The Structural Barriers to STEM Engagement
Executive Summary
for
Education Scotland

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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.