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A comparative study between the USA and Scotland with respect to selected issues affecting implementation of elementary school technology education

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Abstract
Primary technology or Elementary School Technology Education (ESTE) has been implemented with varying degrees of success in many parts of the world. To a large extent, the degree of success may be due to the type of influence or regulation. This manuscript identifies certain key issues or questions related to the development and implementation of ESTE, and contrasts two different systems, Scotland and the United States. These issues, questions and observations were raised as a result of two ESTE professionals (one from Scotland, one from Missouri) working closely together for one year.

Introduction
There are a number of issues, some of which form barriers, affecting the introduction, development, and implementation of ESTE. Many of these issues are affected by the amount of governmental influence and regulation. Different approaches have had varying degrees of success. This manuscript compares practices in Scotland primarily with the state of Missouri rather than the entire US because too much variation exists between states’ policies and practices to accurately paint just one picture of ESTE in the US. Further, there are a number of similarities between Scotland and Missouri. In this paper the comparisons are largely in a tabular format with Missouri, USA on the left and Scotland on the right. For example the basic statistics are given in Figure 1.

The underlying assumptions between countries’ governmental policies has a tremendous affect on the implementation of ESTE, as explained in subsequent sections of this paper. A comparison is given in Figure 2 (see overleaf).

These practices and cultural values affect the implementation of ESTE. In Scotland, for example, the government was willing to legislate curriculum guidelines and teachers were willing to accept them; whereas in the US, the government would not legislate guidelines and acceptance by teachers is largely on a case-by-case basis. These cultural values affect how each of the seven issues raised in this paper are addressed, which in turn effects the implementation and delivery of ESTE. The issues and topics to be discussed are:
- Technology education as a core subject in elementary schools
- Heritage and evolution of the ESTE curriculum
- Educational standards
- Evaluation of programs
- Resource allocation

<table>
<thead>
<tr>
<th>Missouri, USA</th>
<th>Scotland</th>
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<tbody>
<tr>
<td>5,402,058 total population</td>
<td>5,128,000 total population</td>
</tr>
<tr>
<td>68,898 square miles</td>
<td>78,750 square miles</td>
</tr>
<tr>
<td>1242 elementary buildings</td>
<td>2336 elementary buildings</td>
</tr>
<tr>
<td>525 School districts</td>
<td>19 geographical areas</td>
</tr>
<tr>
<td>620,878 students in K-8</td>
<td>438,000 in Pr 1-7</td>
</tr>
<tr>
<td>28,624 elementary teachers</td>
<td>22,638 elementary teachers</td>
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Figure 1 Relevent statistics
Missouri, USA

Governance in the US has one cardinal principle–local control. The federal government cannot make laws governing or regulating education. Each state (actually, each local community) has ultimate control and responsibility for education. The state determines teacher certification criteria. Teachers in the US value their autonomy and resist national and state initiatives.

Scotland

The national government in Scotland regulates local education authorities, schools, and teacher education institutions. The General Teaching Council for Scotland oversees teachers’ qualifications affecting quality control over the teaching profession. Teachers in Scotland are accustomed to national initiatives from the government, local initiatives from their local authorities and policy development at school level. For the most part, they welcome some structure.

Figure 2 Political control

- Teacher preparation
- Technological activities

1 Technology education as a core subject in elementary schools

Children frequently interact with and utilise a variety of technologies without much thought about the design, development, or consequences. The impacts and extent of technology in society are pervasive, and in some cases transparent. Citizens in the 21st century, more than ever before, will make decisions about the use and control of technology for the betterment of society. This will require an understanding about the workings and consequences of technology.

The workplace has become increasingly complex, dependent upon technologies that for many people are just ‘black boxes’. To remain competitive in a global economy, business and industry will require people that are technologically literate, that is, are able to work in teams, solve problems, capable of adapting to new technologies, interacting with a variety of technologies, and controlling technology, not being controlled by it.

Our observations indicate that governmental influence is more expedient in stimulating change in the curriculum. The major influences for change are shown in Figure 3.

