, particularly in rural areas – opening up greater access, providing extended reach, and helping to reduce geographical disparity in provision. However, this needs to be balanced with increasing demands for a return to a degree of face-to-face provision.

The changing strategy and policy context for STEM

2.14 The Scottish Government mid-point review originally intended for the STEM Education and Training Strategy was not conducted as a consequence of the COVID-19 pandemic. Instead, the fourth annual report for the Strategy represents a refresh for the Strategy's extension to 2025. It does this acknowledging that the context for STEM education, and indeed education as a whole, is incredibly dynamic. It also recognises that:

> *"…it is essential that our approach to STEM skills stretches from early years, through school and into higher and further education and on to the world of work. Getting any single element right will not of itself be sufficient to fully leverage the potential of our young people, or maximise their opportunities."*

2.15 This refresh followed the OECD Review of the Curriculum for Excellence (CfE).[5] The Review found that the CfE continues to be a "bold and widely supported initiative", with the flexibility needed to improve student learning further. However, it acknowledged the need to improve implementation of CfE through the BGE, particularly with regard to the balance between breadth and depth of learning, with delivery supported by a clearer framework and supporting documentation. From the point of view of schools and teachers, the Review also argued for building curricular capacity at various levels through enhanced collaboration between practitioners and educational settings (i.e. schools, colleges and universities), as well as ensuring dedicated, ring-fenced time to lead, plan and support CfE at the school level. Importantly, the Review suggested that there was a need for greater clarity and coherence in Scotland's education institutional structures, to support effective implementation of CfE.

2.16 The Scottish Government has announced reforms to Scotland's education system, and in particular the creation of new agencies to replace SQA and Education Scotland. This will result in the establishment of two new bodies with responsibility for developing and awarding qualifications, and for improved support and professional learning to teachers and schools, and provide advice and guidance on curriculum, assessment, learning and teaching. A new independent inspectorate body will be created alongside these.[6]

2.17 This reform was announced as part of the Scottish Government's response to the Ken Muir Report, *Putting Learners at the Centre: Towards a Future Vision for Scottish Education*.[7] The Report

[3] https://education.gov.scot/nelo/
[4] https://blogs.glowscotland.org.uk/glowblogs/stemnation/
[5] https://www.oecd.org/education/scotland-s-curriculum-for-excellence-bf624417-en.htm
[6] https://www.gov.scot/news/new-national-education-bodies/
[7] Ibid.

sets out the case for a renewed vision of education in Scotland, one that places the learner at the centre of all decisions – in line with Article 29 (Part 1(a)) of the United Nations Convention on the Rights of the Child, which states that a child or young person's education should develop their mind, body, talents, personality and physical ability so that they can achieve their fullest potential.[8]

[8] https://www.unicef-irc.org/portfolios/general_comments/GC1_en.doc.html

3 Understanding the structural barriers to STEM engagement

Introduction

3.1 This chapter of the report presents our findings from the consultation programme. The aim of the primary research was to obtain a detailed understanding of the various barriers and challenges currently faced by schools and other educational organisations in engaging young people in STEM learning, notwithstanding the outcomes of the current reviews of the Scottish education system referred to in the previous chapter.

3.2 We have adopted an evidence-based approach, listening to and triangulating the views and ideas of learners, parents, headteachers, teachers, and local authority and college STEM leads to help inform our findings.

3.3 The scope of the consultation exercise included the following topics all of which are perceived to pose, to some degree, barriers to STEM engagement in schools.

- Transitions/cluster working/progression in learning
- Processes and structures in secondary schools
- Factors affecting subject choice/senior phase pathways
- Equality and equity
- Challenges in setting up STEM pathways
- Parental advice/science capital/awareness
- Career advice/support

3.4 Our consultation topic guides were used flexibly taking cognisance of the varying roles and responsibilities of the individuals being consulted. The learner and parent online surveys asked questions which reflected the scope of the research outlined above.

The learner voice

3.5 In presenting our findings we have adopted the approach which puts the 'learner voice' at the centre of our considerations. This reflects the findings of the report provided to Scottish Ministers by Professor Ken Muir who has provided independent advice on aspects of education reform in Scotland[9]. The report, Putting Learners at the Centre: Towards a Future Vision for Scottish Education, cites:

"the importance of placing the learner at the centre of all decisions"[10]

…" where learners' voices, experiences, perspectives and rights are central to decision making"[11]

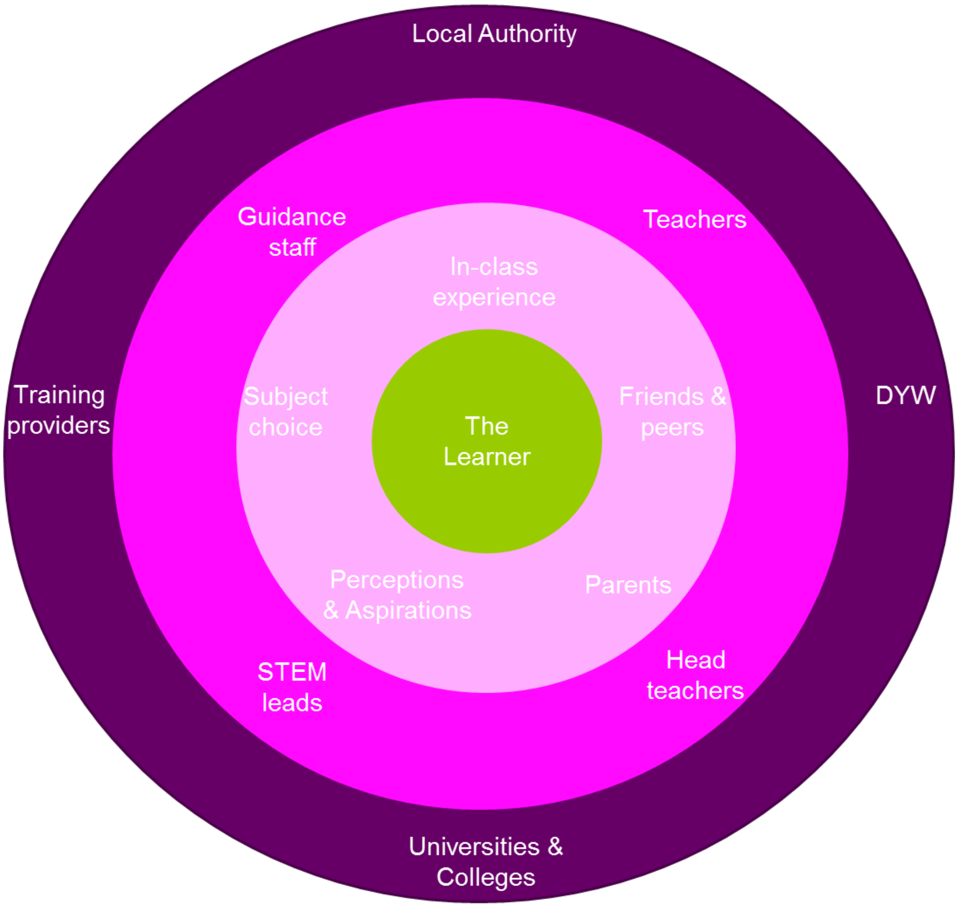
3.6 Figure 3.1 below depicts the numerous influences and influencers/decision makers currently facing the young person in their potential STEM learning journey. It aims to depict the complexity of the learner environment.

[9] ibid

[10] Ibid.

[11] Ibid.

Figure 3.1: Influences and barriers to STEM engagement



3.7 In the rest of this chapter we present and build our consultation findings around this approach working from the external, outside influences inwards to the school environment. The next chapter, Chapter 4, then presents the views of the learner and parents which are drawn from the online learner and parents surveys.

Wider education landscape

3.8 In this section we present the views of those consulted, namely a number of local authority staff with responsibility for STEM engagement and college representatives who are either STEM leads and/or are members of a regional college STEM partnership. Their views are broadly representative of colleges and local authorities as a whole.

3.9 We present our findings under the following headings: commitment to STEM learning; processes and structures in secondary schools; cluster working/transitions; challenges in setting up STEM pathways; operational barriers; and role of the RIC.

LA STEM leads

Commitment to STEM learning

3.10 Evidence suggests a mixed level of commitment to the promotion of a STEM agenda in schools as defined by either scale of resource available within the local authority or level of activities being delivered. In some, for example, there is a dedicated STEM co-ordinator, perhaps supported by a RAISE Officer and others. In others, the role of quality improvement officer includes a part-time responsibility for STEM. In addition, some local authorities, for example, North Ayrshire, West Lothian and more recently Shetland have explicitly acknowledged the need for dedicated STEM promotion and resource and are very proactive in promoting STEM pathways and careers. However, in some cases staff resource for STEM within local authorities is a temporary appointment. Glasgow City Council by comparison, has a well embedded strategic approach to STEM with accompanying action plan and staff resources, and adopts a proactive approach to STEM promotion and learning, and partnership working with industry and schools. Within the local authorities consulted, a staff complement of four is the maximum STEM resource employed. Many make use of partner resource in the form of DYW staff and Education Scotland's STEM and other teams to bolster resource for delivery training and other STEM activities.

3.11 Further evidence of a commitment to STEM learning is the activity undertaken by some local authorities to proactively consider their approach to STEM learning and develop appropriate strategies, training and activities. For example, North Ayrshire conducted a baseline survey of STEM knowledge amongst practitioners to inform the subsequent design and delivery of a professional learning programme. In West Lothian, they have adopted a key industry sector approach in developing a STEM strategy which includes the development of 'agile curriculum pathways' aligned to industry need. In a similar vein, Shetland's new quality improvement officer (with a STEM remit) aims to adopt a key sector approach with a focus on liaising with employers in the oil and gas and renewables sectors. In Dundee, the local authority established a STEM network across primary schools through their RAISE officers and programme. This involved evaluating the needs of schools and then delivered practitioner training, model lessons and STEM teaching resources.

3.12 Of those authorities (the majority of those whom engaged with this research) with a proactive agenda they state their aims to include: providing opportunities for schools and learners to engage in STEM activities; supporting and creating local pathways; and using STEM learning as a vehicle to increase attainment levels in schools in areas of deprivation in particular.

3.13 Other pertinent feedback included the need to highlight STEM as a context for numeracy and literacy and not a choice between STEM and other subjects. Most consultees also highlighted the fact that STEM can very often take a 'back seat' in schools' improvement plans behind numeracy and literacy, and health & wellbeing, rather than being a context in which these can be taught/delivered in schools. In part, this may be a legacy of the teaching response to remote learning during the COVID-19 pandemic, and the immediate response following the relaxation of lockdown and social distancing measures to ensure the academic, health and social wellbeing of pupils. However, there is a clear need to promote STEM up the teaching agenda in many schools, though this should be alongside rather than at the expense of Literacy and Numeracy.

3.14 There are numerous examples of a proactive commitment to STEM. Glasgow City Council has adopted a 'train the trainer' model, thus aiming to cascade STEM knowledge and learning to all practitioners.

3.15 The local authority in North Ayrshire has developed strong links into the science heads of all secondary schools. Most schools have STEM Ambassadors and are supported to run STEM competitions; and they are proactively increasing engagement with outdoor learning and sciences for Primary 1 and Primary 2.

3.16 In Dundee, the local authority has delivered an engineering challenge with Dundee & Angus College, as well as a pond life project and a Lego League challenge. Since the lifting of restrictions post-lockdown, they have also delivered a significant amount of practitioner face-to-face training, including unconscious bias training. RAISE officers were also given the challenge of making the STEM network across Dundee sustainable beyond the end of their secondments.

3.17 West Lothian has taken a 'whole school community approach' where the aim is to increase awareness of STEM pathways and jobs and to increase the level of uptake of college courses. This included, for example, the production of exit points documentation for S4 and S5 for each school course choice.

3.18 Aberdeenshire Council has trained science champions to deliver training in primary schools with the aim of increasing confidence in delivering science lessons.

3.19 There is widespread evidence of an appetite and commitment to developing STEM learning in local authority education departments across Scotland. Sharing knowledge and approaches across local authorities, however, is still very dependent on the enthusiasm of individuals, their personal networks and their appetite to participate and contribute to the STEM networks which already exist. There has been a good response to the Education Scotland STEM LA STEM Leads Network, established by ES in 2022 and the Learning for Sustainability (LfS) Leads Networks, both supported by MS Teams networks. Connecting more STEM leads to these recently established and growing networks will facilitate further knowledge exchange.

Processes and structures in secondary schools

3.20 Whilst local authority STEM leads have little input to subject offer and selection by secondary schools they are able to monitor data for each school vis-à-vis national comparators for the level of uptake of science subjects. However, they are familiar with the constraints and barriers within the secondary school operational environment that can combine to restrict and discourage the uptake of STEM subjects. The main issues raised are those of a lack of teaching staff resource, timetabling processes and the accompanying restrictions on subject choice, curriculum requirements and in some cases, school departmental structures.

"Primary schools love science but there are big issues in secondaries; staffing & timetabling issues as core courses are set in stone"

3.21 The lack of teacher resource can manifest itself in various ways. Examples cited include low levels of engagement by secondary schools with primaries to enable effective science transition due to time pressures. The provision of extra/new courses can also depend on the availability of the appropriately qualified teachers.

3.22 Timetabling issues are reported by all consultees as an issue. For example, extra courses depend on pupil numbers. In one school, a rural skills SVQ5 course had insufficient level of take up, so pupils had to choose alternative subjects, and as a result, were potentially lost to the sciences department. There are also examples where timetabling can impact on a diverse take-up of STEM subjects, for example, column choices preventing learners from choosing both home economics and design and manufacture, which may reinforce stereotypical choices.

3.23 The timetabling constraints of traditional 32 period time allocations in secondary schools has been recognised by all consultees and they share the view that mathematics & sciences should come together for bigger blocks of learning. In Scotland's newest, state-of-the-art secondary school, Bertha Park in Perth, timetabling includes 20 periods each of 80 minutes which provides bigger blocks of learning time to facilitate project based, inter-disciplinary learning. The school's infrastructure also lends itself to this approach with sufficient access to IT equipment, an auditorium, open plan classrooms and breakout areas, which create an inspiring and inclusive educational environment for STEM and other disciplines.

3.24 Whilst the school curriculum is currently, necessarily prescriptive to a degree, it is felt that the big challenge for schools is how to make it more inventive and engaging in the S1-3 phase in particular, thus encouraging a greater uptake of STEM subjects in the senior phase whilst keeping specialisms in senior years. Some consultees felt that, in contrast to primary school teaching, the current delivery model of the curriculum serves to restrain teachers' approaches and restricts innovation in STEM learning.

