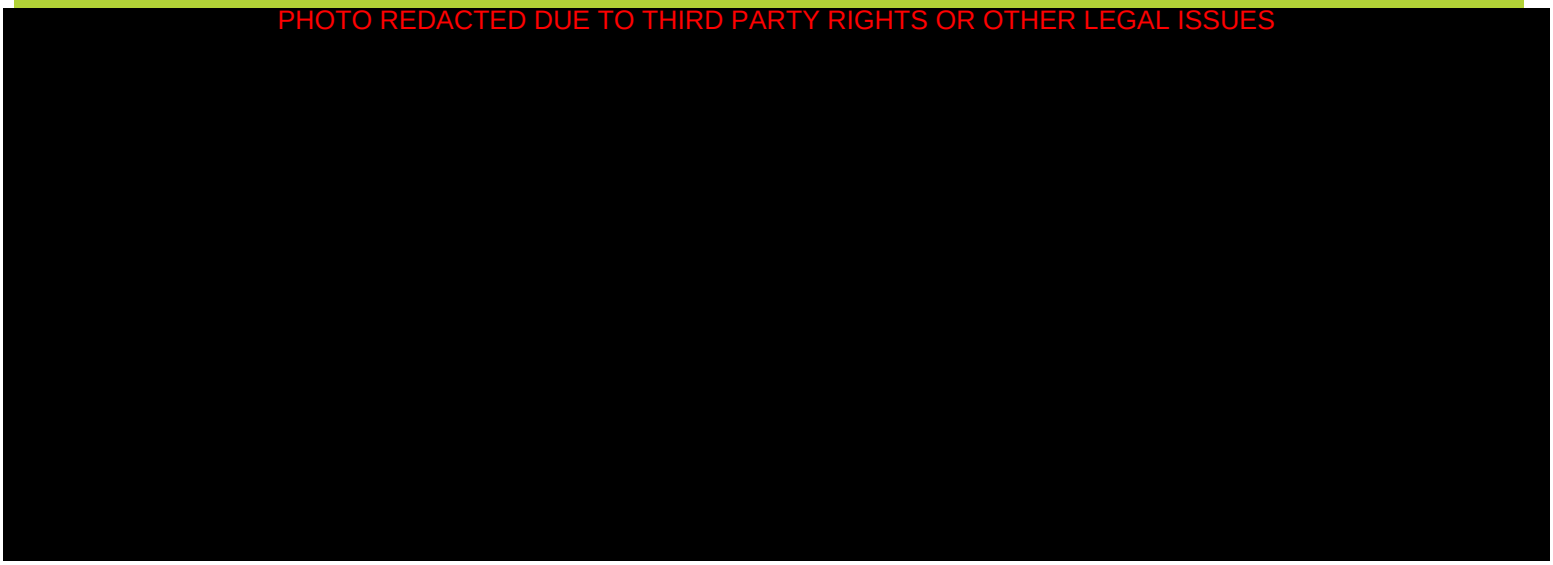
Education Scotland
Foghlam Alba

Building Society

Young people's experiences and outcomes in the technologies



Transforming lives through learning

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1. Foreword

This report continues the series in which Education Scotland evaluates the quality of young people's learning and achievements, in this case in the technologies. The report contributes to the overall picture of what it is like to be a learner in a Scottish early learning or childcare setting or school in this second decade of the 21st Century.

The technologies unarguably form a central part of Scotland's heritage, identity and future. Their importance cannot be overstated whether as an economic necessity, a social influence or a vital educational experience. The technologies make a core contribution to key Scottish Government policies, within and beyond education in aspects such as sustainable economic growth, a feature which echoes throughout this report. The technologies have the potential to impact hugely on children's and young people's learning, achievements and readiness for the world in which they will live and work.

This report celebrates much that is good in learning in Scottish technologies, and equally sets out much that can be done to improve outcomes for our children and young people, and our communities.

The report adopts the title 'Building Society' to reinforce the values which underpin the Scottish concept of the technologies – as inspiring, enabling, supporting and equipping our children and young people to take their learning in the technologies and use it to make people's lives better.

2. Introduction

In this report, we explore how the technologies contribute to young people growing and learning in Scotland. We rehearse what we mean by 'the technologies' in Scotland's curriculum, setting out their breadth and rich diversity. We identify strengths in learning which are evident across the technologies, those specific to each of the distinctive curriculum areas which make up the technologies, and to the sectors of early learning and childcare setting, primary, special and secondary schools. Importantly, we describe where

the technologies, collectively and individually, fall short of their potential as a key aspect of young people's experience in education. We identify an agenda for ourselves, Education Scotland, to do more and better to advance learning in the technologies. We then suggest, in a spirit of partnership, an agenda for each of our partners, with the aim of building strong alliances. In doing so we recognise the simple fact that no single organisation or interest group, no single initiative or development programme, can hope to address the range of issues set out in this report. We invite partners, in alliance with Education Scotland, to identify and commit to the parts they will play in improving the technologies deal for young people in Scotland.

In creating this report, we set out to take steps wherever possible to present our professional judgements and conclusions in ways which promote the idea of a 'live agenda'. We recognise that the report is a product of its time. Many of the issues it raises are long-standing, problematic and elusive of simple solutions, so this report does not set out to offer any quick fixes. The technologies agenda will change even as we share it with you. It follows therefore that the report's conclusions have to be taken forward by all of those with an interest in the part technologies can play, in helping young Scots realise their potential and build their community, their society.

Our report is based on a comprehensive range of evidence and data. Firstly, we made around 40 specific, exploratory visits to early learning and childcare settings, primary, secondary and special schools. *(This report includes direct reference to their work, shown throughout the text as italicised comment in boxes).* The information from these visits was supplemented by reports and contributions from fieldwork undertaken by other Education Scotland colleagues. The report therefore gives voice to many children and young people in Scotland, and to those around them who influence their journey through the technologies. The report draws on evidence from research, including reference to practice in technologies across Europe and beyond. Young people's achievements in external examinations provide further important data, contributing to a comprehensive picture of how technologies experiences are impacting on young people and their communities.

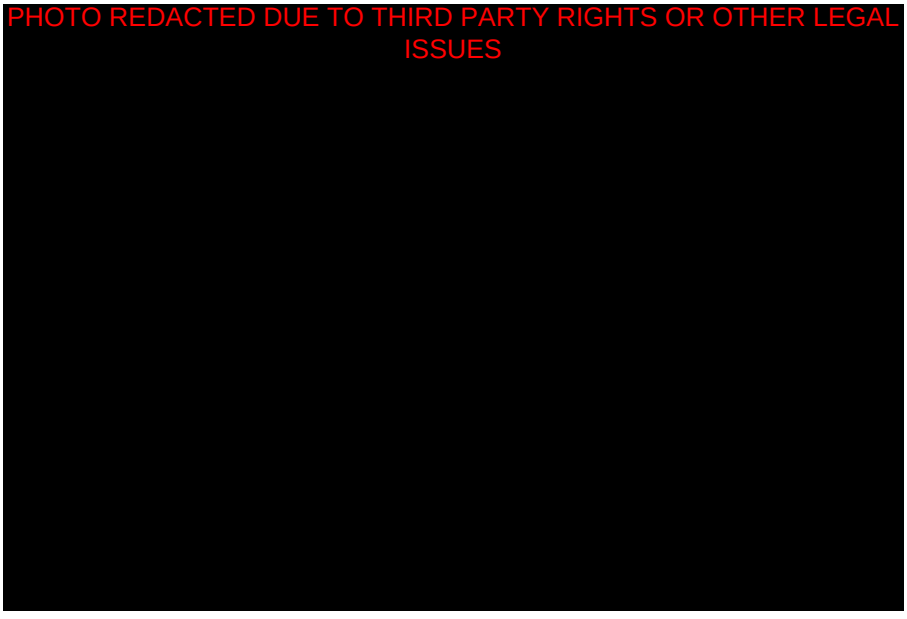
So what do we mean by 'the technologies'?

In Scotland's curriculum, the technologies are currently described as six distinctive areas of work. These are:

- technological developments in society;
- information and communications technology (ICT) to enhance learning;
- business;
- computing science;
- craft, design, engineering and graphics; and
- food and textiles.

'The technologies form the heart of the curriculum for young people in the school. The young people use a variety of digital devices and systems with growing confidence, to support and inspire their learning. They design and create products to improve the school environment and playground, developing valuable intellectual and practical skills and gaining an awareness of issues of sustainability. They demonstrate good teamwork, applying business and enterprise skills in organising events such as school fairs. Young people enhance their independent living skills, learning to cook and bake, developing important knowledge and attitudes relating to healthy eating. They enjoy talking about the kinds of jobs and careers they might have, and know how different digital and manufacturing technologies play a part in these jobs.'

The similarities and differences of these six areas of work – at times referred to as 'contexts' and at other times as 'subjects' - are explored later in this report. However, one issue to deal with in this early part of the report is to recognise the widespread practice of taking the term 'technology' to relate solely to the digital technologies of ICT, computing science and the like. We consider these digital technologies, themes of paramount importance in developing our society, in depth in the report and draw some important, forward-looking conclusions. We address the importance of better understanding the difference between the identity and purpose of computing science, as a specialist field; and those of the digital technologies more generally, which emerge as key to improving learning across the curriculum – comparable with, most obviously, literacy, numeracy and health and wellbeing. However, we look with equal interest at the other, 'practical' technologies in business; craft, design, engineering and graphics; and food and textiles, together making up the Scottish curriculum concept of technologies. In short, we explore the idea of the technologies as intellectual, practical and binary – heads, hands and digits.



The evidence we gathered for this report includes lots of good practice, at times outstanding and inspirational. This report has a part to play in bringing that good practice to a wider audience, with the expectation that it inspires, supports and drives improvement. However, our focused visits were deliberately intended to reveal a truly representative cross-section of practice, to highlight and evaluate both strengths and weaknesses. As the

report confirms, our visits underlined how variable young people's experience of the technologies can be, both from 3 to 18, and within and between schools and centres. For too many young people, experiences in the technologies are not always strong enough. We believe that position needs to be improved, at a time when Scottish young people are emerging into a world which is changing, educationally, economically and socially, at an unprecedented rate. With that background, the report sets out an ambitious, inclusive agenda for improvement, inviting all those with an interest in the future of Scotland's young people to play their part in full.

Context

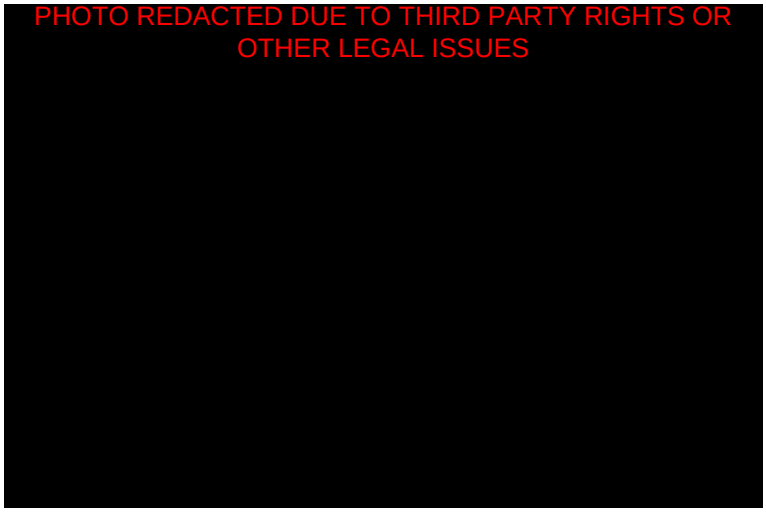
A world-class performance in the technologies is essential to Scotland's future and the prosperity, health and wellbeing of its young people. We can be proud of what Scotland's technologies have achieved. However, that pride cannot lead to any sense of complacency when faced with the accelerating progress in the technologies around the world, for example in Brazil, Russia, India, China or Singapore. Scotland's young people and communities need to be able to compete, thrive and provide leadership in that challenging environment. It follows that children's and young people's learning has to be of real quality, real-world and real-time. These core ideas are explored fully in this report.

Scotland has a strong tradition of excellence and innovation in technological research. This is especially true in areas such as engineering, electronics, optoelectronics, biomedical research, genomics and cell engineering. Scotland's people need to be skilled in technologies and to be aware of the impact of technologies on society and the environment, now and in the future. Learning in the technologies provides a strong foundation for the development of skills and knowledge which are, and will continue to be, essential in maintaining Scotland's economic prosperity.' Technologies Principles and Practice (2009)

3. Technologies learning and achievement 3-18; the findings of the review

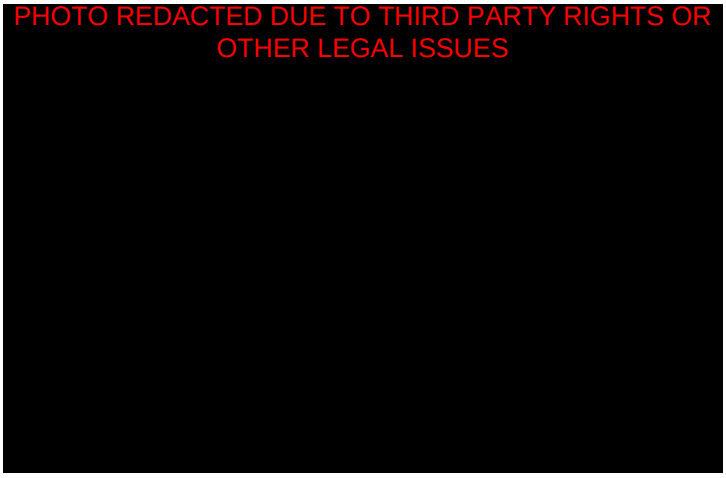
Early learning and childcare settings

Across the early learning and childcare setting sector, all children are benefiting to a greater or lesser extent from some aspects of technologies experiences, as they begin their journey through the broad general education. For a minority of children, planned play activities provide a valuable range of opportunities to learn and develop early knowledge and skills in, for example food and control technologies, preparing food for snacks and 'events', and working with programmable toys.