Missouri, USA

Calls for elementary school technology education (ESTE) in the United States have come primarily from professional associations, including the American Association for the Advancement of Science (AAAS), the National Research Council (NRC), the International Technology Education Association (ITEA), the National Council for Social Studies (NCSS), the National Council of Teachers of Mathematics (NCTM), and others. This is not to be confused with calls for ‘computer literate’ students, coming from a host of agencies including those in the White House.

Scotland

Calls for primary technology (ESTE) in Scotland have come primarily from the government. The Scottish Consultative Council on the Curriculum, an independent government advisory body, has played a major role in the development of the Scottish Curriculum at all levels. There was a growing perception in Scotland, partly fuelled by the National Curriculum in England and Wales, that technology education should be an important part of young people’s education (Scottish CCC, 1996). This was further emphasised by the Government white paper, Realising Our Potential - A strategy for science, engineering and technology (1993) which called for reforms to the 5-18 school curriculum.

Figure 3 Promotion of technology teaching in primary schools
Whether initiated by government or professional associations, our position is: Just as with literacy and numeracy, technological literacy/capability requires focused, progressive study and application throughout the school years.

2 Heritage and evolution of the ESTE curriculum
ESTE has evolved along different paths in Scotland and the US. The evolution in Scotland was more a function of central planning and control, whereas in the US curriculum evolved independently, developed primarily by teacher educators. This comparison is shown in Figure 4.

Where there has been a centralised effort to standardise ESTE in Scottish schools, there has been no co-ordinated effort in the US.

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<td>Although practical studies in the United States can be traced to European origins in the 18th century, for purposes of this paper, ESTE has its roots in the works of Bonser and Mossman (1923). They developed the concept of Industrial Arts as a part of general education for all children in the elementary school. This beginning was largely focused on what may be viewed as social studies today - concern for rapid changes in the social structure of society due to industrialisation, and to help children learn about and cope with this change. There was increased attention given to elementary school industrial arts during the 1960s. Two competing philosophies emerged at this time that persisted until the 1990s. One view, typified by Gerbracht and Babcock (1959), stated that 'industrial arts doesn't exist as a subject in the elementary school, but rather as a means to assist the school in teaching better the subjects it was already teaching' (a methodological approach). A competing view (Scobey, 1966) asserted that technology was a subject to be included in the regular curriculum (content approach). In the 1990s ESTE evolved to be recognised as both content and methodology, and a subject appropriate for all children (Foster &amp; Kirkwood, 1997; TAA, 1996; Wright, 1997). ESTE has also shifted from a 'social studies' to a 'math-science-technology' focus. Further, there was a growing consensus that elementary school technology education had its own methodology and was not just 'watered down' secondary technology education (Foster &amp; Wright, 1996; Wright &amp; Foster, 1997).</td>
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<td>The roots for the organisation of technology education are based on the Primary Memorandum (1965) which defined environmental studies as the context for science and social subjects. Since that time, environmental studies has served as an integrated organiser for these parts of the curriculum while also providing links into language and the expressive arts, especially through the skill areas. Most primary schools in Scotland also provided for home economics in the forms of sewing and cooking and for other crafts such as weaving and woodwork. These formed precursors to some of the present technological activities. The Primary Science Development Project (PSDP, 1985), which was a Scottish Office funded project, developed as a result of research into the primary curriculum at stages four (eight years) and seven (11 years). The research found environmental studies lacking in the provision of science (HMSO, 1980). Following PSDP developments in a government funded national course, technology in the primary curriculum was held in July 1989. This course was attended by curriculum advisers, head teachers and teacher educators from all parts of Scotland. For many of these people it was their first introduction to the subject of primary technology. Primary technology was recognised as a subject in its own right and incorporated into the Environmental Studies Guidelines in 1993 (SOED, 1993).</td>
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Figure 4 Evolution of primary technology education
As a whole, the US has staunchly objected to national curricula, guidelines, or even exams. The principle of local control prohibits the development of a national curriculum. However, concern about student achievement has caused some professional associations to undertake ‘standards’ development efforts. Thus, we have 17 different national ‘standards’ projects with no means to cause them to be used. It should be noted that these are not government sanctioned or endorsed, and typically are funded by private moneys. The Technology for All Americans Project developed a Rationale and Structure for the Study of Technology (1996). Currently, the TAA project has completed two revisions of the proposed content standards for grades K-2, 3-5, 6-8, and 9-12. The standards will be field tested in the fall of 1998, and are scheduled for release in March 1999.