3.25 This chimes with the recommendations of the OECD 2021[12] report on the review of Scotland's Curriculum for Excellence (CfE) which recommended that:

"a better balance be found between the breadth and depth of learning throughout CfE, and that the senior phase be adapted to better match the vision of CfE."

3.26 The current focus on assessment in the senior phase is counter to the aspirational vision of CfE which is:

"to help children and young people to become: Successful learners; Confident individuals; Responsible citizens; and Effective contributors."

Developing the capabilities and attributes of the four capacities should be embedded across all learning.

3.27 A number of consultees asked whether there was an opportunity for Education Scotland to accelerate a new approach to STEM learning in the BGE phase. For example, this could involve working with schools to facilitate the introduction of/more interdisciplinary learning given there is a new Curriculum Innovation team in post, whilst waiting for the outcome of the implementation of the OECD and other reviews' recommendations.

Cluster working/transitions

3.28 It is accepted that the progress made in STEM learning and teaching in primary schools in recent years has been both significant and positive. However, the transition from primary to secondary school presents a much more varied picture and a bigger challenge for schools and local authority education departments.

3.29 Glasgow is an example of having a well-developed STEM strategy and action plan. Across the local authority area, they currently have some 80 STEM practitioners in primary schools and a STEM lead in every secondary school. They have also made good use of Education Scotland's STEM Grants Programme, especially in early learning and childcare settings. The local authority recognises that the enthusiasm for STEM in P7 has dissipated by S3 where they have seen fewer pupils (both boys and girls) taking STEM subjects with Computer Science uptake in particular experiencing a real decline.

3.30 Dumfries and Galloway report similar issues. They feel they are making a real difference in primary settings but recognise that S1-3 requires further support where they feel a more inter-disciplinary approach is needed. This would also address what they feel to be a disconnect amongst teachers of different disciplines.

3.31 In North Ayrshire, further support is needed in supporting transition from primary to secondary to ensure consistency from cluster to cluster.

3.32 They have set up a volunteer pilot where P6 and P7 pupils work with secondary teachers. This is part of the local authority STEM team's improvement plan which aims to improve their current transition approach which involves pedagogy in primary which provides an understanding of the secondary school STEM approach.

3.33 There is agreement amongst all consultees that the links between primary and secondary schools need to be made better and stronger. There is perhaps a need for this to be more prescriptive and formalised, and a collaboration model proposed and adopted across all local authorities.

[12] OECD (2021), Scotland's Curriculum for Excellence: Into the Future, Implementing Education Policies, OECD Publishing, Paris, https://www.oecd-ilibrary.org/education/scotland-s-curriculum-for-excellence_bf624417-en

Colleges and STEM pathways

3.34 Within the sample of local authorities consulted there is overall evidence of good links and relationships with local colleges to develop STEM pathways and encourage their uptake by school pupils. This takes the form of personal networks amongst STEM leads, college visits for primary and secondary schools and other activities, and participation in the STEM college partnerships.

In **Dumfries and Galloway** the STEM College Partnership is chaired by the local authority STEM lead and Director of Curriculum of the college. In addition they have a unique facility in 'The Bridge' a learning facility bridging the gap between education and employability. Learning and training provision is provided by local schools, other council services, further and higher education partners, specialist providers and partners such as Skills Development Scotland, NHS and local businesses. Learning is aligned with DYW growth sectors of STEM, hospitality, engineering and creative industries. Primary schools use it two days a week with their teachers and 4 secondary schools currently align their timetables to the Bridge to encourage the uptake of STEM pathways.

3.35 Another example of close partnership working between local authority and college is West Lothian and Forth Valley College. West Lothian schools work with their local college to provide National Progression Awards, Foundation Apprenticeships and SCQF Levels 1-4. Pupils spend two days a week in-class and online. The local authority also runs the West Lothian Virtual Campus currently serving S6. This allows learners to access a subject not available in school or at the local college. It is a blended learning model delivered online at home or school in small groups with tutor interaction. This is considered a very successful model which could be used more widely across year groups, and elsewhere.

3.36 However, there are some operational barriers to increasing STEM pathways via access to college course and training provision. The college planning cycle, i.e. commencing in September, sees schools approached in November for their training requirements. In most cases this is too late to tie in with schools' resource and timetabling planning activity. Ideally schools require to feed their needs into colleges as early as June.

3.37 For the more rural local authorities, the time and financial cost of transport to college campuses and releasing staff can be barriers to offering new pathways to pupils. This may be countered by making greater use of online virtual learning available from colleges, other learning hubs and private providers where necessary. Take-up of remote/virtual CLPL (as well as other support in other sectors/industries) in remote areas such as the Highlands and Islands or the South of Scotland suggests that this would be an effective approach to increase the reach of CLPL activity in rural, remote and island areas.

Barriers faced by LAs in promoting STEM

3.38 LA STEM leads would like more time (and therefore feel they need more dedicated resource within the Education Department) for school engagement across all departments, and to influence school improvement plans. They recognise that building relationships with guidance teachers and DYW leads is key. However, more important is the engagement with the relevant school faculty (e.g. science, technology) which they feel is one of the main influencers of S3 pupils in subject choice for STEM.

3.39 Whilst not directly in an operational school role, local authority consultees have, in the main, teaching experience, and are able, therefore, to recognise and appreciate some of the key barriers to STEM learning which have been discussed earlier. All are in agreement, however, that the fact that there is no dedicated time for STEM learning per se in the Broad General Education (BGE) phase at S1-3 makes it hard to maintain awareness levels of STEM amongst pupils in the lead up to the senior phase and subject choice. Re-imagining the BGE in secondary schools would involve adopting project-based learning and inter-disciplinary learning. This approach is not without its operational challenges, not least of which would be engaging all school departments. As one consultee said:

"The English department don't see the relevance of STEM."

Role and influence of the RIC

3.40 There is varied feedback on the role and influence of the RICs from local authority STEM leads. For some, the view is one of poor communications and co-ordination across the RIC.

"Not sure who does what in the RIC."

"[There is a] lack of credibility in the RIC based on past activities."

3.41 Some have suggested there is a need to get teachers involved from each local authority to enable networking and knowledge exchange across the RIC area. One suggested good example of this is the West Partnership (RIC for the West region – East Dunbartonshire, East Renfrewshire, Glasgow City, Inverclyde, North Lanarkshire, Renfrewshire, South Lanarkshire, and West Dunbartonshire), whose West OS sees teachers participating and contributing from across Scotland. Sciences and STEM related subjects were the first subjects to be consolidated and added to West OS.

3.42 Additional Support Needs (ASN) schools have reported particular difficulties in engaging with the RIC stating that there is more support available through the ASN network. Education Scotland's STEM Team have since established an ASN-specific STEM network in 2022/23 in response to feedback regarding the fact that ASN practitioners were least well-served in relation to STEM professional learning, which has been very well received.

3.43 The above chimes with recent feedback in the Ken Muir report[13] for the Scottish Government:

"Regional Improvement Collaboratives are not visible at the school or classroom level. For many, it is not clear what added value they offer the life and work of schools. … it can appear that they inhabit an uncertain place between Education Scotland and local authority roles which further adds to the confusion about their purpose, activity and contribution."

3.44 However, some RICs have proved in other (non-STEM) areas that they can secure engagement from schools. For example, the South West Collaborative has an Outdoor Learning Group driving learning sessions which have attracted up to 90 staff (predominantly primary teachers) at each session but there has been nothing similar for the sciences. Evidence shows that the structures can exist to work cross-local authority on mathematics and numeracy and outdoor learning, but this is somewhat dependent on existing structures and priorities within RIC areas. Given that STEM is not a single workstream, it may require a different approach.

College STEM leads

3.45 The college STEM leads who were consulted all recognised it is in their interest to promote STEM, that stimulating demand generates future learners at the colleges. Making STEM more visible and ensuring it is on the college agenda is critical. They all work with schools to varying degrees to seek to widen access to further education, and in some cases higher education, in college.

3.46 The colleges consulted report vast differences across schools in their approach and level of resources and commitment to STEM learning. For example, some schools can be considered 'early adopters' who understand the importance of STEM and proactively encourage it in their school. In some cases, colleges focus on these schools as key influencers. Other colleges focus on those secondary

[13] Ibid.

schools where they have an established relationship. Working with the local DYW group is also considered a good way into schools and nurturing relationships with teachers as cited by Lews Castle College UHI for their engineering and renewables courses. DYW is also an alternative route into schools where the local authority has less commitment to or resource for STEM. In Ayrshire, however, the college finds it easier and better to work through the three local authorities to access schools and plan and co-ordinate activity, the latter being a better conduit into schools as each Ayrshire local authority has a STEM lead.

3.47 But whilst some colleges are proactively trying to stimulate demand and plan for the future, they are not yet seeing an increased interest in STEM-related subjects. However, this is against a backdrop of a fall in student recruitment across the board as a result of the COVID-19 pandemic. It is felt there is a need to continue to break down the barriers to taking STEM subjects, by gender and for other characteristics/issues. For example, there are perceptions amongst employers and young people that a degree qualification is needed to become for example, a lab technician. Some feel that school and other career advice can be outdated. Some colleges, therefore, actively target support to school careers advisors in order that they better understand industry as well as provide support to teachers, most of whom are graduates with little or no industry experience.

3.48 From an internal delivery perspective, those new to college lead roles (and others involved in STEM) can find it difficult to understand and get to grips with the extensive range of support for STEM that exists (resources and organisations). A better way of communicating what is available across the STEM landscape and its numerous actors would be welcomed.

3.49 As in secondary schools, there are also time pressures for lecturers: time to apply for grants and/or funding; time to arrange for a staff secondment and/or their post backfilled; and time to develop college/school partnership working. A number of colleges also mentioned, in addition to the time challenge is the college credit system which in some cases is considered a real barrier to doing more STEM promotional work. This may be because credits supporting engagement with primary schools was paused at the start of the pandemic to protect places for new college entrants who may have been out of work due to COVID restrictions. However, in November 2021 the Scottish Funding Council (SFC) reinstated this guidance in their mitigations letter to the college sector. SFC credit guidance for 2022-23[14] includes an allowance for STEM activity with primary schools which is above what many colleges were previously claiming.

Dundee and Angus College Head of Sector chairs the Regional STEM Partnership. The partnership is gaining momentum considering organising a STEM Expo – and both primary and secondary schools are engaging. Links into the Tay Cities Deal and potential funding is beneficial. The college are developing new courses as a result in for example, wind turbine operations and maintenance for 2026/27. The partnership is also driving more STEM CLPL for teachers in schools. There is also a new Skills Academy which is college-led in partnership with local Universities located in the Michelin Scotland Innovation Parc providing classrooms and science labs.
The college is running the Lego League for learners aged 9-16 (13 teams and 100 learners) the Young STEM Leader Award inside certificated college courses. There is also a programme where HNC/HND students to go into primary schools and support teachers and learners – which develops HNC student confidence and skills whilst supporting primary school pupils (and opens up the potential of STEM teaching to the HNC/HND student). The college has developed a STEM strategy connecting to all partners in the regional partnership – with measurable targets.

[14] https://www.sfc.ac.uk/publications-statistics/guidance/2022/SFCGD082022.aspx

3.50 Consultees agree that an effective regional STEM partnership groups can be very beneficial in stimulating collaboration and activity across the education ecosystem at all levels. This is well demonstrated by feedback from Dundee and Angus College presented below.

3.51 But there is the need to recognise that there are regional variations in terms of STEM industries. For example, Ayrshire College has great industry links to engineering and construction but far less so those industries which require digital skills specifically. In line with the original vision for the regional STEM partnerships, they should have an approach to the design and implementation of STEM learning activities and teacher CLPL which is bespoke to the needs of their area.

3.52 The sharing of knowledge and approaches to STEM promotion and engagement was also flagged as very important and useful if available. The STEM College Leads Forum at ESP (Energy Skills Partnership)[15], was highly praised for its support in general and as a platform for knowledge exchange and the sharing of best practice.

"It's great to learn from other colleges who are doing really good things like North East Scotland College, NESCOL's SuSTEMability programme for primary schools".

Another example was Borders College sharing their own STEM Strategy and Action Plan with other colleges at the forum.

3.53 Overall evidence suggests that colleges have an appetite for and accept that they have a critical role to play in delivering and encouraging STEM.

The school environment

3.54 This section presents the findings from our consultations with a sample of secondary school headteachers, depute headteachers, school STEM leads, STEM subject teachers and guidance staff. We examined the structural and operational barriers to STEM engagement faced in the school environment.

Challenges in setting up STEM

3.55 A number of challenges have been identified in setting up new STEM pathways in secondary schools. These are: staff recruitment and resource and teacher skills. We discuss each of these in turn below.

Staff recruitment

3.56 Headteachers report a fundamental challenge in recruitment of STEM teachers. This is particularly acute in certain subjects (computer science, mathematics and home economics) and in certain geographies (rural). Whilst recruitment is a more general issue for some schools, it is a particular issue for STEM subjects as opposed to non-STEM subjects.

3.57 Endeavours to recruit more STEM teachers have, to date, proven to be insufficient. One school has one teacher to cover all of Design & Manufacture, Graphic Communications, Practical Woodworking and Metalworking. The salaries offered to teachers do not match those that STEM subject teachers can achieve elsewhere. There is, therefore, little incentive to do a PGDE qualification and become a computer science teacher when you could become a software developer, given the far greater earnings potential in the private sector.

[15] ESP is the college sector agency in Scotland for energy, engineering, construction and STEM whilst also leading on the Climate Emergency Skills Action Plan

3.58 Although staff shortages and recruitment issues in STEM subjects are not universal, it is a clear challenge. Computer science seems a particular challenge with many schools not having a subject teacher at all, and this is affecting subsequent learner throughput into college (and subsequently the skills base). It is true that some schools have fared better, either through long-term retention of staff, good school reputation and/or location.

3.59 Partners working with schools (e.g. colleges) also observe teacher shortages, which is reducing school capacity and stretching the STEM teachers that do exist, so that these teachers too can struggle to engage with other organisations.

3.60 Teachers themselves do not directly cite staff shortages, yet it is clear from the feedback they are under considerable time pressures. This is most frequently cited in the senior phase and in relation to the need to deliver the curriculum in order to satisfy assessment needs. This leads to very limited capacity to do much over and above delivering the curriculum (see 3.64 below).