More generally, children have many opportunities to learn about structures and mechanisms, and to use computers to reinforce their emerging literacy and numeracy skills. Most programmes in early learning and childcare settings therefore provide some important foundations in technologies learning. However, few are yet ensuring that all children have opportunities to develop their knowledge and skills across all the relevant aspects of technologies.

In some early learning and childcare settings, children are clearly benefiting from high quality learning in the technologies.



'*Children use cameras very well to make their own photograph album. They independently use computers to play games, watch DVDs and listen to music. Children are very interested in how things work, for example investigating clock mechanisms at the 'tinkering table' and sequencing numbers to make their own clock faces. Parents commented that their children are transferring their learning about time, from nursery to home.'*

For these children, play activities are having a significant impact on their knowledge, for example of different materials for engineering or construction technologies; and in skills development such as through creative uses of digital technologies such as cameras and microscopes. These experiences are successful in laying the foundations of learning in the technologies, based on motivating activities which have been well designed to address the early level Experiences and Outcomes[1] set out in national advice. Children have also begun to produce evidence, on which staff could base confident judgements, about their progress through the early level Experiences and Outcomes. Importantly, these initial examples set down a marker, for early learning and childcare settings and beyond, to adopt effective, measured approaches to assessment.

'Children program the 'wolf' to follow a route to the three pigs' houses, motivated well to stick to the task, and enjoy reading the story as it unfolds. A related activity involves the children in problem-solving, finding their way through a maze displayed on an interactive whiteboard. The children are skilled in using colours to record blind alleys, and show determination in completing the task.'

In these settings, children are highly motivated and confident, working well with their peers, and were keen to involve members of the review team in their learning. Learning for these children highlights the effectiveness of responsive, creative programmes delivered by staff who have developed confidence and expertise in the technologies. The impact of the local authority's ICT framework is clearly evident in children's confidence and skills with a number of digital technologies.

Some technologies Experiences and Outcomes feature prominently across many early learning and childcare settings. Baking and cooking are popular activities, including in settings where some children need additional support in their learning. At times, these children access their entitlement to a full technologies experience by using assistive technologies, resources, devices or software specifically designed to meet the children's specific needs. This report later explores more fully the roles of the technologies in meeting additional support needs in children and young people, for example in the setting of special schools.

National guidance provides a set of 'Experiences and Outcomes' for each area of the curriculum 3-18, to identify what every child is expected to undertake and learn.

Using construction materials and kits, children in many centres develop skills and knowledge about some qualities of different materials and ways of creating joints in structures. In this context, it is important that activities are carefully planned to promote successful outcomes, for example when re-using materials to create models. Properly planned, such tasks provide children with a growing base of knowledge and skills, whilst encouraging experimentation with the resources provided. However, too much emphasis on the concept of 'junk modelling' sometimes fails to give children a sense of success, to encourage their discrimination in the choice of resources, or to begin to explore ideas of sustainability. We return to these important themes later in this report.

Children's understanding of different aspects of technologies is enhanced in centres which make full use of their location and local environment. For example, one centre had developed a high quality outdoor learning area. With parents' help, children had built a greenhouse by re-using plastic bottles. They had built willow shelters, learning how to use craft tools safely and effectively. However, there were also centres where the location or environment, for example, close proximity to shops, businesses or health facilities, had not been appropriately exploited for their learning potential. That omission represented a lost opportunity to use real-world contexts to extend children's technological capabilities.

Children display considerable creative capabilities in the technologies in expressing ideas and in solving problems - such as which food to choose to create a balanced snack, how many squares to programme a vehicle to advance, or which brick to use to form the corner of a play house. Creativity, an innate feature of children from these early years and beyond, emerges as a central defining characteristic for the technologies which is revisited throughout this report. The importance of an emphasis on creativity cannot be overstated, presenting rich opportunities for children to apply higher-order thinking skills including analysis, design and evaluation.

Children develop important foundation skills and knowledge, for example in early computer-related thinking and digital creativity, or in control technologies or structural engineering. These outcomes confirm the value and validity of these themes from the earliest stage of children's learning. A further, major strength in provision in the early years is the relative absence of any gender stereotyping, when children are tackling technologies tasks. Their natural interest in learning, by exploring, extends naturally into technologies activities.

Early learning and childcare setting staff should celebrate this strength, whilst remaining vigilant in ensuring that children themselves, parents and staff, do all they can to promote equality of interest. Technologies activities are generally popular with almost all children, and, for many, represent a particular source of motivation and interest.

Not all early years practitioners have the combination of confidence and skills necessary to provide children with high-quality experiences in technologies. There are a number of reasons for this, including the competing priorities, national and local, which early learning and childcare settings have been given to focus improvement. Technologies rarely feature in the early stages of curriculum improvement plans. In looking to improve provision, practitioners should take the opportunity presented by the definition of the *'significant aspects of learning'*[2] for the technologies. These organising principles provide a helpful, summative definition of what the technologies are 'about'. They provide a straightforward scaffold for early learning and childcare settings and beyond, developing the central purpose of 'design and create' as common across the technologies.

Technologies learning and achievement 3-18: the findings of the review

Primary Schools

All children at the primary stages have opportunities to learn about some aspects of technologies, although the depth and reach of the experiences are too often limited. All have the opportunity to develop skills in, for example, using digital technologies to research, process, organise and present information. All children learn some of the principles of

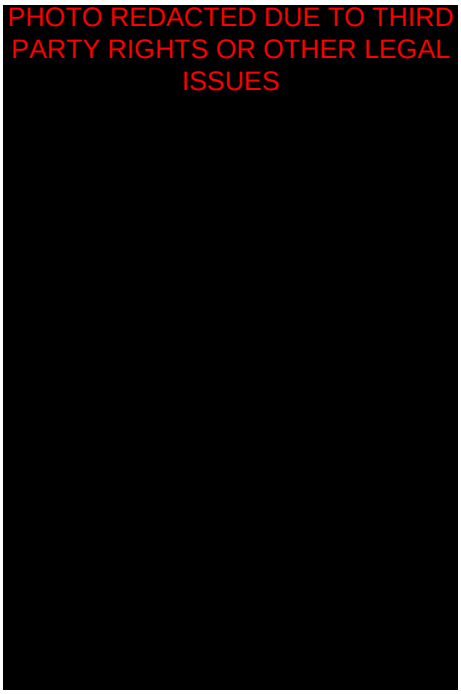
[2] The technologies 'significant aspects of learning' are:

- finding, discussing, organising and evaluating information through the technologies
- understanding how technological products work and how they affect people
- planning and organising technological activities

Further information is available at http://www.educationscotland.gov.uk/Images/Technologies040314_tcm4-746156.pdf

[2] Glow is Scotland's online resource for schools, using the internet to provide an extensive range of facilities and resources to support learners.
http://www.educationscotland.gov.uk/learningandteaching/approaches/ictineducation/glow/index.asp

engineering structures, as well as how to choose and use different materials to exploit their particular properties.

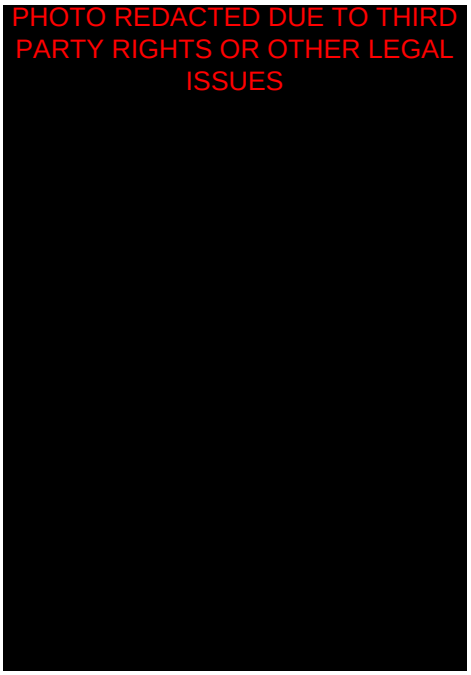


All have some experience relating to food technologies. Such experiences of technologies have long been established as part of primary schools' programmes across Scotland. In some cases, these activities have been improved through setting them in appropriate, innovative contexts, such as outdoor learning. They represent important learning, but in too many cases still fall far short of delivering children's full entitlement to technologies.

'Children have good opportunities to extend skills in using craft tools, which they had first experienced in the nursery, for example to build a Viking house model. Some of these skills have been put to good use in the context of the John Muir Awards scheme, where children create products as part of the conservation stage of the award. These skills are further extended through important involvement of children in community developments, including planning and enhancing the school play area, and working on the local trim trail. Staff take care to ensure good progression in skills, which children record in profiles using Glow resources. Children's technologies experience was enhanced by visits including one to Pitlochry hydro-electric scheme, exploring how engineering projects can support sustainability objectives.'

Involvement of parents and the community brings additional stimulus to some technologies learning, for example in activities relating to food. In one school, children in P6 took part in a food project with their associated secondary school, which involved them cooking together with a member of their family. In another school, children in P7 worked with parents and grandparents to create an 'Indian feast' as part of a wider project on India. This example demonstrates the contribution which the technologies can make to interdisciplinary projects, and to raise awareness of issues of social diversity. The school also draws on specific expertise among its staff, which includes a staff member with expertise in nutrition.

Given that the confidence of staff across the technologies is a major factor influencing the quality of children's learning, it is vital that primary schools identify, cultivate and capitalise on any specific expertise available to them, including making appropriate use of specialist skills.



These skills might be sourced, for example, from associated secondary schools, local colleges or partners in community learning and development. The interests of individual staff, whether teacher, classroom assistant or other support capacity, is often a telling feature in schools which offer high-quality technologies learning. These characteristics offer rich opportunities to enhance children's learning and motivation in specific ways.

'The children clearly benefit from the structured programme in ICT, and are able to describe out-of-school activities such as popular computer games where they are able to recognise and apply the skills they have learned. The children enjoy creative opportunities in coding, preparing short animations, and have a high level of awareness of career opportunities relating to the digital technologies. The principal teacher has built considerable expertise in using Glow, an enthusiasm which is reflected in the children's motivation. All classes post Glow blogs – 'being creative is a good skill because you can even use it when you are writing'!'

Most children have experience of re-using or re-cycling materials to create models, for example in the context of topic studies, or extending into art and design programmes as a popular craft activity. The theme of sustainability emerges again here, as already noted in early learning and childcare settings.

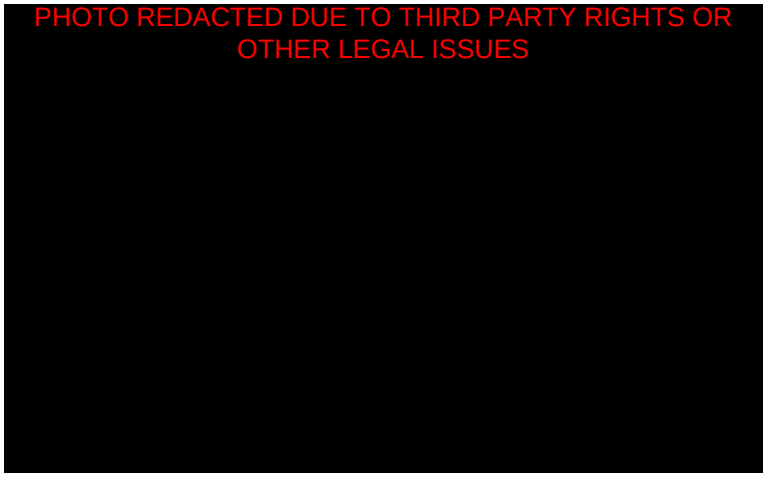
Creativity continues to be a core feature in the technologies programme in many primary schools. Importantly, it emerges as a potential force across all the technologies contexts, and across both the digital and 'practical' technologies. Children respond well to opportunities to personalise their learning in technologies, and appreciate the chance to solve problems in their own ways. They enjoy matching their ideas with those of others, justifying decisions and raising their awareness of the potential for teamwork to generate new solutions. In these respects, children are developing skills with clear relevance to their

futures, including to the world of work, extending their creative potential as individuals and as members of teams.

Across primary schools, most children have some opportunities to work with food in a range of different contexts, developing skills in food preparation, knowledge about food groups and awareness of key principles of healthy eating. Children enjoy the practical, real-world learning which these experiences offer, and most are highly motivated when elements of problem-solving are introduced. It is a point of particular interest that higher-order thinking skills are clearly evident in high-quality programmes in primary schools, ensuring that the technologies meet all children's needs.