The technology education standards are not curriculum, nor are they binding on any state or agency. It is hoped that local curriculum developers would write curriculum based upon the standards. Ideally, each state would develop guidelines consistent with the standards.

Most states, including Missouri, have guidelines for secondary technology education but not for ESTE. State guidelines are not comprehensive curriculum, and they are not binding.

Missouri recently underwent a major revision of state-mandated student assessment, which is used in part to accredit schools. This assessment, to an extent, drives the curriculum. The Missouri Mastery Achievement Tests were replaced with the ShowMe Standards, a performance-based system with broad sweeping goals, many of which may prove difficult to assess. Technology education is not included in the standards. Indeed, the only reference to technology is computer applications. Ironically, technology education may prove to be one of the best methods to assess student performance and mastery of the ShowMe Standards.

Teachers in Scotland are accustomed to national initiatives from the government, local initiatives from their local authorities and policy development at school level. For the most part they welcome some structure in the form of a framework which allows them to customise to their local needs. The 5-14 programme, a government initiative begun in 1989, culminated in Guidelines for English language, mathematics, expressive arts, religious and moral education, and personal and social development. Advice was also given on assessment and reporting. The Guidelines, unlike the National Curriculum for England and Wales, are not statutory but have been implemented to some degree by all local authorities and schools in Scotland. Teacher education institutions have also modified their programs to model the 5-14 curriculum advice.

A technology curriculum was introduced as part of this programme within Environmental Studies 5-14 (SOED, 1993). Two knowledge and understanding outcomes were defined, understanding and using technology and understanding and using the design process to be taught in conjunction with the skills of planning, gathering evidence, applying skills and presenting solutions and interpreting and evaluating. Statements were also produced suggesting that pupils should develop informed attitudes in relation to the impact of technology on society and the environment. This means that technology education forms part of the curriculum in Scottish schools for all children from the ages of 5 to 14. However the Scottish CCC recognised that, ‘much remains to be done to improve the quality of pupils’ overall experience of technology education from nursery through to secondary schooling’. (SCCC, 1996 p:1). Their position statement identified four aspects of technological capability: technological perspective; technological confidence, technological sensitivity, and technological creativity which needed to be developed to produce technologically capable young people.

### Figure 5 The setting of standards
On this issue, our position is: a centralised co-ordinated effort is more effective in developing elementary technology curriculum, provided that it doesn’t stifle creativity and new approaches.

3 Educational standards
There is considerable debate regarding the value and appropriateness of content standards. The issue is one of local control and autonomy versus the need for national standards as shown in Figure 5.

On this issue, our position is: content standards are a valuable asset for both curriculum developers and teachers' planning. Standards should be established to equalise educational opportunity for all children. Again, the US, with its lack of national educational guidelines, has not progressed as far as Scotland in terms of curriculum and standards for ESTE.

4 Evaluation of programs
Good instruction requires good planning. It also requires evaluation to determine if the goals are being met. The issue here is not about evaluation, but rather WHO is responsible for evaluating and ensuring that there is appropriate progression of learning?

Figure 6 shows a comparison between the two approaches to planning and evaluation.

Schools need evaluation to develop quality ESTE programs to provide children with progressive learning in elementary technology education. There are no guidelines or standards in the US by which to evaluate elementary technology programs, whereas Scotland has established national guidelines.

On this issue, our position is: local schools should be empowered to conduct their own evaluations, based upon established standards and guidelines.

5 Resource allocation
Elementary technology education requires tools, materials, and kits not found in the typical elementary classroom. A comparison between the two approaches to funding is given in Figure 7 (see overleaf). The issue is whether additional resources should be specifically identified for ESTE, and how it should be funded?