Teacher skills

3.61 There are also barriers in terms of teacher skills and capabilities to deliver STEM learning and ongoing challenges building STEM capital amongst staff and leaders. At primary level, there are challenges ensuring that there are dedicated staff to sustain a programme of STEM learning and teaching. In some areas (e.g. East Renfrewshire), the local authority has identified a nominated science champion in every setting. This is supported by a budget and a strategic programme to ensure practitioner access to STEM resources and learning materials. However, even with this proactive approach, turnover of staff is a key challenge which affects the continuity of teachers who champion STEM learning.

3.62 At primary and secondary level, as well as the early years and childcare sectors, practitioners typically do not have industry experience. As a consequence, a number of colleges in particular are trying to help bring this experience into the school setting. Examples include Dundee and Angus College and UHI College Outer Hebrides, the latter a good example of an explicit strategy to foster better college/ school relationships.

3.63 Some schools are themselves very active in developing employer and industry links, including success in securing employer input into new curriculum development. One example in Angus has seen a major food producer input into home economics course design, co-designed with teaching staff and delivered in school by the teacher (an S3 course in Food & Technology Design). Other schools have developed strong links with local renewable energy companies and other food and drink manufacturers (including distilleries). Some courses have led to learner presentations at local events/festivals.

3.64 Despite staff constraints and time pressures, there are very many examples of good STEM project activity, often provided outside core school hours and often utilising voluntary staff time inputs. Some of these examples are cited in subsequent sections. Career-long professional learning is a good way of developing staff capability, including through the STEM Grants Programme, also cited below.

Processes and structures in secondary schools

Delivering the curriculum

3.65 A barrier to further STEM engagement in secondary schools is the demand of delivering the curriculum. Repeated feedback highlighted that the heavy emphasis on assessment in the senior phase, presented a particular challenge. Teachers feel that so much is required by the curriculum that they cannot afford to take the time to try new things. There is also very little non class-contact time. In many cases teachers *want* to do more, they simply need more time to be able to do it. There is, therefore, a sense that what the SQA want (in terms of delivering courses and assessment) and what Education Scotland wants (in terms of more learner engagement in STEM) do not match-up. Whilst there is more scope within Broad General Education (BGE), the feedback applied across secondary schools.

3.66 Further, there remains somewhat of a 'silo' approach within secondary schools, geared around specialist subjects, with faculties/departments also typically operating in isolation from others. Some schools are managing to break this silo approach down more than others, and some have achieved greater levels of project-based interdisciplinary learning (IDL). However, for increased STEM engagement, much more needs to happen in this vein. There are of course numerous challenges in establishing IDL groups, which needs buy-in from different staff members. Whilst some IDL can be delivered through the drive of enthusiastic class teachers (who are able to bring in colleagues), more often this needs headteacher/senior management team buy-in and leadership. STEM may still be seen as just one priority (alongside other priorities) and needs championed within the overall plan for the school.

3.67 ASN schools are delivering holistic IDL more consistently, with a strong emphasis on approaches like computational learning, problem solving and collaboration, the meta-skill aspect of STEM, and learning about STEM applied in different situations. This is being developed in conjunction with timetable changes to address inconsistency of STEM offer across year groups, and is an approach worth exploring further in relation to the mainstream Secondary school sector.

3.68 More widely, there are challenges to get new areas of interest – many of which are STEM-relevant – into the curriculum, with the notable example being climate change/ sustainability. This continues to be poorly covered by the curriculum, recognised in the Muir Report[16]. There is also a need to embed STEM more firmly into existing qualifications. The issue of time taken to bring in new areas to the curriculum has been a long-term challenge.

Resources for STEM learning

3.69 Some elements of STEM can be resource intensive and many schools report that they lack the financial resources to invest in STEM. There are, however, several good examples of sharing of resources, such as UHI College Outer Hebrides running a competition involving 17 Primary schools thus extending the reach of available resources. Here, the College also has a STEM learning space similar to a 'Newton Room' to try to bring access closer to schools and introducing learners (and teachers) to new developments, such as the latest developments in blue and green hydrogen as a more sustainable energy source, to demystify this. The Energy Skills Partnership (ESP) are a partner in this approach.

3.70 In terms of shared resources for STEM, collaboration is effective, although collaborative working could be far more widespread. Overall, individual schools typically lack STEM resources (say, compared to colleges) and so there is scope for colleges to make their facilities more available to schools (e.g. IT, construction resources for CDT). It is also the case that there are equity gaps in terms of access to resources, including teachers in more affluent areas having more time to build STEM capital and relationships with further and higher education rather than having to address structural issues arising from inequity and inequality.

3.71 Further, many schools experience structural challenges associated with the practical delivery of some STEM subjects and courses, including the growing lack of IT suites. Increasingly, investment is in personal IT equipment for learners (e.g. iPads etc from P6 upwards in Glasgow) and as a consequence many IT suites have disappeared. Given the huge issue of timetabling for cross-curricula activities, there is also the issue of inflexible spaces (e.g. traditional labs) that compound timetabling challenges. To ease this, some schools have been redesigned, building in flexible spaces to allow more cross-curricula teaching. In summary, school facilities are often inflexible and do not enable IDL opportunities, and so there is a need for more flexible-use spaces.

[16] Ibid.

3.72 In other ways, technological advancements have facilitated positive change. The massive increase in the use of online learning and resources through the pandemic – and staff upskilling in online delivery methods – has increased employers and partner access to classrooms. There are now good examples of employers having remote access to schools, or schools arranging live video call inputs, for example in relation to COP26. Initial employer engagement online into a classroom can be a good way of starting the process of building a stronger relationship.

Leadership and management

3.73 Whilst there are many structural and process barriers to greater STEM engagement, strong and proactive leadership can overcome at least some of the issues. Fraserburgh Academy, for example, shows what can happen if there is positive and proactive leadership. The aforementioned Academy is in an area of relative deprivation, with all the structural constraints facing secondary schools, yet has demonstrated a willingness to do things differently, including building a strong cluster approach, developing a whole cluster STEM strategy from 3-18 years. They work effectively with the local college NESCOL and bring creative approaches to new curriculum development (e.g. the use of Craft Maths at the Academy as a pathway to the College) and look to lever in resources to support the delivery of STEM wherever possible.

3.74 Support from senior management /leadership teams and headteachers is therefore essential. It can be very difficult for teachers to implement STEM teaching ideas and projects (including the nuances around improving gender balance in participation of STEM) without management team support. However, where strong leadership for STEM exists, staff time can be created for dedicated planning of STEM activity for staff and pupils. As well as strong headteacher and management/leadership teams are the benefits of an effective school improvement plan that builds in STEM (and departmental improvement plans). STEM here needs to be integral, not an add-on.

Transitions/cluster working

3.75 At primary level, there continues to be a good level of STEM learning activities delivered in many P6 and P7 classes, often driven by the enthusiasm and capabilities of certain teachers. Consultations revealed many examples of this, including:

- Composite P6-P7 STEM classes in Shetland – here they have made good use of in-house STEM resources whilst drawing in support from SSERC and undertaking training for other school clusters). This has led to some success in maintaining enthusiasm in STEM amongst learners into S1 and S2;
- STEM Tuesdays at Tarbolton Primary school, South Ayrshire – here they have planned lessons around the STEM Tuesday for the whole school. Teachers collaborate on planning and resource development, allowing teachers to specialise in particular areas. Pre-COVID, teachers led three sessions on the day with three different classes. STEM Tuesdays have returned by pupil demand. There is also evidence that this approach is being rolled out in other schools in South Ayrshire; and
- STEM IDL project activities, Port Ellen school, Islay – here there are many projects which incorporate many elements of STEM. Through the drive of a teacher there, projects have included archaeology, involving scale drawing, analysing aerial photography etc., plastics in ocean (involving liaison with a school in Hawaii) and most recently a project developing with a local distillery. Each has involved creativity in the STEM planning and clarity on learner expectations/ outcomes.

3.76 These are just three examples, and many other primary schools have been involved in coding and so on, often (although by no means always) with STEM Grants Programme support. Many schools are quite proactive in running these and several primary schools report benefiting from the 'central resources' of the local authority, including those in more remote and rural schools. Projects work best where this relevance of teaching for learners i.e., where primary school pupils can see a direct impact from what they do (e.g. creating habitats, planters). Team teaching is also effective, yet also challenging to make happen in terms of planning, co-ordination and time commitments.

3.77 Even though there are many successes at primary school level, there remain issues of staff confidence to deliver STEM, including the lack of confidence in a gender-aware curriculum and teaching. The STEM Grants Programme and other support measures have helped in this space, yet this remains a constant challenge to keep the confidence up amongst primary school teachers in relation to STEM. Whilst there is a raft of exciting STEM-related activity (from sensory gardens to dedicated outdoor learning areas) there is an ongoing challenge to grow and embed this. As mentioned, sharing resources is important, as are all endeavours to upskill primary school (and early learning and childcare) practitioners (e.g. one Dundee and Angus College's use of HNC/HND students to help deliver STEM learning in local primary schools).

3.78 Even within the primary school setting, the curriculum is viewed by some as cluttered with scope to incorporate more learning through STEM within it. Engineering is an area where skills are lacking most amongst primary school teachers, with more of the primary practitioner learning opportunities related to science (and mathematics) rather than engineering. Teachers also lack confidence in areas such as basic coding which is often outside their comfort zone. Some colleges therefore (e.g. UHI Outer Hebrides) have offered training to teachers (e.g. in robotics).

3.79 Tarbolton Primary School is a good example of the dedicated STEM lead successfully upskilling colleagues, thus helping to deliver STEM learning across the school, including both STEM specific and interdisciplinary learning projects. This cascading of knowledge to staff has helped build their capability and confidence, so that STEM learning sits largely with the teachers, rather than with the STEM lead.

3.80 Some secondary schools are putting a considerable amount of emphasis and resource into STEM at the S1-S3 BGE stage and seeing some positive results in terms of enthusiasm for STEM. This is part of a longer-term view to build engagement with STEM. However, this is not yet generally translating into an increased take-up of STEM subjects in the senior phase and it remains the case gender imbalances in the take-up of STEM persist.

3.81 One school is specifically developing a dedicated S1 STEM course. It is too early to see the long-term impact of this but theirs is a genuine attempt to deliver IDL. This has taken a lot of work to develop and forms part of their overall STEM strategy and desire to create pathways into STEM. For the S1 course, the school is developing resources based around a number of challenges – with a lesson attached so that there will 8-10 challenges and 8-10 lessons (one lesson for each challenge session). These combines 'hard' and 'soft' skills. Another example is Monifieth School in Angus, where the school has worked as part of cluster-led IDL from primary into secondary and where there is a focus in S1 on problem-solving and breaking down subject silos. Four S,T,E,M subject teachers have come together to deliver a timetabled STEM course, focusing on issues such as a best-practice new town development and renewable energy in the form of wind power.

3.82 At Larbert High School, Falkirk, they run a STEM Academy Programme to capture the interest of those keen in STEM. This engages primaries in their cluster and the STEM Academy lessons sit alongside discrete science and technology lessons. This helps to stimulate greater uptake in the senior phase (and continuation into senior STEM Academy) in turn leading to accreditations and qualification (including Skills for Work qualification at the end of S3). This frequently then leads on to industry placements and ultimately exposure to university level research, supported by Forth Valley College and Strathclyde University, as well as major employers such as Obashi and Network Rail.

3.83 The research identified further examples of good practice, and these are too numerous to document here. At the same time, much of this is extra-curricular, project-based activity, quite often through competitions and often where external funding can be secured (e.g. Formula 1 design competition). Again, this is often reliant on the drive and enthusiasm of certain staff members. As discussed, this is easier to carry out prior to the senior phase. Arguably, there is a need for more STEM within subjects to get round issues of timetabling. It is hard to keep the momentum from primary schools going into S1 to S3, and harder to still to continue engagement into the senior phase beyond subject teaching.

3.84 There is a recognition amongst schools that staff need confidence in STEM (including a greater awareness of the barriers to participation for different genders) before this can be transmitted to learners. As such, one school (the Community School, Auchterarder) is developing a STEM self-improvement evaluation framework with staff which is looking at cross-subject observation to assist with staff learning to build confidence and understanding of STEM application across subjects – building STEM capital across teaching staff. Others are looking to take advantage of support measures such as Education Scotland's Secondary Sciences Network, set up post pandemic to allow science teachers in secondary school to share practice, approaches and resources through GLOW. Many consultees valued the support available via SSERC for secondary school professional development. There is also some evidence that non-STEM staff are developing an appetite to learn and develop STEM skills using mechanisms such as tech to teach and opting in to STEM-related CLPL sessions with external experts.

3.85 Further, it remains that for those learners pursuing five Highers in one sitting, or equivalent, there is a much lower tendency to be involved in employer visits, STEM work placements etc. There is limited time or effort to introduce this cohort to real employment situations (when compared to those who may take other pathways). A broader approach is possible through S1 and S2, but this reduces even into S3 and then again in S4, and then the 5 Higher approach in the curriculum does not allow STEM/project-based learning. Work experience/ visits could/ should therefore be built into courses at Higher, and across a range of STEM-related subjects, from health courses, energy courses and including experiences such as lab sciences etc.

3.86 Overall, STEM engagement works well where there is a cluster STEM coordinator and the adoption of a whole school approach. This means that STEM is more likely to be delivered across the school curriculum, for example with Design and Manufacture alongside more mathematics and sciences subjects and with a focus beyond just, say, practical on the Design and Manufacture side. Such schools are using design and technology subjects in a creative way to apply science and embed STEM.

Factors affecting subject choice/senior phase pathways

3.87 Across those consulted, there were several examples of schools working well with colleges to offer increased pathways in the senior phase. This includes a school in Dumfries & Galloway creating new courses offerings for learners such as Environmental Science and Food Production to diversify into areas where there is local demand from employers (e.g. renewable energy/ sustainability). We have already mentioned examples of schools working well with Dundee & Angus, Forth Valley, UHI and North East Scotland Colleges amongst others. At the other end of the spectrum, however, school links with colleges is weak with a limited relationship and where some schools complain of a lack of college placement opportunities e.g. in relation to Skills for Work National 5.

3.88 Where good links exist, sometimes these are driven by the school, sometimes the college and sometimes the regional STEM partnership or DYW coordinator (or all of the above). Good working relationships can lead to the promotion of apprenticeships, increased work placements, college and employer site visits (e.g., engineering, technicians etc.) and so on. As discussed, school subjects are still narrowly drawn, so some schools are working with colleges to deliver STEM masterclasses to increase choices and STEM pathways.