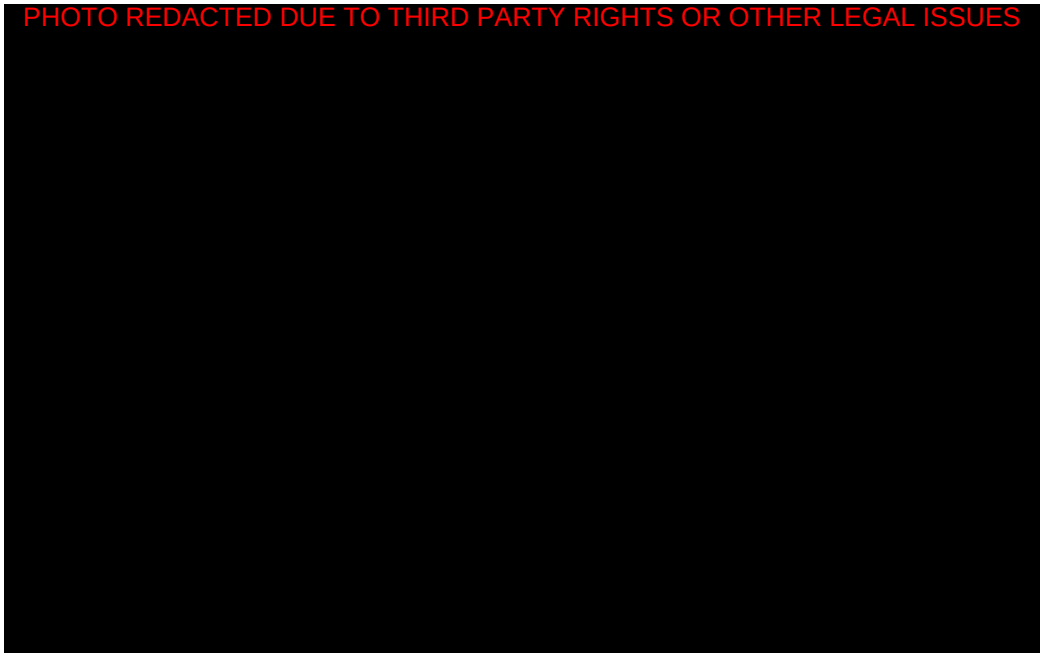
'The school's programme in technologies has a substantial impact on children's overall learning experience. Staff have prepared a framework of technologies experiences, including a specific programme to support progression in ICT. These experiences provide an important structure, whilst retaining the capacity to respond to current technologies themes such as those featuring in the media. At P1, children extend their skills in programming toys, often in the context of problem-solving challenges. Children in P1 are confident in using tablet computers for activities to enhance their learning in numeracy. In P5, children learn vital aspects of personal safety relating to use of the internet, in the context of well-structured development of search engine skills. Provision at P7 includes some very strong aspects, including a programme specifically in computer science. Children follow a modular programme over eight weeks, developing their skills in coding.'

However, the scope and impact of this school's approach is not yet common enough across the sector. All primary schools need to meet children's technologies entitlement in full. The school's success has been achieved as a direct result of effective improvement through self-evaluation, driven by purposeful leadership and with appropriate priority given to the technologies. Children's achievements in the technologies make an important contribution to the school's overall high levels of performance. Children's technologies experiences promote motivation and challenge, and enhance other core outcomes such as numeracy and enterprise.



The school has ensured a balance of approaches to the technologies, with structured programmes such as that in computing science, alongside more open-ended contextual opportunities for technologies to emerge in topics. However, it is important that primary schools do not place an over-reliance on technologies learning solely through interdisciplinary approaches. Such an approach leaves too much to chance. It runs the risk of providing an incomplete technologies experience, short of the full entitlement which our children deserve.

Some primary schools are particularly effective in helping children recognise their technologies skills in the wider context of skills for learning, life and work. For example, many schools capitalise on the technologies when developing children's attributes in enterprise and entrepreneurship, including making original craft products for sale at school fairs. These experiences, when raised and highlighted in dialogue between staff and children, reinforce the connections between learning, enterprise and work more generally.



'Key features of the school programme included helping children understand the connections between technologies and careers, for example through its annual careers and world of work fair.'

Children at the primary stages frequently present the outcomes of technologies tasks to their peers, encouraging self- and peer-assessment, depth in their learning, appropriate specialist vocabulary, and enhancing their ability to handle questions and argue their case. Staff are able to draw on these presentations as sources of evidence for assessment, for example organising plenary reviews to test depth in the children's learning. Children in primary schools frequently use ICT for presentations, and there is a need to ensure they make appropriate progress in this area. In too many cases, children's use of presentation software does not progress significantly across P1 to P7, and their experiences are too often limited to one specific software application.

Primary schools often develop technologies learning in the context of major events in the life of the school, for example summer fairs or whole-school environmental projects. Children enhance their food technology-related skills, or craft skills and associated awareness of aspects of enterprise and entrepreneurship, by designing and creating items to sell. Charity fund-raising events provide a popular focus for baking and cooking, extending practical skills, enhancing numeracy, and building teamwork. These valuable experiences are important reminders that children's total curriculum experience includes activities relating to the wider life of the school, to interdisciplinary experiences, and to children's personal achievements beyond the classroom. Children enjoy taking part in national competitions and design challenges, for example those deriving from the Primary Engineers Programme. The breadth and apparent complexity of technologies activities sometimes present difficulties for staff assessing children's progress. However, the emergence of the *'significant aspects of learning',* in national advice from Education Scotland, offers an achievable approach based on 'rounded' assessments of a realistic scale and frequency.

'Children take part in a range of technologies-themed clubs including digital photography, model-making and jewellery. The range of clubs takes account of the need to keep the technologies attractive and relevant equally to both girls and boys. By P7, children are developing impressive technologies skills. Staff are actively engaged with the associated secondary school, to draw on specialist expertise and resources, and also to ensure that individual children's achievements were recognised as the appropriate starting point for technologies learning at the secondary stages.'

Some schools make good use of examples of technologies featuring in the press and social media, often supported by related online materials. These approaches are popular with children, capturing the immediacy of real-world, contemporary or 'real-time' developments. It is clearly essential that primary schools ensure properly designed programmes are in place for technologies. Equally it is important that these programmes can draw on current and emerging technologies themes in the media, for the relevance which they bring to children's learning. Current examples drawn from the media highlight the fact that technologies are central to everyday life. Appendix 1 considers some possible approaches to using media coverage to generate high-quality learning in the technologies.

Special schools

Technologies experiences form an important part of the curriculum for children and young people in special schools. The Experiences and Outcomes are, appropriately, the same as those for their peers, delivering the technologies learning entitlement. However, at times the technologies have particular qualities and relevance for young people with additional support needs.

'The curriculum and learning approaches are well designed to meet the specific needs of the young people in the school. Care has been taken to ensure equality of access to address the young people's different needs, in the core technologies programme but also well supported by assistive technologies. The mainstream programme, which forms the spine of young people's experiences, focuses well on social and vocational technologies. The impact on the young people is clear, in the motivation which they show in practical workshop and kitchen tasks and in the confidence they demonstrate using computers and other ICT devices. Young people are proud of the improvements they have created around the school, building their self-esteem and growing their interest in work beyond school.'

Staff in the school work creatively and with determination to identify activities appropriate and relevant to all children and young people, providing as full an entitlement as possible. For example, children in the early years and primary stages enjoy hands-on experiences in food and craft contexts, progressively more challenging and increasingly emphasising independent living skills.

'Children develop their capacities with a clear focus on life skills, for example baking and cooking. Children's learning is enhanced by the school's practical approaches which include rearing its own hens, with the eggs used for baking and cooking; and through the children's involvement in growing vegetables, then using them to make soups. Children's learning about food is appropriately set in a wider context including Fairtrade and Eco schools links. Children make lots of use of ICT, for example in their 'Friday project,' gathering digital photographs of their work to include in their assessment profiles, and to add to the school's photo collections and displays.'

These activities have a strong influence on children's confidence and self-esteem, providing important opportunities for particular talents to emerge, including those relevant to work and to independent living.

'The children are given good support to develop everyday technologies skills, including using scanners at self-service tills, and texting and making calls using mobile phones. They have opportunities to explore construction skills using kits, although a more progressive planned programme would help ensure more appropriate challenge and purpose in their learning. Many of their technologies experiences arose in the context of topics such as 'the shop', which staff used skilfully to help the children see the connections in learning between, for example, numeracy and healthy eating.'

Interdisciplinary learning approaches remain popular across special schools and units working with primary-age children. Among their strengths, topic-based approaches help children see at first-hand how their learning fits into broader, real-life settings. However, an over-reliance on topic approaches risks delivering the Experiences and Outcomes in an incoherent, unstructured way, unlikely to deliver appropriate planned progression.

'Young people develop a range of valuable practical skills in cookery and in craft, often relating to enterprise activities. For example, they create products to sell at the local authority's annual Christmas Fair. They build furniture and play equipment for the school playground, and create 'buggies' to race. Children show an awareness of how these skills relate to technologies careers. They enjoy greatly the opportunities to incorporate their own ideas into creative technologies tasks, for example in designing kites, or preparing 'trash fashion' garments for a fashion show. Young people re-used polycarbonate soft drink bottles to build a greenhouse, encouraging further exploration of important themes of sustainability. Many find specific motivation in using computers – 'computers help me speak better' – and for popular games including one based on important creative principles of computer aided design.'

These activities provide a powerful example of technologies outcomes giving young people direct experience of creating improvements in their own environment, enhancing the quality of their lives and potentially leaving a legacy for others. This case study also raises the issue of computer gaming and its value in learning. Well-chosen computer gaming approaches have much to offer young people in this school, but only because these 'games' have been subject to the same professional checks as any other learning activity – for example their overall ethical standards, age-appropriateness, contribution to young people's entitlements, and purposefulness and structure. Subject to that quality of professional scrutiny, but only then, it can be seen that computer gaming approaches represent a rich resource for schools to consider. Young people enjoy 'junk modelling', and 'trash fashion', both of which, properly planned, can stimulate positive technologies experiences. These established activities also provide the opportunity to consider the wider implications of sustainability as one of the most significant issues of our time.

Assistive technologies

'Learners with disabilities at all levels of education – pre-school through to adult education – are vulnerable to exclusion from educational opportunities….
For learners who do not have access to primary education, this also results in their not achieving the necessary basic skills for long-term social and digital inclusion. This limits their access to further educational opportunities as well as employment – both of which result in long-term social and economic costs to societies.'

The World Report on Disability 2011. World Health Organisation / World Bank

Scottish schools have developed significant expertise in deploying specialist technologies to meet specific learning difficulties among children and young people. The impact on young people is, at times, key to enabling them to experience more fully their entitlement to a broad general education, deepen their skills and knowledge to progress into S4 to S6 and access qualifications to enable them to proceed to positive destinations. The focus of the assistive technologies is, understandably, ICT and the wider, emerging technologies. However, the analogue or practical technologies likewise hold out great value for all children and young people, including those for whom access to these technologies can be challenging. The objective of providing a full educational experience should embrace both the digital and the analogue technologies, for their value educationally, socially and vocationally. Schools working with children and young people with special needs found the resources and support offered by the CALL Centre (Communicative and Assistive Technologies for People with Disabilities) particularly helpful in ensuring these young people's access to a full curriculum. www.callscotland.org.uk

Technologies learning and achievement 3-18: the findings of the review

Secondary schools

The technologies play a vital role in young people's learning in secondary schools. Collectively, the technologies make a significant contribution to young people's growing abilities as informed, active and responsible citizens, able to play a full, creative part in developing their careers and communities. Across Scottish schools, many young people form positive, forward-looking views of the technological skills they develop. They see how, in their careers and lives beyond schools, these skills can influence the quality of people's lives hugely.

'Young people in the school are very positive about their technological experiences. They enjoy the particular learning environment in some subjects, including the sense of freedom in workshop and studio locations, and the associated levels of trust which they are shown in these settings. The young people can relate this working environment to the 'real world', and the kinds of technologies careers which they might pursue. They can describe a number of motivating tasks which they feel reflect well the idea of real-life stimulus such as website design in business and ICT, and communicating with their primary school 'buddies'.

Creativity and problem-solving are confirmed, once again, as central purposes of the technologies, and as important justification for the technologies' place in the curriculum. Each of the four different secondary 'subject' contexts – business education, computing

science, craft design engineering and graphics, and food and textiles – brings a distinctive, specialist contribution to young people's overall technologies experience. These specific contributions support young people's understanding of the ways in which technologies affect their daily lives, and the potential they offer to make life safer, healthier, more creative and more fulfilling.

'Young people are benefiting greatly from some effective technologies experiences as part of a well-designed S1 to S3 curriculum. Their experiences in computing science have a marked impact on them, with impressive outcomes in developing new skills and knowledge, and an enthusiasm for the subject. Young people are highly motivated by these experiences, encouraging many to progress to Higher and Advanced Higher. Staff were praised by young people for the ways in which they ensure relevance and currency in their activities. For example the Advanced Higher class adopt a very practical, 'hands-on' approach to learning about robotics, artificial intelligence, and exploring the architecture of personal computers. These fine experiences are fully reflected in young people's performance in national examinations where their attainment has been sector-leading.'

Young people's performance in computing science and food and textile technologies in the school are exemplary. However, their performance in other aspects of technologies is less strong, reflecting the inconsistency seen in many schools. These differences might be regarded as inevitable, an outcome of a complex range of factors in a school. However, the questions raised by such inconsistencies in performance need more careful consideration, given the recognised importance of all aspects of the technologies, economically and socially.