Funding resources is always a dilemma. On this issue, our position is: funding IS typically available but it may take the re-prioritising of school goals to adequately fund ESTE.

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<td>Schools are evaluated through the Missouri School Improvement Plan (MSIP). This plan requires the school to set five-year goals. Within each school, plans are made for continual improvement by program area. This does not require program areas within the school to collaborate, nor does it require articulation among grade levels. This lack of articulation is most crucial between buildings, since students do not all attend the same secondary building. Planning between buildings, is not required.</td>
<td>Primary schools in Scotland work toward a long-term developmental plan; usually of three years duration. Such a plan is formulated and agreed upon by all the staff in the school and presented to the board of governors and local authority for approval. Schools may work individually or cooperatively to achieve the necessary goals and use a variety of different agencies and resources. Costs for these developments are met through direct funding to schools from local authorities.</td>
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Figure 6 Planning and evaluation
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<td>Schools receive some basic state support on a per capita basis, although it is usually not adequate to sustain the school. Most financial resources for education come primarily from local property taxes. Thus, there are wide, inequitable variations. This funding system creates stress for schools since their operating budgets are not guaranteed, but tied to the value of local real estate. States cause local schools to adopt policies by linking them to funding. This is one way that the state can set priorities for schools. Additional moneys are made available from the government for special projects. Thus, they are not binding unless the school district wants the additional money. Districts must establish priorities to allocate scarce resources. A good deal of a districts’ funds are spent for activities which only benefit a few students that elect to participate, for example extra-curricular sports or music. Programs that benefit all children should receive the highest priority.</td>
<td>Funding for resources is secured through national and local taxes. Local authorities are allocated national funding for their schools, which covers new buildings and some staff and curriculum development. Local authorities allocate resources to schools depending on a number of factors, the major factor being the size of the school. All schools receive per capita allowances, but these may vary between local authorities. Rural schools because of their small school roles often receive special funding to enable them to purchase resources which they otherwise could not secure. The national government also funds special projects including conferences, curriculum development and perceived areas of need. Local authorities were subsidised for developments within the 5-14 program subsequent to its publication. This type of funding is usually for a limited time period. Initial teacher education is funded by the national government which also governs the number of teachers being trained for the different education sectors and subjects.</td>
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</tbody>
</table>

6 Teacher preparation

Clearly, teachers need training and preparation to teach elementary technology. A comparison of approaches is given in Figure 8. The issues are how much and what kind of training, how it should be funded and whether this training should be voluntary or compulsory.

There is a need for confident, competent teachers of elementary technology. At the present time, pre-service programs are not addressing the needs of elementary technology. Although in-service programs are available, teachers are not electing to pursue them.

On this issue, our position is: additional training should be required at both the pre-service and in-service level without additional costs to practising teachers.

7 Technological activities

The issue is what constitutes a quality technological activity? For example, is simply following the directions in a construction kit,
Missouri, USA

Pre-service: Teacher preparation currently requires no experiences with design or technology. Teacher certification is a state responsibility granted through an approved teacher education program. No state requires technology education for elementary teachers. There are just a few university programs in the entire US that offer an ESTE course for elementary majors. Currently, a required ‘integration’ course for elementary majors is being developed at the University of Missouri to begin Fall semester 1998. Depending upon the faculty selected to develop and teach it, this course may closely resemble ESTE preparation.

In-service: Teachers are required to complete a number of course credits to renew their teaching certificate. There is no requirement for ESTE. Training or upgrading in technology usually means working with computers. The only training in ESTE in Missouri has been initiated and conducted by the University of Missouri ESTE team. That is, ESTE in-servicing is still so new that it is largely unknown, and therefore, little demand for it exists.

Specific in-service activities worth noting are the 1995-96 ESTE Initiative (rural) and the 1997-98 Urban Initiative. In 1996, a team from the University of Missouri conducted faculty development workshops and week-long classroom demonstration projects in five rural elementary schools, each in a different district, in central Missouri. In 1997, a team worked with teachers and students in urban Kansas City, Missouri, schools; and in 1998, with teachers in urban St. Louis.