3.89 It is widely reported that the COVID-19 pandemic has led to some setbacks in bringing forward pathways and learner interest in STEM, especially where there has been reduced opportunities for practical work (for example use of science laboratories) and reduced opportunities for employer visits. One school in rural Perthshire reported that senior phase STEM offers have not been as popular/successful as hoped, citing that this was a result of the pandemic. It was certainly the case that a lot of the extra-curricular STEM activities (via after-school clubs for example) were not delivered as a result of the pandemic and this may have negatively impacted on STEM take-up (and reversed some gains that were being made to increase take-up).The COVID-19 pandemic also led to an increase in inequality arising from the impacts of COVID-19 (such as increased poverty, a rise in young carers, absences from school, increase in domestic abuse, reinforcement of gender roles at home) which have all negatively impacted learners' ability to engage across the curriculum, including STEM.

3.90 Many schools wish to offer the most flexible and wide-ranging set of options they can, so that more pathways are available to learners (and so a learner *can* do three Sciences for example etc.). This is not always achievable, however, especially within the staffing and timetabling constraints identified. Learner pathways in certain STEM subjects are not available if, say, there is no computer science teacher in S4-S6. It is therefore often left to colleges to try to fill the gaps in computing – from cyber security, to programming/coding in primary and secondary, through to HNC Computing. Again, schools with strong college links are the ones most likely to benefit most from this support. Others are seeking to be creative to overcome issues of staff constraints, such as using the STEM Grants Programme, to create a computer offer using non-computing staff.

3.91 In a number of instances, schools report the 'creative timetabling' of STEM subjects, repositioning STEM subjects so that they clash as little as possible with other subjects. However, others considered there to be sufficient flexibility within CfE to allow for STEM to be timetabled, for example in moving from the 3+3 model of teaching split (BGE/senior years split) to 2+2+2 – integrated science until end of S2, allowing for deep thematic teaching, then individual science in S3/S4, then N5 teaching in S4. These schools report that they have been able to create more flexible pathways as a result, increasing subject choices and positively impacting on attainment. This perhaps brings in the question as to whether more can be done to support senior leadership teams and local authorities to collectively mould timetables to ensure more effective delivery of STEM (and other) education.

3.92 Several practitioners report that STEM subjects are still seen by learners as difficult and perceived to be associated with males and elitism. This remains a barrier to take-up (including a perception is it harder to get a good grade) and in turn this can affect the extent to which schools seek to make STEM subjects available. The offer in schools is also uneven across the S, T, E and M – with mathematics still a core subject (and hence universally offered), typically followed by sciences. The 'T' (technologies) on the other hand may have a more limited offer in schools and there is little 'E' - engineering (with a view expressed that engineering needs to move more into problem solving, perhaps linked to global issues and the Sustainable Development Goals).

3.93 Despite all the best efforts of schools to create STEM pathways, much still is vested in the enthusiasm and capability of the individual teacher and this remains one of the key determinants of learner subject choice, as highlighted through the engagement with learners themselves in Chapter 4. In essence, this means there needs to be a focus on building the capacity and expertise of STEM teachers. This will be achieved through the recruitment, nurturing and developing of high-quality teaching staff who are aware of the gendered barriers to taking STEM subjects, and who are committed to promoting diversity and equality.

Equity and equality

3.94 In terms of overall access to STEM and equity of access, it remains the case that learners need literacy and numeracy skills in order to access STEM subjects and there remains too much of a gap in terms of those with and without these core skills. A higher proportion lack literacy and numeracy skills amongst certain groups and in certain geographical areas, notably those with greater levels of multiple deprivation due to the structural barriers presented as a result of poverty. This continues to reinforce inequity in the take-up of STEM in schools.

3.95 Beyond this, there continue to be cultural and perceptual barriers to the take up of STEM, and within schools some practical barriers related to access to, and availability of resources, including IT equipment and laboratory space. Those schools in areas of multiple deprivation typically do not have as high take-up rates as more affluent areas in sciences, for example, and there needs to be a breaking down of the perception that these subjects are only for 'high achievers' or for those who are male, middle-class or white. Those from areas of multiple deprivation can face additional challenges in achieving well in STEM-related learning, perhaps due to the lack of science capital they experience or due to less learning support being available to them out with school. Regardless of learner background, there is a need to change perceptions that many STEM training and job opportunities require individuals to be "high-flying scientists/engineers", a perception that demonstrates a lack of awareness of the many varied STEM career pathways. There is also high demand for other roles (e.g. technicians within laboratories), where different pathways may exist.

3.96 School teachers in rural areas perceive a lack of equity in access to STEM support. They do not, for example, have a science centre on their doorstep, so many are seeking to make good use of links to local colleges and, where possible employers (although even this can be challenging since they often lack large employers too). Others successfully make use of local rural assets, notably the outdoors and rural economy employment sectors (such as food and drink). The pandemic (and resulting increase in availability of online CLPL for teachers) has also helped overcome some geographic barriers to take up of STEM support, which in turn has helped the delivery of STEM for learners.

3.97 As highlighted, the delivery of STEM learning is often reliant on the will of staff and the available leadership/collegiate time. Understandably, schools and departments have their own priorities. In larger schools, this can often be better managed, and a broad spectrum of STEM learning delivered, However, in smaller schools it becomes more of a challenge. This creates issues of inequity and geographical inequality, as many smaller schools are typically located in rural areas.

3.98 There remain institutional and cultural barriers to addressing gender inequalities. One former (female) industry engineer, now a college STEM lead, says lots *can* be done to engage women and girls, but not enough *is* being done. Some of those interviewed felt that national programmes, such as the Young STEM Leader Programme and Primary Engineer, were good for engaging children of all genders. At the same time, there is scepticism about some approaches (e.g. women in STEM courses for female learners only) with softer 'step into STEM' type approaches preferred.

3.99 Some consultees fed back that there is a sense that tackling gender inequality continues to be a bit piecemeal, and that whilst there are certain good initiatives, these are not widespread enough. Given the efforts of Education Scotland's IGBE team and others, this may be somewhat unfair. However more could still be done. Some individual schools/ teachers are trying to drive greater change, such as one consultee (in the Angus area) who cited that the female computer science teacher is extremely proactive (and effective) at promoting the subject to girls, although it is recognised that a role model approach is not sufficient to overcome gender balance barriers (and it is the relationship between the young person and the teacher that is critical, on not the gender of the teacher). Rather, efforts to address gender balance in STEM are only effective when embedded in a sustainable, intersectional, whole setting approach aimed at addressing inequality more generally. Practitioners may consider that gender equality within a department is important, however wider research indicates that it is the typically the quality of the teacher-pupil relationship and how the learner intrinsically values the subject that is critical.

3.100 Overall, the report finds that positive change *is* happening, but it is slow. The role of parents is critical here, and there is still a need to break down certain perceptions held by parents, through more sustainable approaches, and conveying to parents the wide range of opportunities afforded by alternative STEM pathways. Unconscious gender bias means some STEM careers have been discounted before children reach nine years of age. Emerging self-identity due to societal gender norms means that for many learners STEM does not align with who they feel they are and what is 'for them'.

3.101 As stated, there are good examples of positive change, for example the UHI STEM Hub reports a very positive increase in female apprenticeships in STEM, including engineering (although this does not happen everywhere, partly a result of approaches to careers advice still being directed at boys – see next section). The UHI STEM Hub is, however is continuing to try to break down traditional cultural barriers. This includes construction for example, which is traditionally male dominated. The Hub is changing the way STEM professions such as building design, architecture and surveying are described and articulated thus increasing take-up in (although there are still challenges in take up of Mechanical and Civil Engineering). In their recent round of admissions to UHI there was a strong increase in female take up of social sciences (with one consultee suggesting that this is linked to an increased awareness of global sustainability and climate change issues).

Careers advice and support

3.102 Careers advice and support available in schools can struggle to keep pace with the changes in industrial sectors, employer demands and employment patterns. Some colleges (e.g. Dundee and Angus College) are therefore taking the lead in trying to update the knowledge of school careers advisors (#nowrongpath). Elsewhere, Moray College have developed S3 taster days linked to their 10 STEM pathways, and here they ensure they involve careers advisors as well as teachers in these events.

3.103 Where strong partnerships exist, guidance and careers advisors are part of this, for example the UHI STEM Hub. Careers advice and support works best where schools and teachers are highlighting the career possibilities associated with STEM subjects/pathways as part of their teaching and learner engagement (including STEM links to finance, HR, hospitality, healthcare, etc.). Again, DYW coordinators and Regional Groups, SSERC and others can and do feed into and support this activity, but more remains to be done. Schools that engage parents are also more effective and relate STEM subjects to 'real world' jobs. There continues to be a need for better careers advice which can often encourage learners to make choices based on what they enjoy or feel that they are good at. This can perpetuate gendered choices. Careers advice still typically signposts boys more often towards work-based learning or apprenticeships, rather than girls.

4 The learner voice

Introduction

4.1 The preceding chapter considered the wider and school environment in which learners study STEM subjects. It also examined the perspectives of schools, teachers, local authority and college STEM leads and other stakeholders with regard to structural barriers and challenges for learner engagement in STEM. This chapter sets out the findings from engagement with learners through the online learners' survey, as well as learner-focused findings from across our consultations with STEM leads and teachers. It also draws on relevant findings from the online parents' survey, and desk review of secondary evidence. In doing so, it contrasts the learner voice with that of those that provide the learning.

4.2 In total, the online learners' survey received 1,309 responses. The profile of respondents to the learners' survey is detailed in the Tables 4.1 (school stage and gender) and 4.2 (disability and caring) below.

Table 4.1: Profile of Learners' Survey Respondents by School Stage and Gender

School Stage	%	Gender	%
Primary 6 or Primary P7	32%	Male	45%
S1-S3	37%	Female	50%
S4-S6	31%	Prefer Not to Say	5%
Total	**100%**	**Total**	**100%**

Source: ekosgen survey of learners, 2022 (School Stage n=1,303; Gender n=1,074)

Table 4.2: Profile of Learners' Survey Respondents by Disability, Care Experience and Carers

Disability	%	Care Experience	%	Young Carers	%
Yes (including additional support needs)	12%	Yes	14%	Yes	8%
No	60%	No	41%	No	72%
Don't Know	20%	Don't Know	41%	Don't Know	15%
Prefer Not to Say	7%	Prefer Not to Say	4%	Prefer Not to Say	5%
Total	**100%**	**Total**	**100%**	**Total**	**100%**

Source: ekosgen survey of learners, 2022 (Disability n=754; Care Experience n=768; Young Carers n=767)

4.3 With regards to ethnicity, eighty one percent of survey respondents were White. Of the remaining respondents, 5% were Asian, 2% were Black, and 1% of respondents were Gypsies/Travellers. Three percent of respondents were from other ethnic minorities, and 9% of respondents preferred not to state their ethnicity (N=773).

Engagement and in-class experience

4.4 The majority of respondents to the learners survey report they have STEM lessons either fairly or very often (87%). Overall, science lessons are preferred the most; 36% identified science as their 1st favourite, and 24% their 2nd favourite subject. Technology was identified as the second most popular overall, with 20% and 26% ranking it their 1st and 2nd favourite respectively.

4.5 Female learners are more likely to identify science and mathematics as their favourite subjects. In total, 46% of female respondents identify science as their favourite subject versus 35% of male respondents, and 24% of female respondents identify mathematics as their favourite subject versus 15% of male respondents. In contrast, males are more likely to report technology (28% of male respondents vs 12% of female respondents) and engineering (26% of male respondents vs 12% of female respondents) as their favourite. Table 4.3 sets out the order of preference by school year grouping.

Table 4.3: STEM subject preference by school year grouping

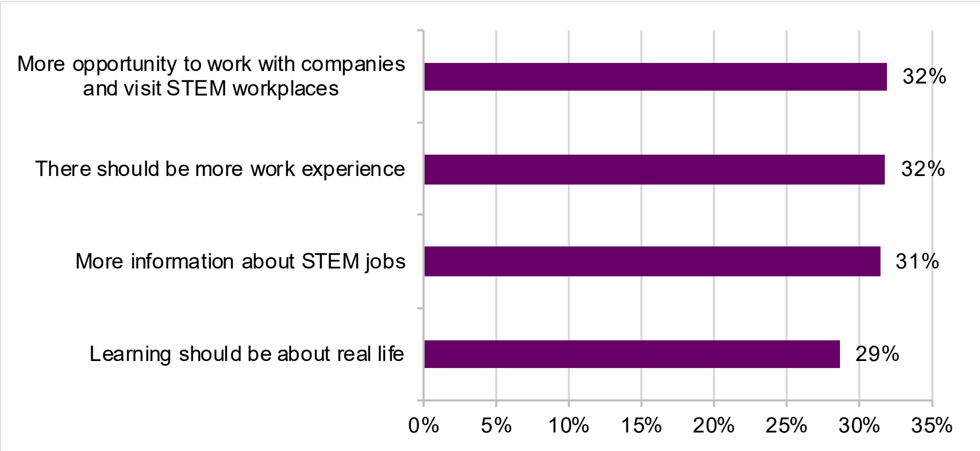
Ranking	P6-P7	S1-S3	S4-S6
1st	Science	Science	Science
2nd	Technology	Technology	Mathematics
3rd	Engineering	Engineering	Engineering
4th	Mathematics	Mathematics	Technology

Source: ekosgen survey of learners, 2022 (n=1,233)

4.6 Active, enthusiastic teachers are critical for engagement of learners. Throughout our consultation with teachers, where there was evidence of teachers who are enthusiastic and passionate about teaching and their subject, it was reported that learners were choosing to take and continue studying STEM subjects, and get engaged in STEM challenges, extra-curricular learning, etc. For some secondary schools, this meant that ensuring the best and most enthusiastic teachers were deployed in earlier (BGE) phases, to maximise the potential for learner engagement and to target pupils with lower enthusiasm and motivation for studying STEM subjects.

4.7 However, evidence from the learners' survey indicates that learners want their learning experience rooted in the real world – subjects and topics that are relatable for them. This includes more applied learning, learning in context, with up-to-date real-world subject matters. Some learners also want greater connections made through their learning with businesses (32%; Figure 4.1). Almost one third expressed an appetite for more opportunity to engage with businesses and visit live workplaces or take more work placements/experience – accompanied by more information on STEM jobs (31%).