Across the different subject/contexts, and across secondary schools, most young people have valuable experiences in, for example, using ICT for research and presentation of projects, or applying business skills in analysing how enterprises work. Almost all schools offer worthwhile opportunities for young people to design and craft small products in plastics, metals and wood, or prepare food and textile products, sometimes connecting with enterprise approaches by selling at school fairs. Young people are benefiting from the new emphasis which many schools are giving to computing science, for example in coding. Some young people are developing important skills in engineering problem-solving, for example using programmable devices or exploring the strength of structures. In seeking to assess young people's progress, staff are able to draw on national advice with respect to the '*significant aspects of learning*', although these organising principles are not yet consistently well-known or used across schools. The theme of assessment continues to exercise many staff, at times due to the challenge of judging standards in practical outcomes and products. However, many staff are gaining confidence and expertise in assessing progress and outcomes. In part this is due to increasing familiarity with the technologies Experiences and Outcomes. Staff expertise is being further developed through professional moderation activities coordinated within their schools, local authorities and more widely.

'Young people demonstrate creativity and work-related skills in, for example, cake decoration. They use contemporary commercial equipment and facilities for food preparation and processing with confidence. Staff enhance learning further by involving expert staff from local businesses. In its curriculum design for the senior phase, the school has taken care to ensure that young people have good opportunities to progress to more advanced programmes. Young people are able to study towards an industry-standard qualification in food hygiene, giving them an immediate advantage for part-time work and, for some, a foundation for a possible career.'

However, in some schools the curriculum is not yet providing the full range of experiences required to meet young people's entitlement. This affects a range of the technologies subjects, but most particularly computing science, business education, engineering science and food and textiles. At times, shortages of staff are a major constraint on schools' ability to provide a full technologies entitlement, for example in food and textiles, and in computing science. Less commonly, but a factor nonetheless, is a lack of expertise in the relevant specialism among the staff in the school, for example in engineering science. At other times, and more within the grasp of schools themselves, the shortfall is due to omissions of key Experiences and Outcomes in school programmes, either due to overall curriculum planning at school level or simply omission at departmental levels. It remains vital, as schools evaluate and refine their practice in the broad general education, that all young people are able to experience the full range and depth of the technologies entitlement.

4. The four curriculum contexts; subjects/curriculum areas; ethos and wider life of the school; interdisciplinary learning (IDL); and personal achievement

In section 4.1, we start by exploring the six distinctive 'subjects' or curriculum areas of the technologies, which together make up the first of the four curriculum contexts:

- technological developments in society;
- information and communications technology (ICT) to enhance learning;
- business education;

- computing science;
- craft, design, engineering and graphics; and
- food and textiles.

We then review provision in the other three contexts of the curriculum. At the time this review was taking place, technologies featured notably less frequently in these other three contexts.

4.1 The subjects/curriculum areas

Technological developments in society

Children and young people become aware of the ways in which technologies have developed and impact on their lives through many different routes. For example, young people's exposure to the media and the views of friends and families provide a growing awareness of the scope and impact of the technologies, their capacity for good and their potentially adverse effects. These are important, real-life influences which form the starting point for early learning and childcare settings and schools. However, it is recognised that these factors can create inaccurate, imbalanced or prejudiced views of the technologies, for example in terms of gender stereo-typing for careers, a possibility which needs to be addressed and challenged by all those with an interest in young people's learning and development.

From the early years, well-planned programmes provide the single most positive, formal starting point for the important task of developing children's and young people's awareness of technological developments in society. The natural inquisitiveness and exploratory spirit of children and young people fit well with the theme of technological developments in society. However, this review found that the topic of technological developments in society receives too little emphasis relative to the other contexts. In subject settings, young people absorb explicit and implicit messages from their programmes and activities, but it is rare for them to experience any planned, formal learning about historical, geographical or societal strands of the technologies. Stronger links and collaboration with social studies expert practitioners offers one possible route to improving provision in this important area of learning. Overall, this aspect of technologies learning needs to be given higher priority, as a key influence on young people's understanding of the interaction of technologies with their world and communities, and their motivation to engage with the technologies.

Information and communications technology (ICT) to enhance learning

Centres and schools generally understand why the more generic context of information and communications technology (ICT) has been included alongside the other technologies in the national framework of Experiences and Outcomes of Curriculum for Excellence. However, embedding ICT in the specific setting of the technologies framework may have given the impression that it is solely a concern for technologies specialists. Although technologies national guidance attempts to portray 'ICT to enhance learning' as a resource and imperative for all staff, that ambitious objective has not been fully achieved.

Nonetheless, ICT is an expected and valued feature of learning across the technologies, for example in business education, craft, design, engineering and graphics, and food and textiles. ICT has a significant role across all these technologies, a factor highlighted in relevant research. No contemporary experience in the technologies would be complete or

credible without an explicit relationship with ICT. However, the technologies review reached into practice beyond the specialist curriculum areas, into the curriculum experience in early years and primary stages, and in wider settings at the secondary stages.

ICT has a highly significant impact on children and young people in some centres and schools. In these cases, children and young people develop a wide range of digital skills, supporting and enhancing their learning and achievements across curriculum areas. They use a variety of devices with increasing confidence, and are often motivated, specifically by the attractions of digital technologies, to continue their study well beyond the school day.

Many schools recognise that, in these purposeful uses of ICT, for example for research and presentation tasks, children and young people are developing important skills for learning, life and work. In some cases, for example in technologies clubs, young people are able to take leading roles in learning, where their individual enthusiasms have given them particular expertise.

Some schools use the facilities provided by Glow to good effect, to support learning in a range of effective ways. Young people benefit from the opportunities to take part in discussions and joint learning activities with other schools. They enjoy learning how to create their own blogs, as ways of communicating within the school community and beyond. Some schools use profiling facilities well to record key data about young people's attainments and personal achievements. Schools appreciate some of the safeguards which Glow ensures, in times when children's and young people's safety on-line remains a major concern. In other schools, young people use alternative media and approaches in preference to Glow. Staff cite advantages such as the continuously expanding applications market and improving range of commercial software available to them.

Clearly, digital technologies have brought potentially immense change to the ways children and young people learn. However, taking account of all the evidence arising from this review, we find that ICT has not yet had enough impact on young people's learning. The inclusion of advice on ICT with the other technologies, whilst logical in one sense, has diminished its influence and impact across the curriculum, and falls short of national ambitions for this crucial influence on learning and achievement. Developments in the digital technologies have accelerated since the original guidance on ICT was issued for

Curriculum for Excellence. These developments have left *'ICT to enhance learning'* looking like a dated concept, a product of its time which fails to promote an ambitious, accurate, forward-looking and creative role for the digital technologies.

Business education

Young people's learning experiences in business contexts, like those for food and textiles, are set out in two complementary sets of guidance for Curriculum for Excellence. In the case of business education, the Experiences and Outcomes are defined in part in technologies advice, and in part in social studies, recognising the two essential elements of this area of learning.

Whilst there are no explicit business education Experiences and Outcomes defined for the technologies before third level, it is clear that children's play activities in the early years and across primary schools generate opportunities for development of awareness of business and, at times, relevant skills and knowledge. Strong examples can be seen in play activities such as those associated with shops or travel agents. Children learn about different business-related uses of technologies in the context of early enterprise activities, gaining momentum in the primary stages as they have more opportunities to develop skills in teamwork and problem-solving, using appropriate equipment and facilities in their simulations of business enterprises to market products or services.

Business education programmes at the secondary stages are sometimes blended with ICT provision, for example in rotas from S1 to S3. As young people progress from S1 to S3 and into the senior phase, they are able to develop their understanding of how the technologies underpin business. Young people are motivated by tasks which use real-life examples of business and its practices, at times enhanced by a combination of individual and group work approaches, reflecting the reality of teamwork in commerce and industry.

'The Young Enterprise group have used social media for 'crowd-sourcing' funds for their business, for market research and for product promotion.'

The central role of the digital technologies is clearly evident in the business education context, as a real-world source of information and as the medium through which many businesses operate. Embedding high-quality learning about business, using the digital technologies appropriately, has a marked effect on young people's perceptions of the relevance of the subject area.

Computing science

Children in the early years are developing foundation skills and knowledge relevant to computing science. This learning is not always fully recognised, although national advice does identify key Experiences and Outcomes for computing science at the early, first and second levels. Children in early learning and childcare settings demonstrate, in many play activities, an interest in computers and what these devices can do. They show growing awareness of such ideas as inputs and outputs, for example when programming moving vehicles. They extend their knowledge of different devices and pieces of hardware.

Many staff in early learning and childcare settings need clearer guidance to lead and support development of 'computational thinking' more effectively, an idea which is completely in step with the principles of the early years curriculum. Across the early

learning and childcare settings and primary stages, there is a clear role for staff, and at times children, to take on the role of ‘champion’ or ambassador for computing science, to clarify its distinct role and differentiate it from the wider, generic digital technologies.

From the primary stages, many children demonstrate a keen interest in computers and computing science.

For example, some take part in computer clubs, and others develop sophisticated skills using popular current games such as those based on creative principles of computer-aided design. Such natural, infectious enthusiasm among young people offers an important opportunity, which it is important that practitioners recognise and exploit. There is rapidly developing interest and practice in the specific field of coding, perhaps inspired by the impact of ‘apps’ (and including ‘Apps for Good’), but equally importantly promoted by the emergence of high-quality, well-structured resources. Some schools make good use of digital expertise among parents, for example through clubs. However, at times a lack of appropriate digital skills among staff at the primary stages is a factor in limiting young people’s achievements. There may be a role for secondary computing science specialists to collaborate strategically, working closely with primary specialists to blend the technical skills of the subject area with primary pedagogical expertise.

Some secondary schools provide exemplary programmes in computing science, enhanced by connections with, for example, local universities and businesses. These schools have successfully differentiated between ICT and computing science, with the former recognised as a permeating, potentially significant influence across the curriculum, where computing science addresses the highly technical and specialist strands of the science of computing, and information systems.

'The technologies curriculum in the school is dynamic and forward-looking, with outstanding contributions in computing science and engineering in particular. Young people are highly motivated by technologies experiences, articulate in describing their projects and achievements, and in many cases fired up with ambition for technological careers. Features of the school's creative approaches include a close working partnership with a local university. The direct benefits for young people include mentoring for Advanced Higher programmes and hands-on experience for Higher pupils of building personal computers and creating operational networks. Young people take part in a wide range of competitions and challenges, in motivating areas including motorsport, and design of remotely operated submersibles for oil exploration. In every respect, it is clear that the headteacher's clear vision and drive, and the high quality of teaching, are fundamental to the ways in which young people are thriving in their experiences in the technologies.'

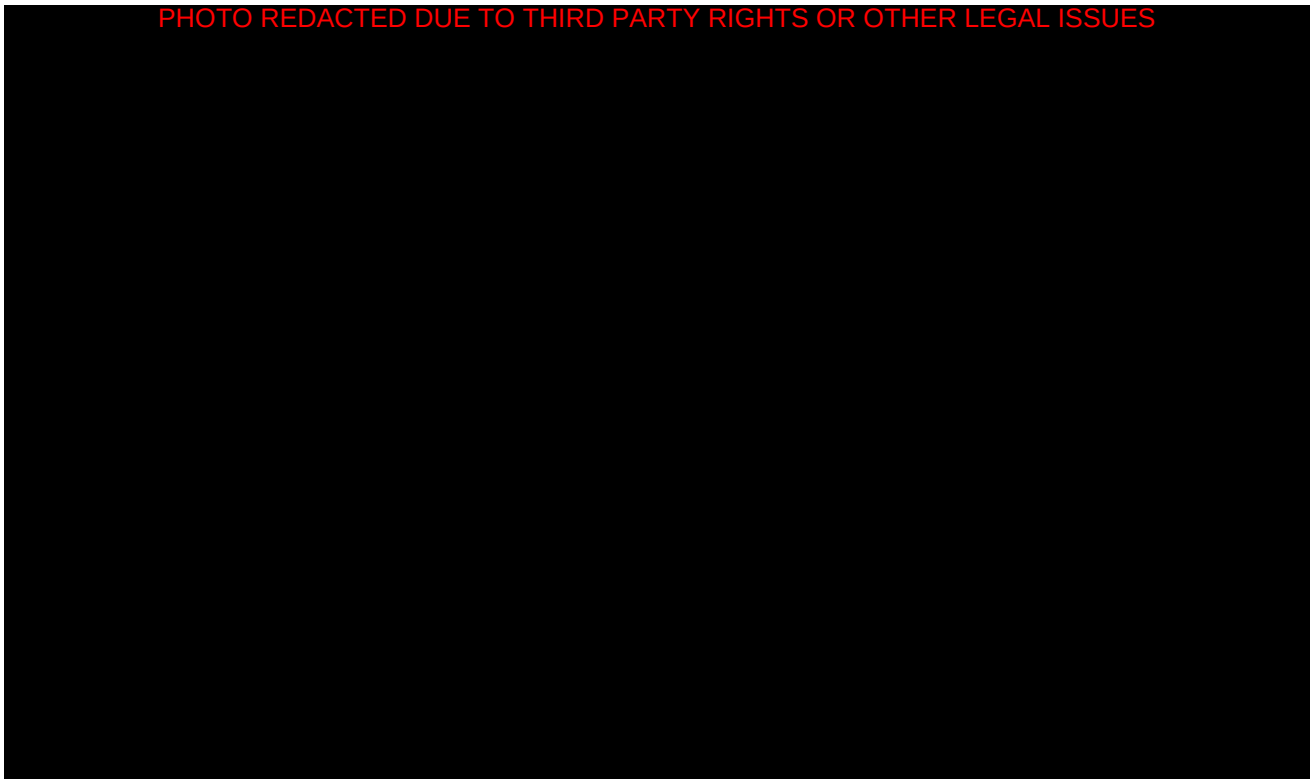
However, such positive practice is by no means universal. In too many schools, computing science has diminished in popularity. The subject can too easily become a sterile and functional experience, lacking in creativity. Where young people have absorbed this negative image, computing science has in some cases been removed from the school's curriculum. This loss is highly significant and, where relevant, should form a priority target for schools to address. Computing science offers too important an experience for it to be left to chance whether it features in a secondary school curriculum or not. The radically-revised curriculum provision in computing science at the senior phase presents an important new opportunity for all secondary schools.