Scotland

Pre-service: In Scotland a number of colleges had introduced technology education into their initial teacher education Bachelor of Education courses through electives. In Northern College, Aberdeen, design technology (an elective) was introduced in 1992 for final year students. At the same time, local authorities were also interested in developing technology education in their primary schools. Many teachers in Scotland, therefore, perceived a need for technology in the elementary school before it was introduced through official documentation.

In-service is needed because recent research in Scotland on teachers' confidence to teach technology (Harlen & Holroyd, 1996), demonstrates the lack of competence and confidence to teach this subject which for many of today’s primary school teachers did not form part of their own education or training. Scottish primary teachers’ perceptions of technology indicate that they believe it to be about products and designing and making. They also perceive it to be consistent with activity methods and enjoyable for children (Thomson & Householder, 1995).

In-service courses are provided by local authorities, teacher education institutions and other agencies. Qualifying continuing education modules such as ‘Technology in the primary curriculum’ (Northern College) and ‘Technology, people and the environment’ (Scottish DEC, 1996), provide through distance learning, a means for teachers to upgrade their qualifications while working in their own classroom environments.

Figure 8 Teacher training

without involving problem solving or creative thinking, a quality technology activity? The approaches of two systems is given in Figure 9 (see overleaf).

There are a variety of acceptable levels of technological activities. On this issue, our position is: ESTE activities should be constructional, manipulative in nature, and authentic. They should engage students in designing and making, in creatively solving challenges that extend or enhance human capability, while critically assessing the consequences of technological endeavours.

Conclusions

Technology education is implemented in many more elementary schools in Scotland than in Missouri. Although each country's evolution and approach to ESTE may have
Technology education activities are occurring in very few Missouri elementary schools, primarily those that have been trained through in-service by technology teacher educators. Technological activities in these few classrooms may take many forms. At times they may be prescriptive, almost a 'paint-by-the-numbers' approach. The other extreme is a totally open-ended design challenge, including designing, making and evaluating a product. Most, however, fall somewhere in between those two.

A great deal of technology education undoubtedly occurs on a daily basis in schools through science, art, or social studies classes. Out-of-school experiences may also contribute to technological literacy/capability through 4-H activities, scouting programs, playing at home with construction kits, tinkering in the garage, basement or kitchen, or through 'Inventors Clubs' at many elementary schools organised by teachers who are not familiar with technology education. These are just a few examples of the diverse ways children might learn about, and have experiences with, technology.

Technology activities in primary classrooms in Scotland usually involve the children in designing, making, and evaluating products. They may also be involved in research of technology of the present or the past in a variety of cultures. Children involved in technology education in Scotland are often in an active learning mode and often found working co-operatively. The context for technology is usually in environmental studies, but it can also be found as a separate strand of the curriculum. The designing part of the process was found to be ‘somewhat erratic’ at Primary 4 (Bramley, 1997) with the making part reflecting Johnsey’s findings that making behaviour formed the ‘spine’ of the process. However in the same study, Bramley found evidence that at Primary 6 the children ‘were engaged in detailed and extensive whole group planning prior to the making phase demonstrating that there is some progression from Primary 3 to Primary 6 if a structured programme is in place’.

Indeed, they may be appropriate for many other countries as well.

- just as with literacy and numeracy, technological literacy/capability requires focused, progressive study and application throughout the school years
- a centralised co-ordinated effort is more effective in developing elementary technology curriculum, provided that it

### Figure 9 Technological activities

### Figure 10 Political statement
doesn’t stifle creativity and new approaches

- content standards are a valuable asset for both curriculum developers and teachers’ planning
- local schools should be empowered to conduct their own evaluations, based upon established standards and guidelines
- funding is typically available but it may take the re-prioritising of school goals to adequately fund ESTE
- additional training should be required at both the pre-service and in-service level without additional costs to practising teachers
- ESTE activities should be constructional, manipulative in nature, and authentic. They should engage students in designing and making, in creatively solving challenges that extend or enhance human capability, while critically assessing the consequences of technological endeavours

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