Figure 4.1: Factors that would encourage more pupils to take STEM subjects



Source: ekosgen survey of learners, 2022 (n=1,019)

4.8 This view is echoed more strongly by parents: 59% of parents want more opportunity for their children to work with businesses through their learning, whilst 52% would like their children to receive more information on STEM jobs through their learning. Forty-seven per cent of parents would like to see more work experience.

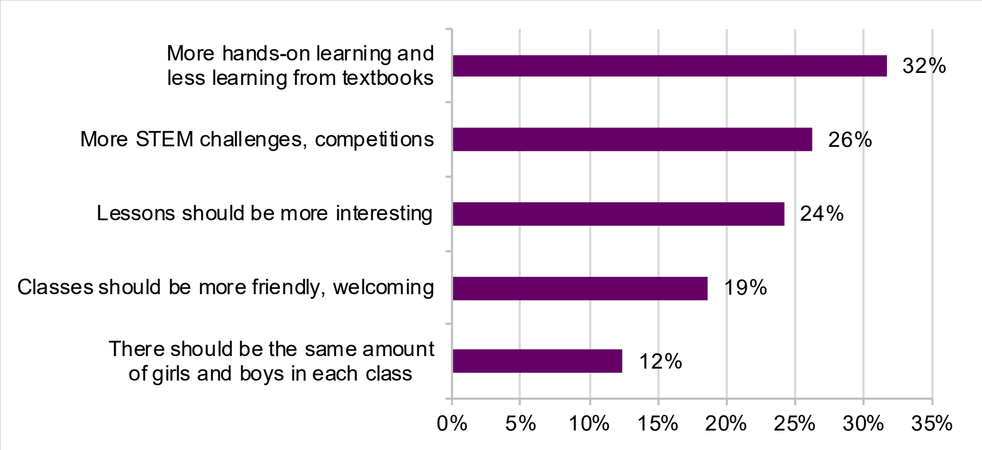
4.9 There is also some enthusiasm amongst learners for more engaging modes of learning. This includes challenge-based learning and experiential learning grounded in real life – help to make learning more interesting. Again, this is more strongly echoed by parents: 46% think learning through STEM should be more rooted in real life rather than more abstract, theoretical learning. Teachers also recognise this. One teacher consulted with reported that:

"Lab skills stuff…WISE challenges – if it's out there, kids want to access it."

4.10 The majority of learners feel welcome in their class (70%), with an average weighted score for how welcome they feel in class of 1.84 (scale of 1-5 where 1 = welcome, 5 = unwelcome). This is at its highest in P6-P7 (77%), with an average weighted score of 1.67. These broadly correlate with the findings from the parental survey. Interestingly, females are slightly more likely to report they feel welcome in STEM classrooms (in particular, +6pp. more females scored this as “1” than males (50% versus 44%), and +3pp. more females scored this as “1” or “2” (81%) higher than males (78%)). The majority of learners also think that others feel welcome in classroom (58%).

4.11 Despite how welcomed learners reported they felt, there seems to be some scope for improving this (Figure 4.2). At least for some learners, an improved gender balance in classes would help. This is particularly apparent in females, with almost double the responses relating to a greater gender balance coming from females (56% of gender balance responses) than males (29%). Interestingly, more females than males expressed an appetite for more STEM challenges and competitions – in contrast to some research that suggests that female pupils are less likely to engage in competitive activities. Care needs to be taken, however, to avoid scenarios where STEM is seen to be for solo-geniuses, or only for high-performing learners.

Figure 4.2: Factors that would encourage more pupils to take STEM subjects



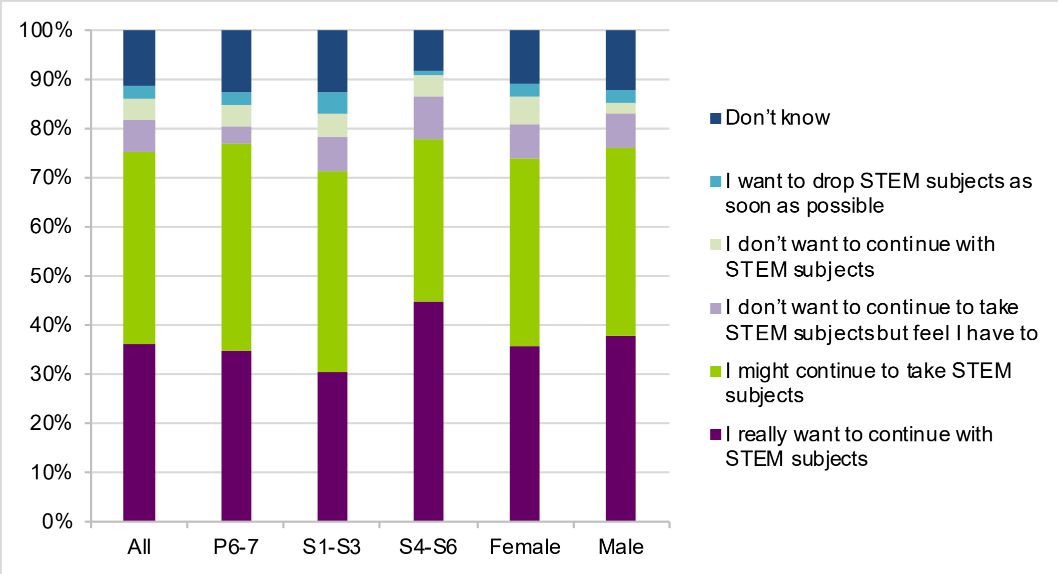
Source: ekosgen survey of learners, 2022 (n=1,019)

4.12 The use of Young STEM Leaders as subject ambassadors was reported by stakeholders as a key tool in helping to grow STEM skills in senior phase pupils, but also in driving engagement amongst both secondary pupils and in primary schools. There were also reports of co-delivery of lessons (between primary teachers and Young STEM Leaders). This helped to boost the confidence of primary school teachers, which in turn enables greater levels of engagement amongst primary school learners.

Subject choice

4.13 Most learners want to or are thinking about taking or continuing STEM subjects (75%; Figure 4.3). This is a positive finding in terms of continued STEM engagement. This attitude is most pronounced at S4-S6 (70%), and amongst males (76% vs 74% female). However, those in S1-S3 are least likely to want to take or continue with STEM subjects – though the proportion is still high at 70%. Nevertheless, learners in S1-S3 are most likely to report that they want to drop STEM subjects as soon as possible (4% v. 3% overall).

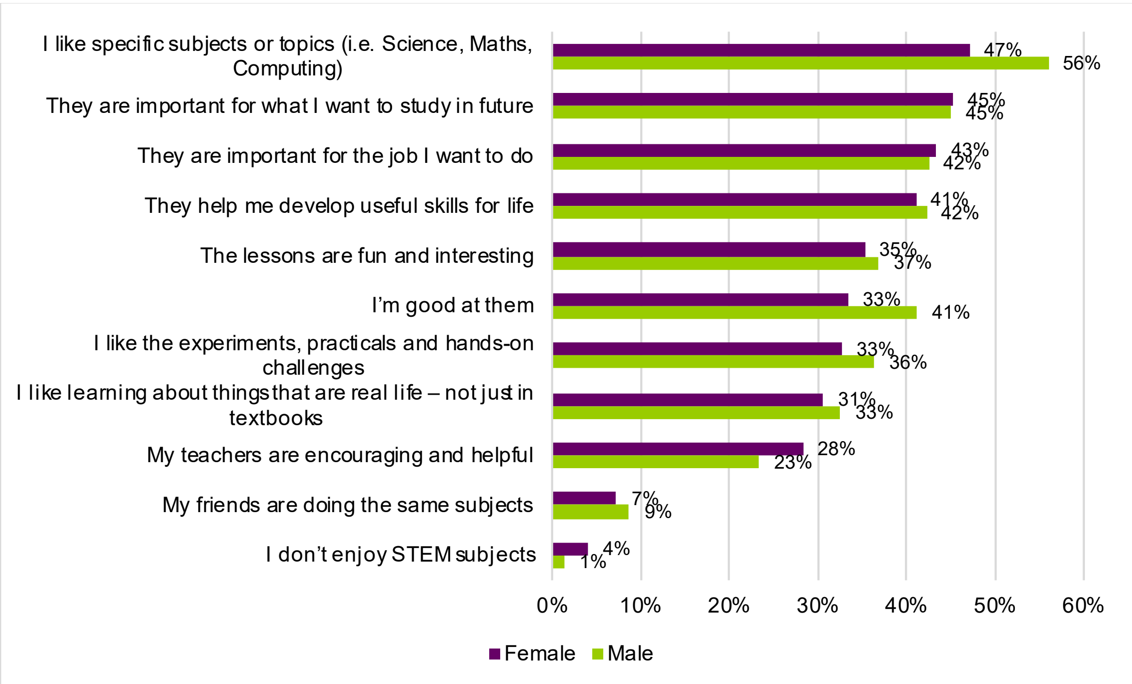
Figure 4.3: Intentions regarding studying STEM subjects



Source: ekosgen survey of learners, 2022 (n=1,185; P6-P7 n=422; S1-S3 n=482; S4-S6 n=399)

4.14 Where learners want to take or continue with STEM subjects, the reasons for this are all strong, positive drivers for (continued) engagement. More than half of respondents want to because they like a specific subject or topic (52%), whilst many recognise STEM subjects as important for future study (46%) or work (42%). Senior phase pupils are more likely to recognise the importance of STEM for future study than those in S1-3 or primary. Primary pupils are more likely to state lessons being fun and interesting as a reason for taking or continuing STEM study. Males are more likely to express a like for specific subjects (56% vs 47% female) or being good at STEM subjects (41% vs 31% female) as a reason for wanting to take them than females. Females are more likely to continue in STEM as subjects are important for the job they would like in the future (43% vs 42% male) and because they find the teachers to be encouraging and helpful (28% vs 23% male).

Figure 4.4: Learner reasons for wanting to continue studying STEM subjects



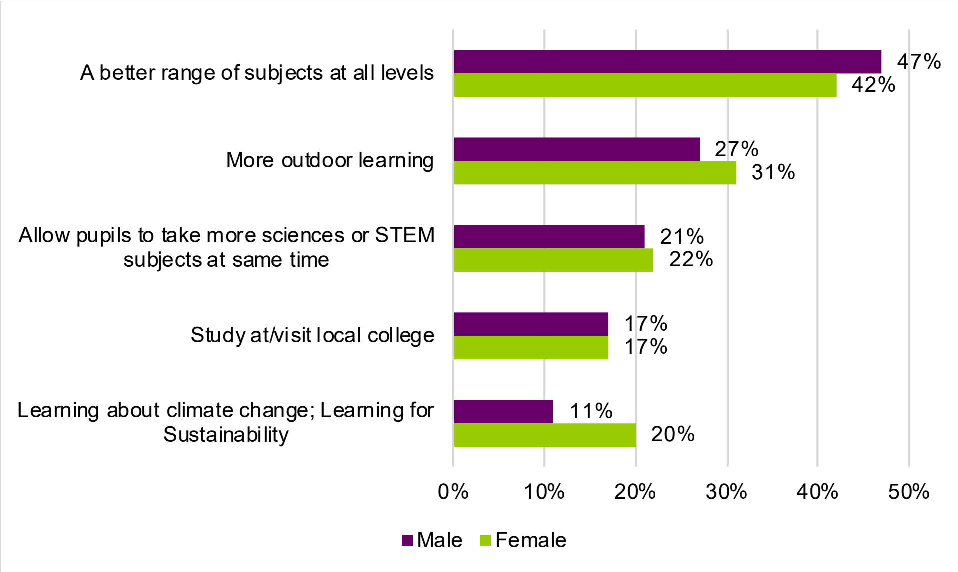
Source: ekosgen survey of learners, 2022 (n=951)

4.15 However, where learners have dropped or plan to drop STEM subjects, not enjoying subjects is the main reason (48% of those dropping STEM subjects said so). While this was the main reason given across all stages, this was more pronounced at S1-S3 level (63% of respondents dropping STEM subjects) than S4-S6 (56%), and was also more pronounced in females (60% of respondents stating their gender for this option were female). Some 30% of learners said that they wanted to drop STEM subjects as they were not good at them, while 30% of learners also believe that STEM subjects are not important for a job and their future careers. These were also more pronounced choices for female respondents, with 66% of respondents saying they did not feel they were good at them being female and 55% of those saying it will not be important for their future careers (that have stated their gender) being female. Males were more likely to say that they were dropping STEM subjects because the exams were difficult (66% of those stating their gender) or because they did not feel encouraged by teachers (100% of those citing this were male).

4.16 A better range of subjects offered at all levels was identified by most pupils as a means to help encourage more pupils to engage with STEM (45%; 54% of parents). Tailoring pathways to all abilities and ensuring parity of pathways etc., (not just the Higher route) is seen as important. Some 11% of learners reported 'no provision of work-based STEM learning' as a barrier. This would help overcome issues of (perceived and actual) difficulty, and confidence in STEM learning. As Figure 4.5 shows, 22% of learners feel that schools should allow pupils to take more STEM subjects at the same time; 40% of parents feel that this should be the case.

4.17 This reinforces findings from the Connect 2021 parent/carer survey, where whilst 45% of respondent parents agreed that there was flexibility in school timetables, 31% disagreed or strongly disagreed there is a flexible timetable with options for everyone. These are important findings when considering that 21% of respondents to the learners' survey felt that their school timetable doesn't allow them to take the STEM subjects they want.

Figure 4.5: Factors that would encourage more pupils to take STEM subjects



Source: ekosgen survey of learners, 2022 (n=1,019)

Perceptions

4.18 Learners view STEM subjects mostly positively (Figure 4.6). Learners in P6-P7 are most likely to report STEM subjects as being enjoyable, fun and exciting, which is positive. This appears to validate the STEM activity delivered at primary level and designed to engage more learners in STEM. Learners in their senior phase (S4-6) are most likely to see STEM subjects as interesting and useful, but also as hard – perhaps reflecting the nature of the subject matter dealt with at this level, and the requirements of examinations/assessment for learning.