Craft, design, engineering and graphics

Children in early learning and childcare settings show their natural creativity in play activities relating to the technologies. They create shops, houses, garages and hospitals using block construction resources, becoming aware of ideas of design, how to make structures stronger, and how to solve straightforward technological problems. They enjoy using tools to cut and shape craft material, and use different resources and equipment to form joints in their products. In some centres, children have good opportunities to use a range of tools and equipment, safely and with growing skills. Although children's graphic work usually focuses on expressive and responsive activities, the early threads of graphic communication are clearly evident, for example where children's pictures interpret or represent a product. Children like programming vehicles, helping them establish an early understanding of control technology.

Technologies programmes in most primary schools generally ensure that children have some opportunities to explore technological ideas, and to design and create products. Children progress best where structured programmes, for example those based on kits, are provided alongside more responsive, flexible opportunities such as those arising from interdisciplinary approaches.

Almost all young people in secondary schools experience some worthwhile aspects of craft, design, engineering and graphics, increasingly so as the broad general education becomes established from S1 to S3. Overall, programmes in the broad general education provide young people with a good range of experiences, although too many continue to give undue emphasis to craft and graphics at the expense of design and engineering. Young people almost all enjoy their technologies experiences. They design and create useful products in metal, plastics and wood. They develop effective manual and computer graphical skills, and solve engineering challenges using electronics or pneumatics. Young people are better motivated when they can see the relevance of their work to the real world, for example relating their tasks to major social and technical developments such as construction projects, energy engineering or resource sustainability.

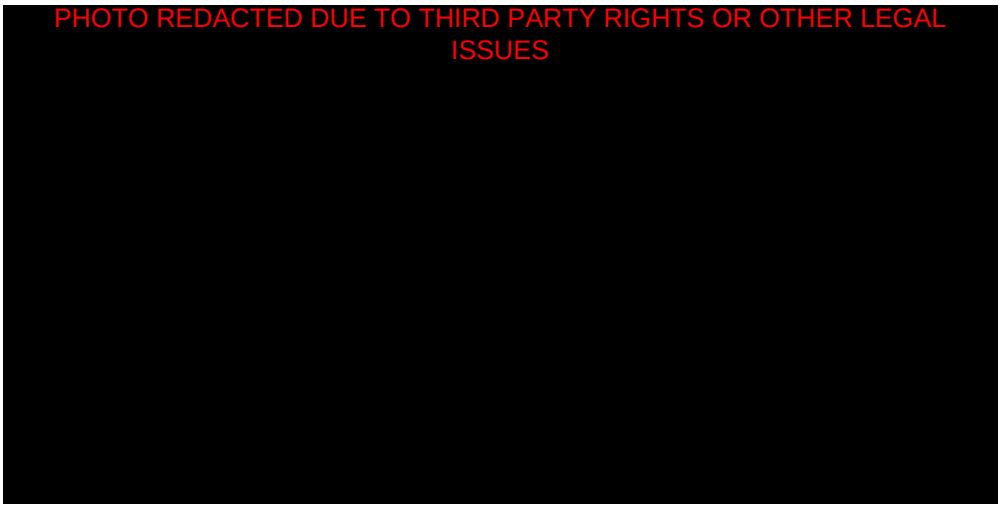


('Hampden Park for the 2014 Commonwealth games – track infrastructure'.)

Other connections which help motivate young people in craft, design, engineering and graphics include careers and enterprise.

Young people enjoy the different environments of these practical subjects and the sense of freedom they experience in workshops and graphics studios.

As young people progress to the senior phase, they recognise how their more specialised technologies skills can lead ultimately to careers and professions.



Skills for work[3] courses are popular with many young people, whether delivered in the school or at local colleges.

Young people at the senior phase continue to have extensive choice within and between craft, design, engineering and graphics, with a number of 'pathways' through Higher and on to Advanced Higher, and units and courses promoting practical skills. The quality of young people's craftsmanship across these programmes and pathways is, in some cases, impressive, reflecting high-quality teaching and the high expectations of staff. The steps taken to renew interest in engineering science, for example the revisions to programmes at National, Higher and Advanced Higher levels, are an important and positive development. However, much remains to be done to attract young people to study engineering, in numbers which reflect the economic and educational importance of the subject.

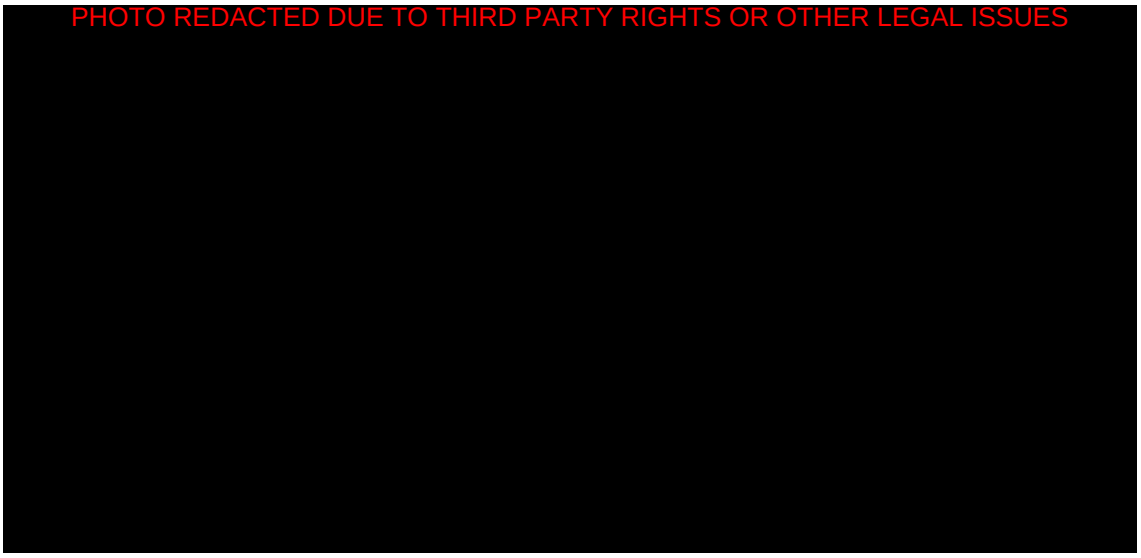
[3] Automotive Skills; Construction Crafts; Construction Engineering; Creative and Digital; Creative Industries; Energy; Engineering Skills; Food and Drink; Hospitality; Maritime Skills; and Rural Skills. More information on Skills for Work courses is available at www.SQA.org.uk

Food and textile contexts

This aspect of the technologies also features in national advice on health and wellbeing. Children in early learning and childcare settings have good opportunities to explore food and textile technologies through their play activities. Almost all help to prepare their own snacks, learning about different kinds of food and how best to handle them with due regard for health and safety. Children extend their knowledge in play contexts relating to, for example, homes and shops, and develop ideas of cooking, such as the courses of a meal, in their 'mud kitchens'. Overall however, textile technologies need to continue to be developed and promoted within the curriculum.

These approaches gain momentum through the primary stages. A few schools give particular emphasis to food technologies, for example through healthy eating programmes in which children cook and bake a varied range of dishes. In these positive examples, staff ensure appropriate attention to important themes such as healthy eating concepts, playing their part in promoting health and wellbeing in a practical setting. Children are highly motivated by these practical, relevant approaches. At times, staff encourage children's interest by connecting their work with popular television programmes on cookery or baking. Other positive examples of food-based activities include children exploring cooking in the context of studies of different countries and cultures, illustrating the valuable contribution which food and other technologies can make to wider issues of equality and diversity. Schools capitalise on expertise among their own staff, but also cast their nets wider into the community, for example involving parents, carers and local businesses. These approaches give special stimulus and credibility for the children and, for some, lay the foundations of particular talents. Children in some schools help to prepare food for events such as charity fund-raising fairs and coffee mornings. They find these experiences exciting, developing their technological skills alongside important inter-personal and customer skills. Whilst textile experiences feature less often than food-related tasks at the primary stages, most children have opportunities to learn about different fabrics, and to design and make small products. Children extend their appreciation of ideas of enterprise and business, for example when they create dishes and craft products from different cultures and traditions.

Almost all young people in secondary schools experience worthwhile activities relating to food. From S1 to S3, almost all cover a broad range of Experiences and Outcomes, providing them with practical, real-world skills. These skills are both an investment in the young people's capabilities for independent living, and a basis for thinking about careers in cooking, catering and hospitality.



Programmes in the senior phase offer a good range of qualification pathways, including some, such as cake decoration, which promote creative skills. Importantly, practical and creative skills are delivered in contexts which also demand much of young people's organisational skills. These tasks help establish good habits of resource management, such as coping with deadlines. Some schools provide opportunities for young people to take industry-standard qualifications, for example relating to food hygiene. These qualifications are popular among young people, for their immediate value in part-time employment, and relating longer-term to careers in food, catering and hospitality. The use of recognised qualifications offers a wider message to the technologies, where many specific practical skills have direct relevance to the world of work. Most young people at the secondary stages develop some knowledge and skills relating to textiles as part of their broad general education. They create fabric products of increasing complexity for their personal use or in connection with enterprise activities. Overall however, textile technologies need to be continued to be developed within the curriculum to ensure high quality experiences for all young people.

4.2 The other three curriculum contexts; ethos and wider life of the school; interdisciplinary learning (IDL); and personal achievement

Ethos and wider life of the school

Schools need to recognise more consistently how the technologies can be developed through the ethos and wider life of the school. However, we noted positive examples where children and young people demonstrated practical, technical skills such as improving the school play areas and trim track, supporting social events for pupils or parents, or in charity fund-raising. In some schools, children and young people show their technological talents and skills by creating props for school shows, or supporting social events. Production of school yearbooks gives some young people the opportunity to develop and apply a range of digital and technological skills.

'All classes in the school make very effective use of Glow, including blogs, through which they communicate information about events in the school and share reports on their recent work with parents. The children show real confidence and creativity using computers and other digital devices, supported by a coherent programme developed by the enthusiastic, knowledgeable principal teacher.'

Interdisciplinary learning (IDL)

In early learning and childcare settings, play activities typically blend learning in the technologies with other outcomes including, for example, literacy and numeracy. For example, children learn specialist technical vocabulary associated with 'shops', as they arrange products such as fruit and vegetables, organise travel brochures and application forms, or use the till when serving 'customers'. Outdoor learning presents similar opportunities. For example, children design and create cycle routes to be followed in the playground. Baking cakes integrates practical food skills with important principles of numeracy, and aspects of health and wellbeing including personal hygiene and healthy eating.

'The children look in depth at the issues associated with wind farms, prompted by local developments. They meet staff from the construction and utilities companies, and compare their views with those of local families. They explore the suitability of the chosen site, at times using video conference facilities and interviewing 'Heather the Weather' at the Glasgow Science Centre.'

Some schools approach connections across learning based on the strong, logical relationships between sciences, technologies including engineering, and mathematics; the STEM subjects. Some interdisciplinary projects are particularly helpful in portraying technologies in social contexts, at times relating to stories or novels which children are reading, or as part of topics with a social studies focus.

'The children in P5 design and build 'motability' vehicles, prompted by their reading of a popular novel. This approach is commendable in presenting the skills of 'design and make' in a way which promotes the value of engineering in helping humans access a full life, and all in a fun setting, which encourages high motivation and interest. It demonstrates how experiences in the technologies can address issues of equality and fairness, sometimes in quite subtle ways.'

In many schools, staff use the contexts of seasons or school events, to plan learning based on groups of Experiences and Outcomes, including the technologies. The best of these experiences, such as charity fund raising or environmental improvement projects, are highly successful in motivating young people, developing skills in problem-solving and teamwork and contributing to their entitlements in the technologies.

'Young people appreciate the value of work which connects their technologies learning with other subjects, for example in running a 'coffee shop' project involving modern languages, English, music and food technologies, and exploring product development and marketing through developing a 'shampoo', with inputs from science staff.'

The technologies offer specific opportunities for connecting learning across subjects, both within the technologies themselves, for example between craft and graphics, and also across the curriculum. The particular challenges associated with learning about technological developments in society might, for example, be resolved by connecting technologies programmes or activities with those in the social subjects. Early learning and childcare settings and schools have not yet invested enough in exploring the specific purposes of interdisciplinary learning, in this case to enhance study of the technologies.

Setting technologies in broader IDL contexts has the potential to reinforce children's and young people's awareness of how technology underpins everyday life.

Personal achievement

Most centres and schools are not well informed about young people's personal achievements in technologies beyond the school day. Young people's accomplishments include those relating to talents they display in their homes or communities. They might include, for example, digital skills, creative crafts, business organisational skills, interests in engineering, personal hobbies and interests, or those gained through participation in clubs, sports and other wider activities. Improving practice in this respect is an important target for the technologies, and across all the curriculum areas more generally. This is relevant, not merely in respect of presenting a fuller picture of the young people as unique individuals, but crucially also as a basis for planning for their future experiences. Staff with responsibilities for the technologies should develop strategies to capture the full range of young people's experiences and personal achievements, in the context of their schools' approaches to tracking and monitoring young people's overall achievements. The wider knowledge of specialist practitioners in community learning and development offers one route to support improvement in this area.