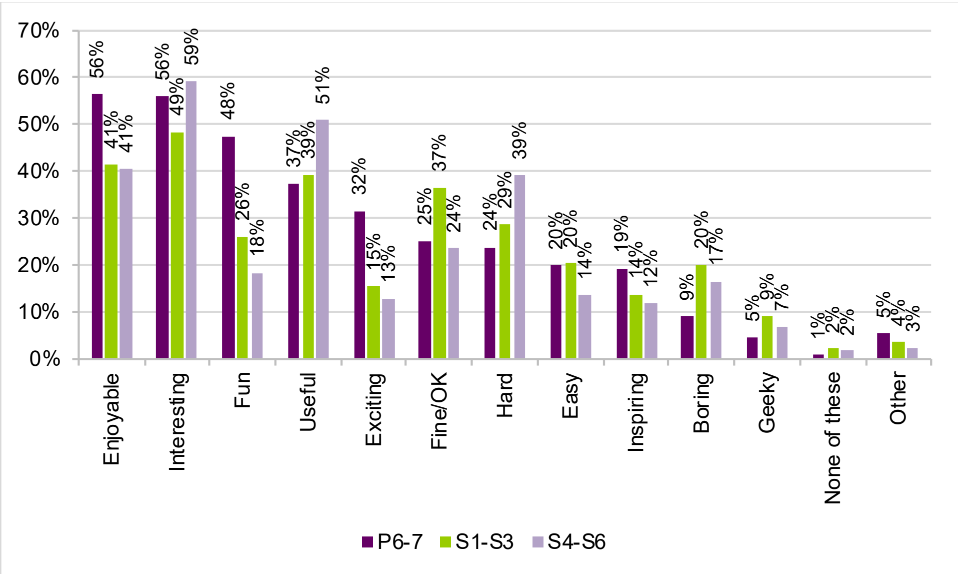
4.19 Female learners are most likely to describe STEM subjects as interesting, with 60% of female respondents to this question answering as such. 49% of female respondents described STEM subjects as useful, while 47% found STEM subjects to be enjoyable. The most common response to this question among male learners was also interesting, with 56% of all male respondents selecting this. This was followed by enjoyable, with 51% of male respondents describing STEM subjects as such and 42% finding STEM to be useful.

4.20 However, S1-S3 learners – those learning in Broad General Education (BGE) – are least likely to think STEM is interesting, and most likely to consider STEM subjects as boring. This indicates a challenge in engaging learners at the BGE phase. S1-S3 learners are also the most likely to report STEM subjects as being 'geeky' – suggesting that perceptions of STEM subjects are most important during this phase.

4.21 Where respondent learners indicated "Other", responses were mixed, with both positive and negative views of STEM subjects. These included learners seeing STEM subjects as challenging, competitive, imaginative, fun, but also confusing, stressful, or unengaging due to the way they are taught – for example, some learners did not like an approach that appeared to be geared around exam preparation rather than teaching for learning.

4.22 However, 28% felt that STEM subjects were "not suited to someone like me", and 20% felt that they "didn't fit in with people who take STEM subjects". Additionally, 12% of learners thought that you needed to be "really brainy" to take STEM subjects. Female learners were more likely than males to cite difficulty with mathematics, with 36% of female respondents to this question selecting this compared to 17% of males. This is an important finding in terms of perceptions of STEM subjects, and "who they are for" – and one that should be addressed.

Figure 4.6: Learner perceptions of STEM subjects



Source: ekosgen survey of learners, 2022 (n=1,243)

4.23 Assessments in STEM are mostly seen by learners as okay: more than half reported that this was the case (53%), though 31% reported that assessments were hard (weighted average rating of 3.22 on a scale of 1-5 where 1 = easy and 5 = hard). Learners have a similar view of the amount of classwork (3.15 weighted average score, 1 = too little, 5 = too much). Some learners reported that they would like fewer assessments (21%), whilst others want more ongoing assessment rather than exams (18%).

4.24 The parents' view of assessment is similar. However, in contrast to learners, parents think there is too little classwork and homework (yet they are more likely to think that other parents view the level of classwork or homework as okay). This reinforces findings from the Connect 2021 parent/carer survey, which reported that 61% strongly agree or agree continuous assessment is a fairer way to reflect achievements and learning. Further, 53% of respondents to the Connect 2021 parent/carer survey strongly agree or agree that three years of external exams (S4 to S6) is too much for young people.

4.25 Interestingly, learners' perception of other pupils' views is similar. Around 34% of learners think that others feel STEM subjects are interesting, and that other learners view assessments as neither easy nor hard (41%, weighted average rating of 3.3). Additionally, 53% of learners think that other learners consider the amount of homework and classwork as okay (3.25 weighted average rating).

Pupil confidence

4.26 Reported confidence amongst learners is reasonably good. The largest proportion of survey respondents think that they are either okay or good at STEM (73% in total), whilst a smaller proportion think that they are really good (16%). The weighted average for self-assessment is 2.52 (on a scale of 1-5, where 1 = really good and 5 = really struggle; Figure 4.7). Self-assessment is better at S4-S6 (2.47), with a larger proportion considering themselves as at least good.

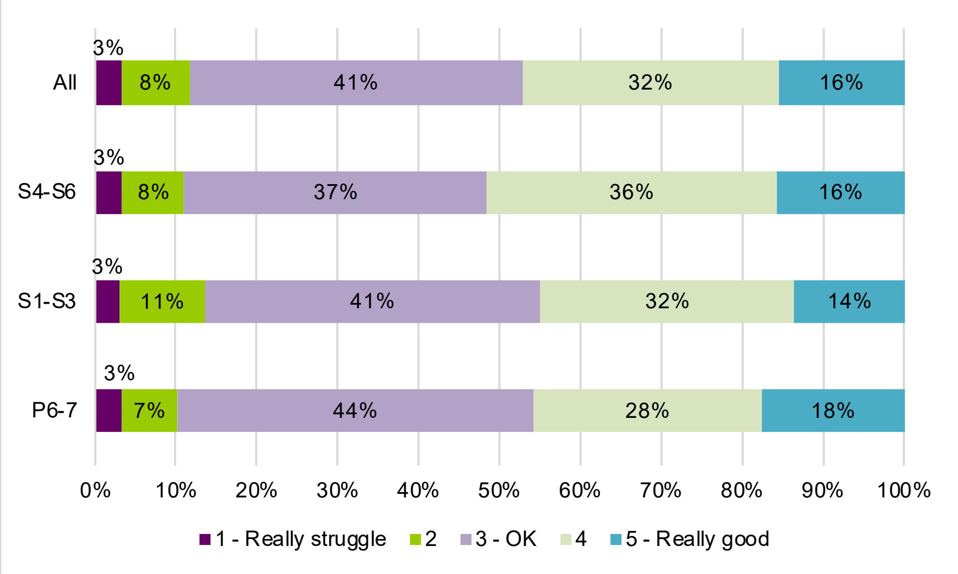
4.27 There is a higher confidence level among males than females. The weighted average for male learners is 2.39, compared to a weighted average of 2.63 among female learners. 53% of male learners consider their competency to be a 1 or 2, compared to 41% of female learners.

4.28 Also, the perception of other learners' capability is positive. Many learners think that other pupils have been told by the school that their grades are good enough (49%). However, 28% think that other pupils have neither been told their grades are good enough nor not good enough – suggestive of need for more encouragement for learners from schools and teachers.

4.29 Males were slightly more inclined to believe other learners' capability was good than females. The weighted average of other learners was 2.17 for males, and 2.23 for females. 29% of male learners believed other learners' capability was "good enough" (1) compared to 25% of female learners.

4.30 The majority of learners' parents think their child's/children's view of their ability is that they have been told by the school that their grades are good enough (73%). Only 3% think their child's/children's view of their ability is that they have been told their grades are not good enough (weighted average rating 1.81).

Figure 4.7: Learner self-assessment of capability in STEM subjects



Source: ekosgen survey of learners, 2022 (n=1,203)

4.31 An influencing factor in learners' confidence may be how STEM subjects are perceived in relation to other subjects. The majority of learners think other subjects are easier, or at least not any more difficult. Thirty seven per cent of learners think that other subjects are easier than STEM, whilst 47% think they are neither easier nor harder (weighted average score of 2.42, where 1 = easier and 5 = harder). However, these views are much stronger amongst learners in S4-S6 (weighted average rating of 2.09). This view is less common at P6-P7, where the majority (54%) think other subjects are neither easier nor harder, but with progression through the learner journey, more learners think other subjects easier. For S4-S6 learners, 42% agree that other subjects are easier, with only 38% thinking that they are neither easier nor harder.

4.32 There is a similar view of other learners' perceptions too. Forty-four per cent of learners think that others find other subjects easier than STEM, with 50% reporting that other learners think other subjects are neither easier nor harder. Parents are more likely to agree that their children think STEM subjects are neither easier nor harder. Around 59% report this, whilst one third of parents report that they think their children find other subjects easier.

4.33 There was a view amongst consulted teachers that for some pupils that are not as confident as individuals as other pupils, with peer influence more of a deciding factor with regard to STEM subject engagement. This appeared to be the case in smaller rural schools in particular. The next section examines the impact of influencers in more detail.

Influencers

4.34 The picture for access to STEM capital outside of the school environment is mixed. Almost half (48%) of pupils are aware of having STEM influencers amongst friends or family. Overall, 37% reported having a parent/carer or sibling working in a STEM job whilst 24% reported someone in their wider family working in a STEM job; 5% reported knowing a friend who did so. However, one third of learners surveyed were unsure whether anyone amongst their friends or family worked in a STEM role, and 19% reported that they knew no-one working in a STEM job. Potentially, up to 52% of learners know no-one working in a STEM job; however, 61% of learners in S4-S6 report knowing someone working in a STEM job, suggesting that actually younger learners are less aware of knowing someone working in a STEM job, or perhaps are not fully aware of what a STEM job is.

4.35 In contrast, most parents surveyed report that they are working in or knows someone who works in a STEM role. Some 60% state that this is the case. However, almost one third of parents (32%)

report that they know no-one working in a STEM job, whilst just over 7% aren't sure if they know anyone that does.

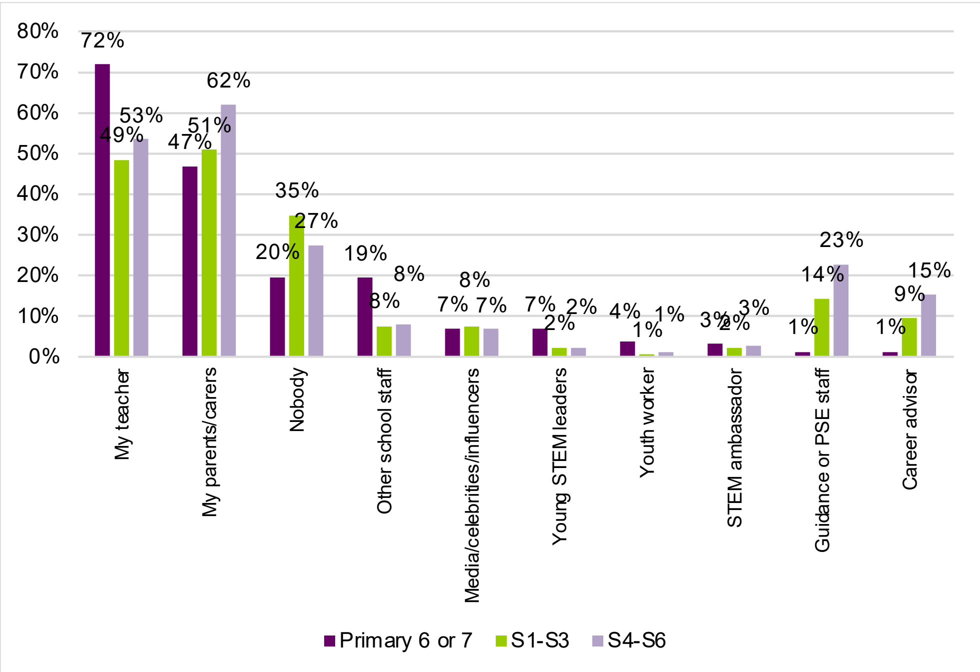
In-school influencing and encouragement

4.36 In terms of in-school influencing, 61% of learners report being encouraged by their teachers to study STEM subjects. This is highest for P6-P7 pupils (72%) and lowest for those in S1-S3 (49%, Figure 4.8). A further 13% reported that other school staff have encouraged them to do so; again this is highest for P6-P7 pupils (19%). Female learners are slightly more likely to be encouraged by both their teachers and other school staff than males (Figure 4.9), with 63% of female learners overall citing teachers are encouraging them (versus 58% of male learners) and 13% of females citing other school staff (versus 11% of male learners). However, there is some evidence that more guidance and encouragement from teachers would be welcomed – around 18% of learners said that they would welcome this.

4.37 A relatively low proportion of learners report that guidance staff and careers advisors encouraged them to study STEM subjects. For S4-S6 learners, the influence of advisors and guidance officers is 15% and 23% respectively, and for S1-S3 learners it is 14% and 9%. Therefore, it is arguable that at the point where most advice needed, critical influencers do not have the reach required. Further, only 6% overall report being encouraged by young STEM leaders or STEM ambassadors to study STEM subjects (this is highest for P6-P7 learners).

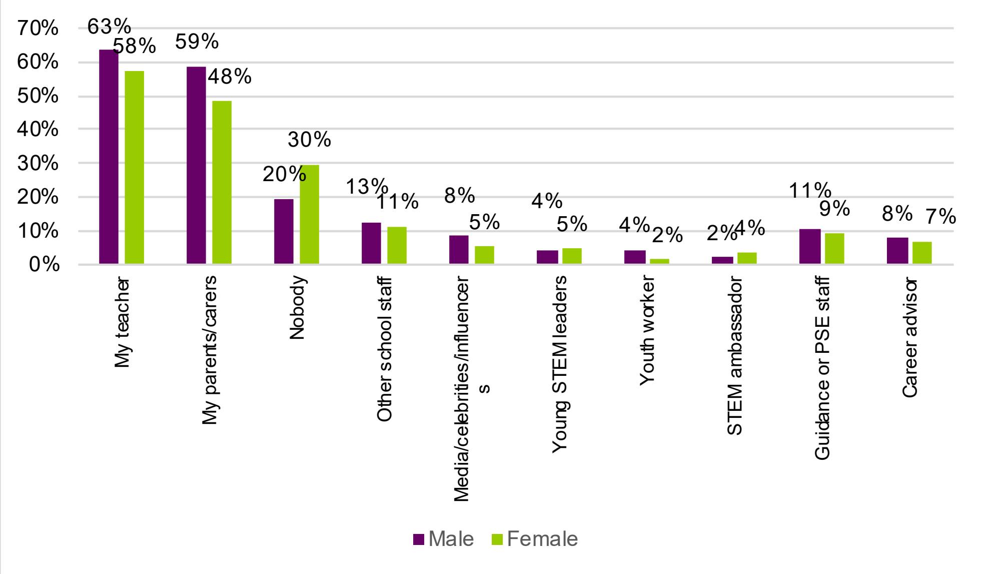
4.38 In addition, 25% of learners report that they have received encouragement from nobody, with 30% of male learners and 20% of female learners citing this. This is important given that ensuring teachers having the right information to be able to provide the right influence and guidance is a vital component of encouraging learners to study STEM subjects.

Figure 4.8: Main influencers of learners regarding STEM subject study (by stage)



Source: ekosgen survey of learners, 2022 (n=789; Primary 6 or 7 n=365; S1-S3 n=169; S4-S6 n=255)

Figure 4.9: Main influencers of learners regarding STEM subject study (by gender)



Source: ekosgen survey of learners, 2022 (n=711; Male n=332; Female n=379)

Friends and peers

4.39 Only 8% of those who took STEM did so because friends were, so this does not appear to be a major motivator for learners taking STEM subjects. However, of those that did drop STEM subjects or are thinking of doing so, 25% reported that it is or was because their friends were not choosing STEM subjects. Additionally, 14% thought that they would be made fun of for taking STEM subjects. For a relatively small proportion, gender stereotypes were an influencing factor, with 15% stating that they thought STEM subjects were "just for girls"; whilst 10% thought that they were "just for boys". Caution is needed here as the persistent gender imbalance in STEM subjects over decades suggest that this data does not capture the full picture or effect.

Parents and family

4.40 There is a reasonably good level of family encouragement for learners. Around 47% of surveyed learners report that they have been encouraged by their families to take STEM subjects. Females are slightly more likely than males to have been encouraged by their families (49% v. 47%). However, 50% reported no encouragement or discouragement. In total, 14% of learners stated that they would appreciate more encouragement from parents.

4.41 In contrast to their own experience, 35% think that their peers have had familial encouragement to study STEM subjects, whilst 62% think that there has been no encouragement either way for fellow learners. This suggests that there is a need for parents to get more actively involved in influencing whether their children study STEM subjects. However, parents themselves report being strongly supportive of children studying or continuing to study STEM, and 88% of parents surveyed report encouraging at least a little if not more.

4.42 Advice given by parents to children in terms of studying STEM subjects focuses on the importance of STEM to most if not all career paths. For example, in discussing the advice given to their children, parents stated that they told their children:

"Regardless of the career they want a good foundation in STEM subjects is important."

"If my child wants to follow his chosen career path he will have to try hard in STEM subjects."

"Everything comes down to science and maths. They're not just important to know about, but you can have great fun in the process."

4.43 Other parents focused on the skills and understanding of the world that STEM subjects can provide:

"Science is excellent for developing problem solving skills and developing creativity whilst learning. It is important to understand themselves and the world they inhabit."

"STEM subjects are new life skills which need to be learned for the future."

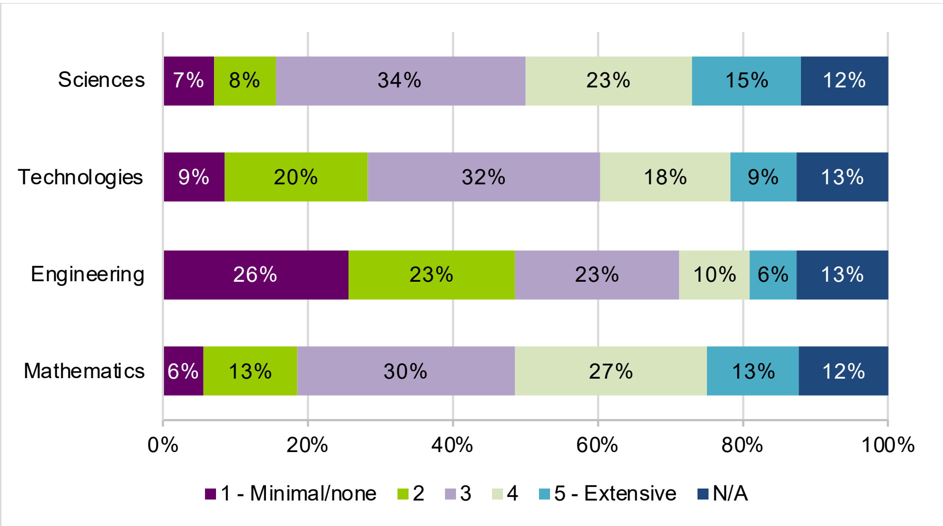
"Even if [they] don't continue with them beyond school they give a skill set which transfers to many other areas."

4.44 Whilst many parents focus on the importance of STEM to chosen or intended career paths or future study, many others indicate that the advice they have provided focuses on what they enjoy, with many parents advising "to choose subjects that they enjoy and are good at" – though it is worth noting that such advice can often be gendered as a result of lack of confidence in STEM subjects on the part of parents, amongst other factors. However, for many, there is an acknowledgement that "it is important to know at least basics for each of them (the STEM subjects".

4.45 Almost 93% of parents either want or would like their children to study STEM subjects. In terms of reasons for this, the majority of parents report that they think STEM subjects help to develop useful life skills (74%), whilst enjoyment is also an important driver for study (65% of parents report their children enjoy the subject, whilst 47% report their children enjoy studying things of relevance to real life). The value of STEM subjects is also cited as important for many parents (48%), as is their children's capability in STEM subjects (44%). However, somewhat fewer parents report that they think their children studying STEM subjects is important for the job that they want to do in future (38%).

4.46 Encouragingly, there is a positive view of STEM subjects from parents. More than three-quarters see STEM as interesting (77%), whilst 56% of parents see STEM subjects as useful. Additionally, 54% regard STEM subjects as enjoyable whilst 43% feel that they are inspiring. Only 9% of parents consider STEM subjects geeky, whilst just 2% think that they are boring. However, parental awareness of technology and engineering as subject areas is much lower than for science or mathematics.

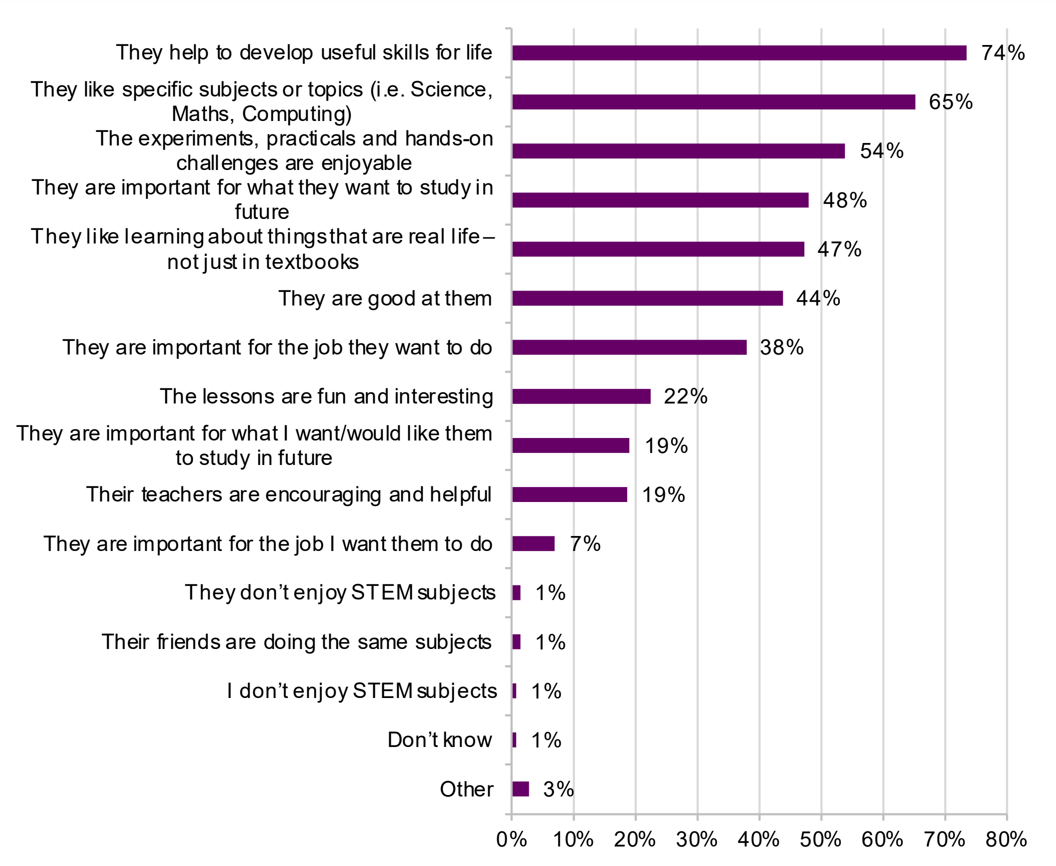
Figure 4.10: Parental awareness of STEM subjects



Source: ekosgen survey of parents, 2022 (n=478)

4.47 The view from teachers is that parental influence is critical. Also, any perceived difficulties regarding parental or carer influence (for example, limited guidance and encouragement for learners from parents/carers) are down to a lack of information regarding STEM subjects or STEM careers rather than old prejudices, or outdated views. Nevertheless, there appears to be some scope to influence the way in which parents encourage and influence learners with regard to STEM study.

Figure 4.11: Parental reasons for wanting their children to continue studying STEM subjects



Source: ekosgen survey of learners, 2022 (n=439)

In summary

4.48 There are some positive findings emerging from the survey of learners. The reported confidence and capability of learners with regard to STEM is good, and perhaps higher than may have been anticipated, though confidence does vary along the learner journey, and also by gender and other protected characteristics. Also, the perceptions of STEM, amongst both boys and girls, are not as negative as anecdotal evidence may have reported.

4.49 However, there are some important issues and challenges arising. There is a clear demand for more engaging and more relevant STEM teaching amongst learners. There is also a particular issue with engagement of those in S1-S3 – it is at this phase where challenges around confidence, perceptions of STEM and decisions around (not) continuing STEM subject study arise.

4.50 The role and impact of in-school influencers is also a clear challenge. Whilst there is limited detail on the reasons underpinning this, that guidance staff, STEM ambassadors and young STEM leaders appear to be having less success than expected or intended is indeed a challenge that must be addressed in order to increase the positive influences around learners regarding continued pursuit of STEM education.

5 Conclusions and priorities

Introduction

5.1 This concluding chapter considers the findings of the research presented in the preceding chapters of the report, and presents a set of conclusions. It then presents a series of priorities for consideration by Education Scotland, Scottish Government, and strategic partners in responding to the evident challenges and barriers to engaging with STEM education in Scotland.

Setting the scene

5.2 It is important to set the scene in terms of the educational landscape with respect to which organisations control or can influence certain aspects of the school and wider environment. This in turn impacts the ability to make structural changes to better facilitate STEM engagement in the future.

- In **school settings**, schools themselves have autonomy in some areas including: teacher recruitment and training; curriculum/lesson planning and timetabling; development and delivery of extra-curricular activity; careers guidance; and education pathway development.
- At the **local authority level**, councils hold responsibility for school budgets, and lead on promotion and co-ordination of STEM activities.
- **SQA** are responsible for the development, validation, quality assurance and awarding of a national framework of qualifications.
- Regional partnerships: There are six **regional improvement collaboratives** (RICs) in Scotland, as well as 13 **regional STEM partnerships**. Each RIC seeks to meet educational needs within a regional context, bringing together capacity from across an area and beyond, to add value through collective efforts. Regional STEM partnerships are college-led hubs that bring together key regional stakeholders to drive progress around STEM in relation to curriculum development, career-long professional learning (CLPL), and STEM skills pipeline development. However, the extent to which there is strategic fit across RIC and regional STEM partnerships' strategies and activities is varied.
- **Education Scotland**, within the context of STEM, provides wrap-around support for STEM education and CLPL, playing the role of 'connector' with and between key partners, and co-ordinating STEM- and gender-aware leadership across Scotland.
- Organisations such as **SSERC** and the **Energy Skills Partnership (ESP)** are involved at various points within the STEM education landscape in activities (including but not limited to) supporting CLPL, partnership and collaboration, and connecting industry to education.

The learner voice

5.3 There are some clear and important issues being identified by learners themselves. Whilst many of these are already known to Education Scotland and other strategic actors in the STEM education landscape, these findings go some way to confirming issues that may only have previously been identified through anecdotal evidence.

5.4 Firstly, there is a real need to ensure that STEM education being provided in schools is rooted in the real world, and of direct relevance not only for their future career choices, but accurately represents STEM-related enterprises and other sectors of the economy as well as its importance in terms of the transition to net zero and learning for sustainability . More and better information regarding STEM jobs is also required.

5.5 Countering the intention or desire amongst learners to drop STEM subjects should focus on enjoyment of and engagement with STEM subjects which will also require a significant gender aware approach depending on subject. Developing and offering a greater variety of pathways and subject offers will increase the number of opportunities that learners have to take STEM subjects. However, it is also important for tackling issues of perceived or actual difficulty, and learner confidence, particularly in relation to gender. Offering and promoting different modes and levels of study to children of all genders and from all SIMD areas will act as an enabler.

5.6 There is demand for increased flexibility in timetabling within schools. This will allow more learners to choose the STEM subjects they want to do, in instances where existing timetable requirements act as a constraint.

5.7 Tackling confidence and negative perceptions, particularly through transition to senior phase, and particularly for girls, is also important. The research has identified that there are lower levels of confidence and engagement, as well as a lower incidence of positive views of STEM subjects. Learners in S1-S3 are also more likely to want to drop STEM subjects.

5.8 Importantly, there is a clear need to strengthen the role and impact of influencers. More guidance from teachers would be welcomed by learners, even though many identify teachers as playing a positive role in terms of guidance and influence. However, evidence suggests there is clear scope for key influencers to have a greater impact – careers advisors, personal and social education staff, young STEM leaders, STEM ambassadors, and so on. Therefore, ensuring that these key influencers can achieve their intended impact and engagement with learners is of critical importance.

Priorities for addressing key challenges and structural barriers

5.9 This section summarises what evidence suggests are the **main challenges and areas for reform/development**. They are presented in the context of the discussion in the section above and consider both strategic and operational aspects of the structural barriers to STEM engagement.

5.10 In identifying priorities going forward, it is important to consider how best to build on the existing positive developments and actions to overcome the structural barriers detailed in this report. Given the many interdependencies, any approach to tackling barriers to STEM education engagement will not be linear, but rather multi-faceted.