5. Curriculum priorities: raising attainment and improving achievement, closing the gap and preparing learners for the future

5.1 Raising attainment, improving achievement

Earlier sections of this report provide clear evidence that learning in the technologies inspires and motivates young people in specific ways, and challenges and supports them in reaching higher goals. For many young people, the technologies convey a sense of real connection with the world in which they live, bringing purpose, 'edge' and motivation to their learning. Effective technologies programmes can spark interest and raise motivation for children and young people across the age range, relevant to a wide spread of talents and career aspirations, and across the practical trades and into the professions.

'Young people in this high-performing school were deeply engrossed in a practical fabric craft task, part of their broad general education, largely due to the skilful, motivating way in which staff structured the activity. The lesson opened with the young people watching a video presentation on the internet, and the high standards and expectations exemplified by staff were clearly proving effective in engaging the class fully. Young people in the senior phase, almost all of whom were progressing towards higher education, showed a keen interest in continuing aspects of food technologies. Around 80 took part in the baking club, which capitalised on the interest inspired by a popular current television programme.'

In continuing to seek alternative strategies to raise attainment and improve achievement, centres and schools should ensure that they exploit fully the special features of the technologies which promote aspiration and inspire motivation in young people.

5.2 Closing the gap

Some of the recognised characteristics of the technologies can impact significantly on young people whose overall circumstances or achievements can be a cause for concern. Many young people find specific motivation in the close connections which exist between, for example, the technologies and careers, providing a key positive influence on the attitudes children and young people hold towards skills for work. Similarly, the natural ways in which the technologies relate to enterprise and entrepreneurship are proven to appeal to young people who, at times, find little relevance in their school experiences. At an even simpler level, the very nature of the technologies – practical; hands-on; creative; workshop/studio based – can impact on young people in substantial ways. Across many schools, it is clear that some technologies, for example the craft subjects, have, in the past, attracted young people whose overall achievements elsewhere in the school may have been modest. That involvement has succeeded in providing these young people with valuable experience, much of it with clear vocational relevance, building their self-esteem and providing them with important foundation qualifications. The technologies can be justifiably proud of this contribution to young people's development, for example in contributing to closing the attainment gap between those children and young people from more deprived circumstances with those from more advantaged backgrounds. However, it is equally the case that the technologies must continue to improve their performance in this key area of national policy, encouraging ambition among the highest attaining young people. The technologies need to continue to find ways of raising, significantly, the achievements of children and young people from less advantaged backgrounds.

5.3 Preparing learners for the future

There is no credible argument that the process of technological change will do other than continue and accelerate into the future. It follows that learning in, through and about the technologies takes on increasing importance, if it is to meet fully the needs of young people as learners, citizens and contributors.

The digital technologies clearly stand out as hugely important in their potential to drive effective learning into the future. Highly persuasive research evidence from studies around the world confirms that the digital technologies merit a much more central role in learning. In guidance for Curriculum for Excellence, the technologies context of *ICT to enhance learning* was an appropriate concept and scale of ambition in its time. However, in light of the pace of educational, social and technological change, that role now needs to evolve to recognise the huge potential of the digital technologies to improve learning.

In the technologies, high-quality programmes and activities capture young people's immediate interests, for example by reflecting ideas popular and current in the media. The flow of topics, issues and ideas offers a continuing supply of stimulating ideas, deriving from the real world. That 'feed', continuously renewing and refreshing, represents a major opportunity for learning in the technologies. Across schools, it is far from commonplace for young people's experiences to relate well to contemporary events and ideas from their daily lives, or that programmes consistently ensure that they promote 'real-world' learning. That is not to suggest that programmes across early years, primary and secondary schools should be based entirely on ideas current in the media, some of which may be transient and superficial. However, careful planning should ensure that close account is taken of 'big ideas' in the world outside school, for example those relating to issues of energy, of sustainability, or events with a technological dimension such as major construction projects,

media developments or natural disasters. By so doing, programmes can provide young people with a continually refreshed and current experience, reinforcing the position of the technologies as permeating features of everyday life and building young people's capacity to interact positively with their developing world.

6. Technologies: sources and resources

This section considers the human and material resource available for the technologies, and reviews a small sample of the support organisations which featured in some of the early learning and childcare settings and schools visited.

The human resource: staff confidence and skills

Professional expertise remains the most important resource for technologies, in common with other curriculum areas. Whilst there is much good practice evident in early years and primary sectors, there are also too many centres and schools where the technologies have not fared well in their development, relative to other curriculum areas. Professional learning in the technologies is a key target for improvement; across 3-18, but with particular recognition of the challenges for early learning and childcare settings, and primary sectors. Key targets include important practical skills, such as those relating to health and safety in, for example, food preparation.

In secondary schools, shortages of specialist teachers can be a significant issue which results, for example, in gaps in the broad general education and loss of progression pathways through the senior phase. Areas most often affected, at times acutely so, include business education, computing science and food and textiles. Schools need to be vigilant that their short- and long-term decisions on curriculum design and staffing issues do not have adverse effects on provision in the technologies.

This report highlights, at a number of points, the special relationship which exists between the technologies and the world of work and enterprise. There is clear scope for more to be done, in terms of professional learning, to equip early years and school staff to build on the strength of that relationship. Earlier examples of valuable partnerships between education and business have included the Teacher Placement Service (TPS) and more recently Enterprise through Education Business Links (EEBL). These approaches have a particular contribution to make to professional learning in the technologies, to keep staff informed about technical and commercial developments and to provide a rich, stimulating and credible resource for curriculum planning. Past initiatives such as TPS and EEBL have required specific administrative structures, but it may be possible for some existing support agency to take on a more enduring, facilitating role specific to the technologies. Such a development would also make a significant, lasting contribution to ensuring Scotland's young people are well prepared for the world of work, chiming with a recurring theme in Scottish education and most recently articulated through the Wood Commission's work on developing Scotland's young workforce. Important developments in accreditation of professional learning, since TPS and EEBL were active, should also be taken into account.

This report argues that the digital technologies need to be given a much more central role in learning and teaching. These technologies need to be recognised as more than an enhancement to learning, and offer a key resource for early years and school practitioners. Whilst many technologies staff make extensive, productive use of the digital technologies,

overall the impact falls far short of their potential. Professional learning for the technologies should include action research into the most effective deployment of the digital technologies to meet learners' needs.

Material resource

Schools and early learning and childcare settings have access to extensive material resources for the technologies. Arguably, the issue facing practitioners is not any lack of high-quality resources, so much as the challenge of finding, and at times funding, the resource which best meets the needs of their young people. Another pressing issue is the financial cost of some technologies learning materials, for example for software, craft or food technologies. Clearly, these costs must be justified in terms of the educational return on the investment they represent.

Education Scotland www.educationscotland.gov.uk are foremost among the providers of materials 3-18. For the senior phase, the Scottish Qualifications Authority (SQA) www.sqa.org.uk provides an extensive array of high-quality materials with an emphasis on accreditation. Further key sources include the local authorities and some from among the professional associations. Overall, centres and schools are able to access good-quality, contemporary resources. Many practitioners work hard to maintain the currency of the materials they are using, although the challenge of keeping practice up to date is significant and is referred to elsewhere in this report. A key skill of staff is their role as 'curator', effectively searching for the most suitable resource to deploy to meet any specific need.

Many staff make good use of Glow, and of the internet more generally including innovative use of social media, to share ideas and resources across teacher communities. These approaches are increasingly influential. They offer the benefits of access to a world market for technologies resources, and a dynamic community of developers with the potential to share good practice more effectively than has ever been the case hitherto.

Support organisations and initiatives

The following examples were encountered in centres and schools visited as part of the technologies impact review. However, practitioners have access to a much more extensive range of technologies organisations, initiatives and competitions, many of which offer specific resources and stimulus for learning in the technologies.

www.educationscotland.gov.uk
www.sqa.org.uk

SSERC (The Scottish Schools Education Research Centre).
www.sserc.org.uk

Many schools extend their capacity to offer high quality experiences in the technologies through professional training and advice from SSERC. However, this important and widely-praised resource has the potential to support the technologies more fully. The widespread perception remains that SSERC is predominantly a science-oriented facility, despite its proven track record in supporting some specific aspects of the technologies over many years. It will be important that SSERC and other support agencies continue to evolve their roles across the family of the technologies.

STEM (science, technology, engineering and mathematics)
www.educationscotland.gov.uk/stemcentral/

Many schools use the interconnections between the technologies, mathematics and science to a greater or lesser extent, for example drawing on resources supplied centrally. At their best, these influences help promote learning which is more coherent and integrative. Centres and schools find the connections logical and helpful, for example when designing interdisciplinary learning contributions to the curriculum. However, STEM can appear disproportionately focused on science, to the relative exclusion of its wider constituency. Given that creativity emerges as a central purpose of the technologies, it will also be important that STEM is seen to embrace creative and innovative objectives alongside its existing goals.

Plan C – Professional Learning and Networking in Computing
www.casscotland.org.uk/plan-c/

Plan C is a government-sponsored initiative aimed at driving improvements in provision in computing science, by establishing a good practice network of 'hub' schools. In 2013-14 and 2014-15, staff in these schools are undertaking 25 hours of their annual 35 hour continuous professional learning allowance, in training specific to computing science, then networking with their local community of teachers and businesses. This improvement model has much to offer the technologies more widely, investing in developing practitioner skills and sharing good practice.

Primary Engineers Programme
www.primaryengineer.com/

This important development has been gaining momentum over the period of this review, and extending its reach into secondary schools. The programme is proving successful in encouraging creativity, raising children's and young people's awareness of the scope, diversity and challenges of engineering. A major strength is the way in which it addresses issues of strategy at national and local levels, as well as providing schools with practical, well-designed and motivating learning experiences. The programme also provides innovative approaches to accreditation, for example leading to Chartered Primary/Secondary Engineer status.

7. Reflections and conclusions

In this section, we draw together a number of strands which emerge in the review of technologies, and which offer the prospect of clearer targets for improvement.

The technologies 'brand': common purpose, unique contributions

The 'subjects' which make up the technologies have been grouped together for many years, in essentially the same way. However, the technologies have not consistently explored their common purposes sufficiently, at local or national levels. They have not established a shared identity which might serve better the needs of children in early years, primary and early secondary levels, through the broad general education. Whilst the core characteristics of the technologies – creativity and problem solving, real-world, real-time –

emerge clearly and strongly from this review, a number of questions arise relating to the idea of the technologies 'brand'.

- What collectively do the technologies have to offer children and young people in the broad general education 3-15?
- How might the definition of a more direct, shared identity for the technologies support early years and primary schools better, in improving provision in the technologies?
- How do programmes for the broad general education, in the different aspects of the technologies, reflect the emerging core purposes of creativity and problem-solving, real-world, real-time?

It may be that the technologies can learn from the experiences of other cognate subject groups – for example the sciences, or the social subjects – where deeper consideration has been given to coherence. That kind of conversation, convened and facilitated by senior staff or local authority quality improvement specialists, could help remove some of the barriers to learning which can arise from dissimilar treatment of similar objectives. The technologies need to do more to identify their collective 'brand' as a significant step towards delivering their potential for young people and their community.

Digital technologies at the heart of learning

This review set out to explore, among other ideas, the notion of 'ICT to enhance learning', as the context was defined in the early days of development of Scotland's new curriculum. Across and beyond the early learning and childcare settings and schools visited, it is often the case that ICT is indeed used as an 'enhancement' to learning; activities, however supportive, which are on the fringes of the main purpose or task of a lesson. In some centres and schools, some of which are described in this report, ICT has achieved a much more significant influence on learning. The impact is clear in a number of respects, including young people's motivation for learning and their ambitions for careers in the technologies. It is important to underline that these achievements are based first and foremost not on the digital technology itself, but on key decisions which staff make about the most effective framework and resource for learning. That conclusion affirms the continuing, central role of staff and the importance of their professional and technical expertise.

Clearly, the concept which emerges from this review is of *digital technologies at the heart of learning*. That powerful identity begs the question as to how best to begin to bring about the necessary changes. As a first step, the digital technologies might draw on the experiences relating to literacy, numeracy and health and wellbeing, the 'responsibilities of all'. Promoting the digital technologies through a new, refreshed approach can highlight their creative potential, whilst beginning to set out strategies to locate these technologies at the heart of learning.

Real-world, real-time technologies

Appendix 1 provides an illustration of how media coverage might be used to prompt and generate high-quality learning in the technologies. The Appendix includes a survey and summary of technologies topics in the media carried out by Education Scotland staff over a brief period in the summer of 2014. That survey, limited though it was, underlines how prominent the technologies are in the media, and offers a rich variety of starting points for

learning activities. Relevant research, including from international sources, highlights the potential for 'authentic learning'[4] to impact on young people in effective ways. Centres and schools should be supported to develop expertise and resources, to draw on technologies stories breaking in the media, within the professional framework of their overall planned programmes for the technologies. Such an approach can learn from the principles established successfully by Game On Scotland www.gameonscotland.org/ including the fact that the flow of potential 'real-world, real-time' topics is limitless. Technologies programmes in early learning and childcare settings and schools should include significant opportunities to capture the immediacy and motivation of issues and events current in young people's lives. Staff should use these approaches to help children and young people connect their learning in the technologies with the world beyond school, to recognise the importance of the skills which they are learning and their links with careers and work.