5.11 The priorities we have identified therefore cannot be easily structured in a typical fashion. We have presented them according to the headings used above to summarise the challenges and barriers; however, they could easily be arranged according to strategic, operational, resourcing, advice and guidance; curriculum structures, timetabling, etc. We have presented them here alongside the summary of the main challenges and barriers impacting on learners.

Strategic aspects

5.12 There are a number of key issues identified which are strategic in nature and which are not under the direct control of the local authority or secondary school. These are as follows.

5.13 **STEM representation within RICs and Regional Improvement Plans**: There is evidence to indicate that RICs, collectively, are not maximising their effectiveness in supporting and promoting STEM education. Whilst it is acknowledged that any approach to regional collaboration on STEM may require a tailored approach different to that for other subjects, there is an urgent need to improve the RICs' effectiveness, visibility and credibility with regard to STEM.

Priority: RICs to have an explicit remit for STEM. This may take the form of explicit requirements for STEM actions including adopting a gender aware approach, to be built into improvement plans or better aligning STEM to existing priorities for example, literacy and numeracy in improvement plans. This should be assessed accordingly through annual review.

5.14 **A lack of engagement with STEM subjects**: Evidence presented throughout this report shows there are numerous factors at play in encouraging or discouraging learners from being aware of and aspiring to participate in STEM learning and/or careers, not least the current focus on assessment and examination results in the senior phase in the majority of schools. As mentioned earlier, the five Higher approach in the curriculum does not allow for STEM/project-based learning, work experience or industry visits and the like. The current qualifications system and the teaching approach which underpins this does not lend itself to engaging learners of differing abilities and with different aspirations. There is a body of evidence to suggest that a range of different qualifications can address this issue.

Priority: As part of the current review and reform of the qualifications system, consideration should be given to introducing new and innovative qualification pathways which have the potential to widen access to STEM learning and careers for learners of all abilities and backgrounds.

5.15 **A new approach to BGE is needed in S1-3**: This requires a refresh of CfE content and the subsequent assessment approach. Some schools have suggested that a move from a 3+3 years model to a more flexible 2+2+2 approach can address some of the challenges here. ES and SQA, and their successor agencies, should consider this as part of the implementation of the Ken Muir review.

Priority: The visibility of STEM to learners should be increased, and consideration should be given to the best ways that learners can be 'hooked' into STEM through the BGE phase. This could include an increase in making more use of real-world STEM examples – perhaps demonstrating the application of STEM to societal challenges – rather than more abstract learning. A '2+2+2' model and other flexible approaches, including IDL, project/challenge-based learning should also be explored as a means to making STEM subjects more engaging for learners.

5.16 **Inter-disciplinary learning as a key enabler of STEM engagement and learning**: This is reliant on change to the current curriculum delivery model. It would also require a different approach to timetabling in schools, as well as there being a need for inter-departmental engagement and non-STEM teacher training/CLPL to support the delivery of elements of STEM education within non-STEM subject areas.

Priority: Education Scotland and partners should consider ways in which schools can be supported to explore opportunities to plan and deliver IDL and joint lessons, as well as ways in which more flexible, effective teaching and learning spaces can be provided and created within schools.

5.17 **The need for a national strategy for teacher recruitment**: Evidence regarding the (lack of) available resource of teaching staff points to the need for more STEM teachers, across all areas but in the sciences and technology in particular. Recruitment is undertaken at the local authority level, but schools and local authorities face competition from the private sector in terms of attracting skilled individuals and are at a distinct disadvantage with regard to pay and conditions.

Priority: Scottish Government and other strategic partners should give consideration to how best to develop a strategic approach to STEM teacher recruitment.

5.18 **College and school 'connections'**: Whilst there is some evidence of schools and colleges collaborating effectively, these examples are not necessarily commonplace. In general, school and college planning cycles are out of sync. As such, it is difficult to co-ordinate timetables and pathways, as well as to co-ordinate the sharing or co-development of teaching and other STEM resources.

Priority: Greater collaboration between schools and colleges should be encouraged and facilitated to improve alignment

5.19 **National and regional structures**: Though improvements have been made with regards to strategic alignment at the regional and national levels, there remains a degree of dissonance between strategic actors.

Priority: Scottish Government, Education Scotland and strategic partners should explore ways in which the strategic STEM education landscape can be harmonised to benefit the learner experience.

Operational aspects

5.20 There are also a series of barriers and challenges that are more operational in nature and are within the control of either the local authority or RIC, or secondary schools themselves. These are as follows.

Under local authority control or RIC influence

5.21 **School budgets**: There is an inconsistency of available STEM resources across regions, local authority areas and schools. Rural and remote schools have additional resourcing challenges. This may extend to both teacher resource and the capability of individual schools to apply for – and secure – grant funding, including through the Education Scotland SGP.

Priority: Education Scotland and RICs should continue to support local authorities, in particular smaller ones who lack resources, in achieving a more consistent and equitable distribution of STEM resources and professional learning support across schools and clusters. Both should continue to encourage and support grant applications from schools that are not otherwise active, lack teaching capacity or successful in pursuing funding for additional STEM teaching resources/support.

5.22 **Cross-local authority knowledge exchange**: Knowledge exchange is still largely dependent on the enthusiasm, passion and good will of individual STEM practitioners and leads – even with support for knowledge exchange from Education Scotland.

Priority: Strengthening knowledge exchange through and across RIC areas through more formalised approaches, rather than relying on enthusiastic individual STEM practitioners, should be a priority.

Secondary school control

5.23 **School Improvement Plans**: There is an evident need to include STEM and gender aware practice in all school improvement plans. Currently, there is a mixed commitment to the promotion and delivery of STEM education across schools, particularly where STEM does not have strong representation at leadership/management team level.

Priority: As with regional improvement plans, school improvement plans should have explicit priorities and actions for STEM, to ensure that STEM subjects have sufficient visibility at the school level. This may be supported by ensuring adequate STEM representation on school leadership/management teams.

5.24 **Science transition activity**: There is no fixed approach to the supporting the transition of learners from P7 to S1. A lack of resource and limited teacher time for non-teaching or planning activities are frequently cited as barriers to developing a more effective transition approach which currently can be defined as a single day or activity. A more effective approach would involve joint curriculum planning to ensure transition learning experiences build on prior learning.

Priority: Consideration should be given to how to support clusters and local authorities to ensure effective progression in learning from early learning and childcare through to primary and secondary and from secondary school to post-college within STEM subjects. Learning can be drawn from the good examples discussed in this report and elsewhere. As with supporting the transition through BGE to senior phase, the use of teaching materials grounded in the real world and in contemporary industrial, sectoral and societal contexts should be maximised.

5.25 **Building capacity, confidence and skills of practitioners**: Developing the confidence and capability of STEM teachers and practitioners is an ongoing need and continues to be addressed through the STEM Professional Learning Grants Programme and support from local authorities, ES and key partners. In line with the teaching-related issues identified through engagement with learners, CLPL including gender aware practice, and industry exposure (directly, and via colleges and DYW) is required to help practitioners better ground lessons 'in real life' and in contemporary business/industry contexts. This is important for building STEM capital across all practitioners and in training courses for teachers and early learning and childcare practitioners.

Priority: There is a clear need to support the development of practitioners through CLPL and industry exposure. As noted above, confidence and capability within the STEM teaching cohort remains a priority focus, but exposure to current sectoral and industry trends is also important. To help achieve this, greater staff development time should be built into timetabling. Partners should capitalise on the need for protected time for STEM CLPL for staff. There is an opportunity to harness the potential of online CLPL sessions – potentially buying into services as well as making best use of free resources, and allow staff to do things in their own time as well (though not depending on this to meet CLPL needs).

However, it is acknowledged that availability of staff (in line with the need for a more strategic approach to recruitment) is a major constraint on this.

5.26 **STEM resources**: A lack of STEM teaching resources (e.g. classroom kit, laboratory equipment and other) is constraining STEM teaching. An additional barrier is the limited availability of flexible spaces within schools for IDL. Better links to college resources are also required to bolster STEM resources available to schools – though the previously discussed challenges regarding alignment of planning cycles (and school timetabling constraints) impacts on school access to these resources.

Priority: Local authorities, schools and RICs should explore opportunities to plan and deliver IDL and joint lessons, potentially in partnership with colleges. Breaking down teaching silos between subjects and departments is an essential part of this since the historic silo-ing between subjects inhibits the potential for effective IDL and cross-subject learning/teaching. Ways in which more flexible, effective teaching and learning spaces can be provided and created should also be explored. The distribution of 57,000 Micro:bits to Scottish schools in 2022 is a good example of collaboration across partners and sectors to support resourcing of digital activities in schools. Similar programmes to support the wider resourcing of STEM learning are required.

5.27 **Guidance staff**: As a result of struggling to keep pace with industry developments and changes within STEM subject areas, guidance staff need access to refreshed materials. They also need to be supported through stronger links with partner organisations, in particular the DYW network and e.g. SSERC, colleges, SDS advisers, ESP, regional STEM partnerships, etc.

Priority: Skills Development Scotland, in conjunction with, RICs, local authorities and schools, and other partners should explore ways in which guidance staff can be supported to improve their effectiveness and reach. Given the evidence outlined above, there is an urgent requirement to equip guidance staff with the resources and intelligence necessary to deliver an effective guidance function, and better influence learners in their choices regarding STEM subjects. This should include training on the effect of unconscious bias and gender stereotypes when advising young people. Secondary schools across Scotland have been supported to recruit DYW Coordinators – they have a key role to play here.

5.28 **STEM ambassadors and young STEM leaders**: As noted in the discussion of findings from STEM learners, along with guidance staff, STEM ambassadors and young STEM leaders are not yet having the reach and impact intended across the whole of Scotland. They are a valuable tool in promoting and securing engagement in STEM but more can be done to help them fulfil their potential. Whilst the precise reasons for this are unclear, it is fair to say that the COVID19 pandemic has had a negative impact on levels of activity during the past two years or so.

Priority: SSERC with input from Scottish Government to give further consideration to the effectiveness of STEM ambassadors and young STEM leaders. Drawing upon the findings from the recent Young STEM Leader Programme Annual Report and the University of Stirling's Programme Evaluation will support this [17].

5.29 **Planning and timetabling**: There is evidence of inflexibility in most approaches to subject timetabling, and a silo approach to curriculum and lesson development is inhibiting the impact that IDL could have in delivering STEM education. More innovation and flexibility is required to create a more learner-focused approach to timetabling, and subject choice pathway setting. It is also essential to enabling a greater degree of IDL, and integrating STEM topics within other (non-STEM) subjects.

Priority: Greater innovation and flexibility is required in timetabling amongst schools and across clusters. Solutions may include longer time periods to allow for IDL, and using more project- or challenge-based learning. This may also extend to pathway development in partnership with colleges, subject to the scope for greater alignment in planning cycles between schools and colleges.

[17] The Young STEM Leader Programme, Annual Report, Academic Year 2021/22, October 2022

Appendices

Appendix A: List of consulted organisations

Table A.1: Consultees

Local Authority STEM Lead Officers	
Dumfries and Galloway Council	West Lothian Council
Falkirk Council	Aberdeenshire Council
Fife Council	Shetland Islands Council
North Ayrshire Council	Glasgow City Council
STEM College Lead Officers	
Perth College (UHI)	Borders College
North East Scotland College	Inverness College (UHI)
Moray College (UHI)	Dundee and Angus College
Edinburgh College	Ayrshire College
Head Teachers / Teachers	
Sanquhar Academy	Tarbolton Primary School and Early Years Centre
Our Lady of the Missions Primary School	The Community School of Auchterarder
Dalbeattie High School	St Luke's High School
Boclair Academy	Currie Community High School
Port Ellen Primary School	Bowmore Primary School
St Margaret's Academy	Corsehill Primary School
Focus Group Sign-Ups	
Aberdeenshire Council	Levenmouth Academy
Angus Council	Lews Castle College (UHI)
Annick Primary	Liberton High School
Arbroath High School	Linlithgow Academy
Armadale Academy	Lochside Academy
Ayrshire College	Logie Durno Primary School
Baldragon Academy	Logie Primary School
Balfron High School	Lourdes Secondary
Banff Academy	Mackie Academy
Bankier Primary	Malvern St James Girls' School
Bannockburn High School	Mary Russell School
Bathgate Academy	McLaren High School
Borders College	Mill o'Forest Primary
Brechin High School	Milne's Primary School
Broughton High School	Monifieth High School
Bruntcliffe Academy	Moray College (UHI)
Burgh Primary	Nicolson Institute
Calderside Academy	NLC Early Learning and Childcare Quality Team
Castlebay Community School	North Ayrshire Council
Cedarbank School	North Berwick High School & Preston Lodge High School
Corsehill Primary	North East Scotland College
Craigmount High School	Our Lady of the Missions Primary
Crudie School	Park View Primary School
Deans Community High School	Perth College (UHI)
Denny High School	Peterhead Academy
Dingwall Academy Highland	Pitmedden School Nursery
Douglas Academy	Port Ellen Primary School and Bowmore Primary School
Dumfries High School	Queen Margaret University
Dumfries and Galloway Council	Ross High School

Dunbar Grammar School	Sgoil Lionacleit Uist Western Isles
Dundee and Angus College	Shawlands Academy
Dundee City Council	Slains School
Dunnikier Primary	St Andrew's HS
Early Years Team	St Andrews Primary School
Elgin Academy	St Andrews Secondary
Elgin High School	St Columba's RC High School, Dunfermline
Elrick Primary	St Columba's School, Kilmalcolm
Energy Skills Partnership – College Sector	St John's Primary
Falkirk High school	St Kentigern's Academy
Fife Council	St Margaret's Academy
Fife Pedagogy	St Paul's RC Academy
Forfar Academy	St Roch's Primary & Deaf School
Fraserburgh Academy	Strathaven Academy
George Watson's College	The Nicolson Institute
Glenlivet PS and Tomintoul PS	Todholm Primary School
Hyndland Secondary	Townhill Primary School
Inveralmond Community High School	Trinity High School
Inverkeithing High School	Turriff Academy
Inverness College (UHI)	University of Stirling
Inverness High School	University of the Highlands and Islands
Kellands School	Webster's High, Kirriemuir
Kelloholm Primary	West Calder High School
Kemnay Academy	West Lothian College
Kilsyth Academy	West Lothian Council
Kilwinning Academy	Whitehirst Park Primary School
King's Park Secondary School	Windygoul Primary School
Larbert High School	Woodmill High School, Dunfermline
Leith Academy	