Gender issues in the technologies

Across some secondary schools, the typical pattern of uptake in each of the separate technologies contexts is an area of concern. In some cases, the subjects of computing science, engineering science and engineering craft subjects, tend to attract boys, whilst food and textile contexts and, to a lesser extent, business subjects, continue to prove significantly more attractive to girls. It is clear that these patterns are long established. That fact helps explain to some extent why these irrational disparities exist, but it presents a paradox when, for example, there is clear statistical evidence (see Appendix 2) that girls outperform boys in many of the technologies subjects.

Some schools can claim a degree of success in attracting numbers more appropriately balanced between boys and girls, for example those in graphics and design. A balance is sometimes more evident in the senior phase, where young people choose the technologies to provide variety, possibly increasing vocational relevance in their overall curriculum. For example, in S5/S6, greater numbers of boys are at times evident in food technology contexts, and increased numbers of girls in craft contexts.

The potential influence of teacher role models can be helpful, for example the increased numbers of women teaching in craft, design, engineering and graphics subjects, and to a lesser extent men teachers in the business, food and textile subject areas. However, issues associated with gender remain a priority for improvement for the technologies in secondary schools. It can be argued that the technologies, by omission and commission, are currently losing around half of their potential population, and half of the population's potential.

Centres and schools should revisit the issue of gender stereotyping, as a specific concern for the technologies. They should draw on research, and take account of cultural, media and other key social influences from 3-18. Staff should identify good practice in terms of curriculum design, subject experience, learning and teaching approaches, career information advice and guidance and the many, more subtle messages which can influence young people's interests and decisions.

[4] For example, 'The 2014 Horizon Report for Schools' published in the Australian Curriculum and Leadership Journal August 2014; www.curriculum.edu.au/

Transitions

The technologies curriculum framework provides, for the first time in Scotland, the opportunity for coherent, progressive experiences for children and young people from age 3 to 18 and beyond. The review on which this report is based has been conducted at a time when early learning and childcare settings and schools were able to access the national framework of Experiences and Outcomes for some years, but few have achieved any real progress in improving curriculum transition in the technologies. For example, little information is shared on children's and young people's technologies experiences or achievements between early years and primary, and primary and secondary stages. Centres and schools need now to set much higher priority on achieving continuity and integrity in the technologies curriculum 3-18, respecting fully the equal value which each sector can contribute to transitions.

Sustainability

Schools and centres are better positioned than ever to begin to relate learning in technologies more coherently to learning about, and for, sustainability. The Scottish Government's strategic Learning for Sustainability Report confirms the high profile which the technologies can give to sustainability principles and practices, and in turn inspires thinking about the kind of learning contexts which sustainability offers the technologies. http://www.scotland.gov.uk/topics/education/schools/curriculum/ace/oneplanetschools/learningforsustainabilitreport. A further recent report from Education Scotland provides 20 case studies of schools, to mark the end of the UN Decade of Education for Sustainable Development, which again prompt thinking about technologies aspects. http://bit.ly/LfSconversations. Importantly, learning for sustainability is integral to the General Teaching Council for Scotland's framework for professional standards. http://www.gtcs.org.uk/standards/standards.aspx. At the practical level of activity, schemes like Eco Schools (Scotland) have achieved a huge impact on schools and centres, highlighting the priority which sustainability themes have achieved in educational developments. The technologies have, of course, played some specific parts in schools' achievement of awards for their environmental work, for example creating facilities in school playgrounds using responsibly-sourced materials. This report recorded earlier the contribution which technologies creativity, problem-solving and craft skills have made in the context of children's and young people's conservation work for the John Muir Award. These elements begin to coalesce around the idea of a sustainability strand for the technologies, perhaps embodying principles of the 'Circular Economy' www.ellenmacarthurfoundation.org/circular-economy which are gaining momentum globally. One outcome might well be the loss of terms such as 'junk modelling' or 'trash fashion', as communities become more aware that there need be no such concept as waste. Beginning in early learning and childcare settings and primary school settings, there is clearly massive potential for sustainability education to form a positive, creative influence across the technologies curriculum 3-18, one which chimes with developments at national and global levels. Such developments can explore the ethical goals of sustainability in the real-world context of economic development, for example by showing the commercial potential of approaches to re-designing, reducing, re-using and recycling.

Improvement planning for the technologies

The technologies rarely feature as immediate or short-term priorities in overall improvement planning timelines in early learning and childcare settings and schools, often finding

themselves in the latest, final stages of programme improvement. This positioning of the technologies is fairly representative of earlier development programmes across Scotland, where typically the sequence of priority would start with language/literacy and mathematics/numeracy. Whilst schools' and centres' management of change requires that priorities are identified and pursued, that traditional sequencing, leaving technologies for later attention, has had both explicit and implicit outcomes: explicit in terms of the lack of investment, for example curriculum time, and professional learning focus, in improvement; and implicit in terms of the perceived 'importance' of the curriculum areas. At a time when schools and centres are looking for new, innovative ways to raise achievement, close the attainment gap and prepare young people for the future, there is scope to review whether alternative models of improvement planning are appropriate. For example, young people in the technologies have significant opportunities to develop their skills across literacy, numeracy and health and wellbeing, the areas identified as the 'responsibilities of all'. In these vital areas, the technologies can deliver on the greater purposes of Curriculum for Excellence, and can impact in significant ways on young people. The technologies can develop skills for learning life and work, for example teamwork, problem-solving and applying digital technologies. Rather than setting them aside for later phases of implementation, schools promoting the technologies earlier in development schedules have the opportunity to address priority concerns in a different, innovative way. Clearly, that places high expectations on the capabilities and roles of staff for the technologies, but the approach offers a different model for centres and schools where the necessary expertise is available. The experiences of the technologies academies in England and Wales might offer some helpful resource and reference point for schools considering how central a role the technologies might play in improvement planning.

Technological developments in society

There is considerable scope for learning in this area of technologies to be improved. For example, closer collaboration with specialist social studies practitioners, can draw on their expertise as consultants, or as collaborators in interdisciplinary learning. Such collegiate working has the clear potential to offer benefits for both the technologies and social studies, connecting the technologies firmly with other influences on human experience.

Technologies, work and enterprise

For many young people, the technologies make powerful contributions to development of skills for work and enterprise. Young people's experiences confirm the close relationship which the technologies have with the creative and manufacturing industries, careers and entrepreneurship. The practical skills promoted by the technologies offer significant opportunities to explore the ideas and motivations of entrepreneurship. For example, young people's skills in software development, food and textile production, and craft or graphics can be complemented by business and digital technologies skills, providing a range of experiences relating to understanding business or, indeed, business start-up. Whilst the framework of National Qualifications supported by SQA includes some helpful features, there is scope to consider whether a coherent award might recognise and promote the idea of a combination of technologies and entrepreneurial or work-related experiences and qualifications.

The technologies can help young people formulate and evolve their thinking about positive destinations in continuing education or training, careers and the world of work. Skills for Work programmes have proved a notable success in a number of technologies

subject/contexts such as *Automotive Skills; Construction Crafts; Construction Engineering; Creative and Digital; Creative Industries; Energy; Engineering Skills; Food and Drink; Hospitality; Maritime Skills; and Rural Skills*. Importantly, Skills for Work programmes also provide the technologies subjects with wider messages about their responsibility to maintain vocational 'currency', not restricted to the trades but across the technologies, and including the professions. These are major, continuing strengths of the technologies which, can be developed in light of more recent thinking on preparation for the world of work for all young people, including the Wood Commission report on Developing Scotland's Young Workforce. http://www.scotland.gov.uk/Publications/2014/06/4089

Summary comments

Three powerful themes feature throughout this report.

1. Technologies promote ***creativity and problem-solving, real-world, real-time.***

The technologies make many significant contributions to young people's skills for learning, life and work. However, creativity and problem-solving need to be recognised as the core business of the technologies, the main justification for their place in the curriculum, and clearly connected with the world in which Scotland's young people will make their way. For many practitioners, this emphasis requires a major shift in the way they design and deliver programmes.

2. Our children and young people require that centres and schools place ***digital technologies at the heart of learning.***

Time and the world have moved on since the role of ICT was seen as 'to enhance learning'. This review confirms beyond doubt that our children and young people need digital skills and technologies to be given an absolutely central role in the learning process – no longer an enhancement or 'bolt-on', but a foundation and a primary consideration for any planned learning.

3. The technologies need to **build a clearer brand.**

Children and young people need access to a more integrated experience for the technologies in the broad general education. Past efforts to improve the technologies curriculum 3-15 have failed in part due to the perceived complexity of the subject area – a 'fear factor'. Core characteristics of the technologies – the significant aspects of learning[5] – provide a basis for:

- *a more coherent approach 3-18;*
- *a more straightforward, less daunting identity and achievable goals for early years and primary practitioners; and*
- *a common agenda for secondary specialists for the broad general education, recognising the continuing importance of their specialisms for the senior phase.*

The Technologies Impact Review has confirmed that there is much good practice in technologies around Scotland's centres and schools. For some children and young people, the technologies Experiences and Outcomes inspire high-quality learning and support exemplary achievement, preparing these young people well for life and work in the rapidly changing, at times turbulent, world in which they will live.

[5] finding, discussing and organising information on the technologies; understanding how technological products work and how they affect people; planning and organising technological activities

'The school provides children with a full and rich technologies experience, including some highly innovative and radical approaches. Central among these is an initiative which released creativity, teamwork and technical knowledge in imaginative ways. The school has developed its play area and facilities, in close consultation with parents, to encourage active play at the lunch break. Resources in the form of recycled and found materials are supplied by the local 'Zero Waste' organisation, suitably checked for safety and hygiene. Children use these materials in creative, at times wholly unpredictable ways. For example, they create tents and 'dens', build hammocks in trees which have been approved for climbing, and design runways and tunnels for tennis balls, using pipes and guttering. The children work in teams, evolving different designs or re-creating favourite ideas. They learn important principles of design and creativity, and knowledge about different materials and structures. These lunchtime activities are hugely popular amongst the children, who are exploring the idea that there need be no such thing as waste.'

However, the extent of change in technologies programmes in recent years has been, at best, modest in too many centres and schools. The technologies need to take stock of their common history and move forward in a more connected, integrative way to achieve the ideals of the broad general education. The digital technologies need to be positioned much more centrally in learning. Technologies programmes 3-18 need to put forward a more convincing case for their place in the curriculum, demonstrating their commitment to creativity and problem-solving, real-world and real-time.

Releasing the potential of the technologies holds out the prospect of more fulfilled young people in Scotland, able to make their way, play their part and thrive in their new world. Many of the challenges in improving the technologies are considerable; but so too are the inspiration, imagination and ambition which feature in many centres and schools.

Education Scotland is committed to making its own strong contribution to improving technologies, for example through strengthening its approaches to working with practitioners in its curriculum, learning, teaching, assessment and support forums, and through coordinating initiatives in the technologies which span into further and higher education. We are also committed to building stronger alliances with our partners, for example to support improvements in young people's readiness for work, including skills development in areas of national priority such as the digital technologies. We will also be extending our work with parents, business and learners themselves, as the central players in this project, to ensure that their potential to contribute to improving the technologies is neither ignored nor underplayed.

We hope that you recognise the agenda below as flowing from this task, the Technologies Impact Review, and we invite you to join in alliance with Education Scotland in making learning and achievement better for our children and young people – building society.

The technologies agenda; a framework for action

The following agenda is based on the three main themes already identified. The many detailed, specific recommendations, implicit and explicit in the report, relate to one or more of these three organising principles.

1. *creativity and problem-solving, real-world, real-time*

Tasks

- *define criteria and audit tools for **creativity and problem-solving, real-world, real-time**, by which children's and young people's technologies experiences can be evaluated;*
- *develop resources to create, promote and support progressive technologies programmes, for children and young people 3-18, which deliver creativity and problem-solving, real-world, real time; and*
- *engage with children and young people, parents and communities, businesses and employers, to create the new resources.*

Teams

- *centres and schools, with local authorities, Education Scotland and support agency leadership and support; with full engagement of partners including children and young people.*

Timescale

- *impact within 3 years.*

2. digital technologies at the heart of learning

Tasks

- *conduct research into learning which exploits digital technologies fully; and*
- *develop initial teacher education and continuing professional learning models, resources and processes which locate digital technologies at the heart of learning.*

Teams

- *centres and schools, with local authorities, Education Scotland and support agency leadership and support; with full engagement of partners including children and young people, and teacher education and professional learning providers.*

Timescale

- *impact within 3 years.*

3. building the technologies brand

Tasks

- *convene short-life development action groups including early years, primary and secondary specialists; and*
- *develop a coordinated/integrated technologies curriculum for the broad general education 3-15, to deliver the entitlement by end of S3 and support appropriate transition into specialist senior phase pathways.*

Partners/teams

- *centres and schools, with local authorities, Education Scotland and support agency leadership and support; with full engagement of partners including children and young people.*

Timescale

- *impact within 3 years*

Appendix 1

Real-world, real-time technologies

The following sample of technologies topics was drawn from media coverage over a period in the summer of 2014. The listing illustrates the range and variety of technologies issues covered in public media, which could be developed into 'real-world, real-time' resources for learning and teaching – effectively, live streaming of technologies into young people's learning. These topics can be followed up by centres and schools in different ways and to differing degrees. For example, those which are more transient in their nature could be raised at school assemblies or in personal and social education discussions. Other topics, such as those associated with medical research or energy engineering, clearly have the capacity to be developed into major units of study relevant across the technologies. Agencies, such as those listed in the resources section of this report and including Education Scotland, are well placed to provide leadership and support to centres and schools in capturing the immediacy and relevance of these real-world, real-time approaches.

Ten Objects of Technology that Changed Our World**;** *Sunday Times*

High-tech must-haves for Christmas; *Press and Journal*

Driverless Cars*; Reuters*

Microsoft's upcoming smart fitness band might work with Apple and Android too*; GMA News*

New technology helps brain signals move paralyzed hand*; Time.com*

BMW 3D prints new thumbs for factory workers*; Guardian*

Dare to be Digital launched by V and A game designer*; Scotsman*

EMEC (European Marine Energy Centre) expands operation to Islay and Harris*; Orcadian*

Personal Safety resource launched by Police Scotland; *Education Scotland's Today's News*

Leuchars Spaceport could be launch pad for great things*; Fife Courier*

Video food blog: Arbroath Smokies*; Scotsman*

Top Scottish judges give go ahead for Viking windfarm*; Shetland Times*

Innovation in Textiles*; Trent University*

Blackest is the new black; scientists develop a material so dark you can't see it; *Independent*

Appendix 2

Messages from the statistics

The following data confirm the diversity of the technologies, spanning from AH Computing to Intermediate 1 Woodworking skills, which highlights the range of needs which the technologies meet. The data also raise important questions, and at times concerns, for example about uptake and attainment by gender. Tackling the issues which underlie these concerns forms a major part of the agenda for improvement in children's and young people's experiences in the technologies.

Uptake[6] and attainment in the technology subjects by S6, in 2014

- *Computing Science and Product Design are the most popular technology subjects. However a smaller proportion of the pupils who take these subjects achieve to SCQF level 6 or 7 than in many other subjects.*
- *Conversely, many of the pupils who take Graphic Communication (and to a lesser extent Information Systems and Technological Studies) achieve SCQF level 6 or 7. In particular more pupils achieved an Advanced Higher A in Graphic Communication than in any other subject apart from Mathematics, Music and the 3 main sciences.*
- *Many pupils achieve Business Management at SCQF level 5+ and 6+, more so than any technologies subject. However very few pupils achieve Advanced Higher Business Management, partly, although not solely, because pupils tend to take the Higher in S6. In 2014, Business Management was the 3rd most-popular S6 Higher after English and Mathematics, 12th most popular S5 Higher and the 17th most-popular S6 Advanced Higher.*

Gender analysis of uptake and attainment of technologies Highers in 2014 for pupils who also took Higher English and Higher Mathematics.

For each pupil, relative attainment for the technologies subject is calculated as the difference between the band awarded in that subject, and the average of the band awarded in English and Mathematics.

- *All the main technologies subjects have higher uptake among boys than girls. However only in Technological Studies do the boys attain relatively better. In Information Systems and Product Design, the girls attain relatively better than the boys, while in Computing Science and Graphic Communication there is no substantial difference.*

[6] Uptake here refers to the number of pupils that had a resulted entry in any course in the given subject. Thus most popular here means the subject with the largest number of pupils with a resulted entry in any course in the given subject.

Uptake[7] and attainment of individual courses 2010-2014.
SCQF level 4

- *At Intermediate 1 and Intermediate 2 in S4, Woodworking Skills is the most popular technology averaged over 2010–2014.*
- *At Intermediate 1 in S5/S6, Computing Studies and Woodworking Skills have been the most popular technologies, averaged over 2010–2014. Attainment in Intermediate 1 Woodworking Skills in S5/S6 decreased in 2014. Applied Practical Electronics was the 18th most popular Intermediate 1 at S5/S6 in 2014, ahead of many of the subjects that are more popular at other levels.*
- *The food and textile technologies contexts of Home Economics: Health and Food Technology; Home Economics: Fashion and Textile Technology; and Home Economics: Lifestyle and Consumer Technology are most popular at this level. Attainment tends to be particularly high in these subjects. However, S5/S6 uptake in Home Economics: Fashion and Textile Technology, and Home Economics: Lifestyle and Consumer Technology has decreased over 2010–2014.*

SCQF level 5

- *At National 5 in S4 in 2014, Graphic Communication was the most popular technology.*
- *At Intermediate 2 in S5/S6 in 2014, Woodworking Skills was the most popular technology. In general Woodworking Skills tends to have one of the highest pass rates of any subject, although this declined slightly in the latest year.*

SCQF level 6

- *At Higher in S5, Graphic Communication and Computing are the two most popular technologies averaged over 2010–2014. An increasing number of S5 pupils took Higher Graphic Communication in 2014. S5 uptake in Higher Computing declined from 2010 to 2012 but increased again to 2014. S5 uptake in Higher Information Systems decreased over 2010–2014, while Technological Studies increased in 2014.*
- *The proportion of Higher S5 entries achieving an A award increased over 2010–2014 in Computing, but decreased in 2014 in Graphic Communication.*
- *At Higher in S6, Computing is the most popular technology averaged over 2010–2014, and increased in 2014. Graphic Communication is the next most popular technology.*

SCQF level 7

- *At Advanced Higher in S6 Graphic Communication is the most popular technology and has been increasing to become the 8th most popular Advanced Higher. Attainment in this course is particularly high, but has decreased in recent years.*

[7] Uptake here relates to the number of resulted entries in the course with a certification date in the given academic year.

Appendix 3

Messages from the research

The following extracts are based on two information searches conducted by Education Scotland's Analytical Services Team. The researchers have, at times, taken STEM (and specifically mathematics and science) as a proxy for technologies, underlining the fact that there is limited research available for some aspects of the technologies, other than for ICT/digital technologies. However, the research findings provide helpful direction for the technologies, where the issues and concerns are common across the STEM subjects.

1. Technologies in Curriculum for Excellence

Introduction

This search was undertaken to gain a view of Technologies, specifically with regard to outcomes for learners within Curriculum for Excellence. Key areas of interest included: technological developments in society; ICT to enhance learning; business contexts; computing contexts; craft, design, engineering and graphics contexts; food and textile contexts.

Key findings

Technological developments in society

- Findings suggest a gulf between the technologies used by learners at home and at school, however the benefits of incorporating emerging technologies into the classroom is unclear.

ICT to enhance learning

- Results were mixed around the benefits of increased ICT use for learning, with a lack of evidence of ICT having a positive impact on learning outcomes around literacy.
- Conversely, there is some evidence to suggest that there is a potential to enhance outcomes in STEM subjects through the use of ICT.
- Overall, the available literature suggests that any gains in students' learning when using ICT were further enhanced when teachers guided students.
- Findings generally suggest that teachers' professional development and pedagogy may need to be enhanced in the areas of technology and ICT in order to promote transferable skills. Some studies propose that broader educational reform, rather than merely an ICT push, is required in order to enhance skills.
- Handheld technologies such as *tablet computers* are generally popular with both teaching staff and pupils, with increased motivation to learn often cited. However from the available literature, findings show that a clear rationale for the use of such technologies is necessary, and that more long-term research is needed in order to determine the impact that these have on learning outcomes.

Business contexts

- The importance of providing learners with transferable skills for use in the contemporary workplace is a cross-cutting theme across the literature.
- The evidence is unclear with regard to how well-equipped with transferable skills learners are when they enter the job market. While some available literature widely suggests that employers may have concerns over the skill levels of education leavers, a recent large scale survey of business states that the overall majority of employers feel that Scottish education leavers are adequately prepared for the workplace.
- Findings advocate the value of employer engagement with schools, allowing learners to connect skills to a real world context.

Computing Contexts

- The findings in this area are limited, however they generally suggest that there must be a practical approach to skills provision in this area.

Craft, design, engineering and graphics contexts

- The literature in this area is limited, however the restricted findings suggest that enhanced technological aspects to this area of the curriculum enhance learning.

Food and textile contexts

- The literature in this area is particularly limited. One study suggests that the prior identification of key skills allows for more effective teaching and learning outcomes, while another suggests that utilising multimedia applications enhance teaching and learning processes.

Conclusions

- Overall, available information identified during this search confirms that teachers are central to improving the outcomes of learners within Curriculum for Excellence.
- In order to improve learning outcomes and provide transferable skills, professional development and pedagogy may have to be revisited to further embed ICT and business elements.
- While the evidence is mixed with regard to whether education leavers lack appropriate workplace skills, findings generally suggest that business engagement with schools would promote the use of such skills in real world contexts and increase career development opportunities.
- While there is a gulf between the level of technology used at home and at school, technology-enhanced educational models require teachers to revisit their pedagogy.
- The overall impact of the use of ICT to enhance learning outcomes is yet unclear, as the evidence does not adequately address the presumed link between motivation, attitude to learning and learning outcomes.
- There is some evidence for the value of working with teachers to encourage ICT development across the curriculum. However ICT is not enough to improve

outcomes on its own; engaged teachers must have a central role in the learning process.

2. Technologies and Global Context

Introduction

This search was undertaken to gain a view of technologies, specifically with regard to successful practices in the attainment of skills that may lead to positive destinations. Key areas of interest included: STEM (science technology engineering and mathematics) skills development; engineering and the BRICS (Brazil Russia India China and Singapore) countries/regions; characteristics of high-performing education systems; employer engagement; and future education trends and context for learning.

Key findings

Global context

Learning in context

The key future trends in education, with considerations, are as follows:

- Globalisation – are our schools equipped for more diverse communities?
- Living Well – are we adequately promoting health and wellbeing?
- Labour and skills dynamics – is education equipping learners with skills to meet demand?
- Modern families – as dynamics change, what can schools do to ensure positive outcomes for all learners?
- Internet and digital technologies – are we equipping students to make the best use of the vast amount of technology and information available?

Good practice in European OECD countries

- High-performing OECD education systems have used a range of programmes and initiatives with regard to improving STEM skills.
- Both reports cited identify socio-economic status (SES) as a key influence associated with mathematics and science performance, therefore differences across and within schools are generally greater than between education systems.
- Ensuring that students are aware of the breadth of STEM career choices is a key focus identified in these reports.
- Good practice in learning and teaching in mathematics and science include a skills-focus, a range of partnerships, linking to real-world contexts, and programmes addressing equity, gender disparity and skills shortages.

Good practice in Asian OECD countries

- Cultural differences play a central role in the success of these top education systems.

- Major curricular reforms are key to many of the top performing countries which generally have included a move away from rote learning to systems based on deeper understanding and problem solving.
- Teacher quality is emphasised, with continuous professional development often seen as a central part of the role.
- The issue of gender disparity in STEM is a recurring theme throughout the literature. The Republic of Korea's success in producing female STEM graduates and engineers seems to be through a series of national initiatives from school level upwards.

Innovation, engineering and the BRICS countries/regions

- The number and type of patents per country demonstrate that major emerging economies such as Russia and China are dominating in this area, however different economies tend to focus on different technologies.
- The findings indicate that while it is clear that the numbers of graduate engineers in the BRICS countries far exceeds that of the UK, UK graduates are better equipped with the necessary professional skills to compete in the labour market.

Technologies

STEM skills development

- There is some evidence to suggest that context-based approaches in science motivate pupils and promote positive attitudes, particularly with low-ability pupils.
- There is good evidence to suggest that such approaches do not adversely affect understanding.
- The literature also finds that inquiry-based instructional practices have a positive impact on understanding.
- Across science and mathematics, the studies emphasise the role of the teacher and that professional development may be necessary for some methods.
- One review found that teaching methods which involve students in co-operative learning have the most impact.

Business contexts and employer engagement

- The literature suggests that there are benefits to school-mediated employer engagement, including equipping students with key workplace skills.
- There are also key benefits for teachers who are involved in this process, allowing them to pass on knowledge of workplace skills.
- Barriers remain in the organisation of this, including employer interest and practical management of those involved.
- A meta-analysis found that feedback was crucial in mathematics instruction, particularly when it included data or recommendations for students.

Appendix 4

Centres and Schools visited as part of the technologies impact review

Aberdeen School for the Deaf, Aberdeen City Council
Alford Academy, Aberdeenshire Council
Alloa Academy, Clackmannanshire Council
Belmont Academy, South Ayrshire Council
Berwickshire High School, Scottish Borders Council
Braemar Primary School, Aberdeenshire
Carolside Nursery and Primary School, East Renfrewshire Council
Clyde Valley High School, North Lanarkshire
Clydebank High School, West Dunbartonshire
Craigowl Primary School and Nursery Class, Dundee City Council
Elgin Academy, The Moray Council
Forfar Academy, Angus Council
Glaitness Primary School, Orkney Islands Council
Glenwood High School, Fife Council
Grangemouth High School, Falkirk Council
Howford School, Glasgow City Council
John Paul II Primary School North Lanarkshire
Kelloholm Primary School and Nursery Class, Dumfries and Galloway Council
Kinlochleven High School, Highland Council
Kirkhill Nursery, West Lothian Council
Mossbank Primary School, Shetland Islands Council
Munlochy Primary School, Highland Council
Newbattle High School, Midlothian Council
Oranges and Lemons Nursery, Dundee City Council
Pentland School, North Lanarkshire
Perth Academy, Perth and Kinross Council
Playpen Nursery, Highland Council
St Joseph's College, Dumfries and Galloway Council
Stanmore House School, South Lanarkshire Council
Strathaven Academy, South Lanarkshire Council
Torphins Playgroup, Aberdeenshire Council
Wallace High School, Stirling Council
West Primary School, Renfrewshire Council
Whitehill Secondary School, Glasgow City Council
Williamwood High School, East Renfrewshire Council
Woodside Primary School, Aberdeen City

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