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Metadata Record: https://dspace.lboro.ac.uk/2134/3162

Publisher: © DATA

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The Transfer of Design and Technology (D&T) to the United States: A Case Study
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Introduction

This paper should be viewed as a report in progress on the difficult attempt to draw upon successful educational practice in one country and transfer that practice to another. It was evident from the start that no direct transfer of program or practice without serious modification would be possible. However, the intent was to take advantage of the progress made in the United Kingdom (UK) in implementing design and technology (D&T) instruction in the elementary grades and use that practice as a basis for a new paradigm for instruction in elementary schools in the United States (US) (Todd, 1997, 1999). The expectation was that despite the problems of adaptation and modification, the proposed transfer would save years of work by building on the leadership in primary D&T provided by the UK (Benson, 1998).

The General Educational Context for this Effort

In the US and UK practical "skills" in technology education (TE) have always been important, but the nature of technology as a school subject and the balance of content and process has been viewed from very different perspectives. In the US, primary attention has been given to determining what is the "content" of technology, while in the UK the focus has been more on its "process". These different perspectives are important, particularly as they contribute to a balanced development of the subject considered "school technology" (Lewis, 1999).

At the risk of over simplification, the following observations are provided regarding the US context:

• TE has evolved largely from "industrial arts" (similar to the UK "industrial crafts").
• TE tends to focus on technical skills and activities with little attention to design.
• TE, in many states, is shaped significantly by vocational funding and thinking.
• For the general public, technology is synonymous with computers.
• Federal funding for TE has been based, to a large extent, on what it could do to improve math and science scores for students.
• Until recently the design and engineering profession have had little interest and involvement in TE.

1 By 1985-86, Ron Todd's familiarity with approaches to technology education outside the US was first-hand, based on nearly ten years of international summer courses. The potential of a transfer of elements of the UK model to the US gained momentum after Pat Hutchinson, a doctoral student at NYU, spent a year as a Fulbright scholar in the UK studying the role of design in CDT. Networks established during the early to mid-eighties laid the groundwork for the ongoing collaborations of the past 15 years.
• TE activities are seldom found in elementary schools and classrooms.
• Integrated science, math and technology (SMT) activities are uncommon in US schools.
• D&T, as concept or practice, was little known prior to the publishing of *ties Magazine*.
• There are no tests and assessment instruments for TE or D&T available in the US.

During the 1960s and 70s, a significant difference emerged in the approaches to technology as a school subject for the two countries. At that time the "official" US vision of technological education veered away from craft skills to an analysis of technology, with considerable attention given to the world of industry and manufacturing. At about the same time, design philosophy caught the imagination of influential British educators like Archer (1978) and Baynes (1969), laying the groundwork for a rather different approach to the practical curriculum.

**The Transfer of D&T to Elementary Classrooms in the U.S.**

Even as enrollments in outdated industrial arts classes plummeted, the National Science Foundation (NSF) began to express interest in a design-based version of technology education. It was NSF's hope to improve student performance on tests of science and math (the "essential knowledge" for the country's economic well-being). Within this context the authors submitted a proposal to the NSF, the major agency in the US that funds science and engineering R&D. In 1991, the NSF provided funding to The College of New Jersey (TCNJ) to implement D&T in selected schools in the US.

**Implementation of the Transfer Effort**

From the start, the problems in transfer came from both the lack of research data on the outcomes of D&T in terms of overall student performance and also that there was little research evidence about the effect of D&T on student performance in science and math. The key "criterion for success," of improved student performance in science and math on specific recognized tests, set by the NSF, was also seen as important by school administrators interested in participating in the project. Dissatisfied with the lack of realism of science and math the NSF saw technology as a means of improving the connection of schooling to the real world (Raizen, 1995, p. 26.). Initially, the administrators were willing to accept the proposed D&T practice on face value. However, the project team members were concerned about this restricted treatment of school technology and attended also to the larger need for technological literacy (IEEE, 1998). This broader rationale included the potential of D&T to (a) help deliver

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2 In Project UPDATE (Upgrading Practice through Design and Technology “Engineering” Education) the focus was to draw upon good D&T practice in the UK to develop curricular materials appropriate for use by classroom teachers in US elementary schools. Project UPDATE/TEI (Teacher Enhancement Initiative) provided support for preparing selected teachers, as trainers, to prepare other teachers to implement D&T approaches with their students. The CD&E (Children Designing and Engineering) Project now provides support for collaborative teams, from business, industry and education, to develop additional elementary-level D&T curricular material that link to real-world settings.
technological literacy and capability, (b) improve other school subjects and (c) generate more interest and involvement of students in SMT, especially among girls.

**Materials development**

The initial effort, Project UPDATE, (Upgrading Practice through Design and Technology "Engineering" Education) focused on the developing curricular materials that would facilitate adoption of D&T practice by US classroom teachers. The project developed nine Contextual Learning Units (CLUs) and supportive materials that include Science and Technology Cards, Practical Math Cards, Concepts in Context booklets, and Project Portfolios. These materials were supported by an array of tools, mechanisms, and devices that helped teachers include concepts and activities related to structures, mechanisms, pneumatics, electricity and control.

Experience in working with pilot teachers using the CLUs indicated a significant change in their understanding of D&T, similar to the findings by Benson and Johnsey in the UK (1998). During presentations and workshops, other teachers indicated interest in the skills, concepts and approaches of D&T. It was clear, however, that US teachers would require training in the use of D&T. Similarly, teachers would need to develop skills, competence, and confidence in using specific materials and resources supporting D&T learning. These insights led to the submission and subsequent funding of a second, on-going grant for teacher training.

**Teacher Training (Enhancement)**

Project UPDATE/TEI (Teacher Enhancement Initiative) developed a cadre of "trainers"—working in nine school-based Demonstration Centers in six states—to prepare other teachers to integrate SMT through a D&T approach. The trainers participated in three courses, each providing 70 hours of training. From these experiences the trainers are teaching three parallel courses, each providing 35 contact hours of training. The trainers are currently preparing a cohort of 400 teachers who come from approximately 100 Outreach Schools.

Teachers are prepared through direct, hands-on experiences to do D&T—modeling how they will have their students do D&T. A sequence of three graduate courses, totaling 105 hours contact time, provides the required UPDATE training. The 105 hours met the requirement of the funding agency and the concern of the principal investigators (PIs) for adequate training time. The past experience of the PIs and advice from UK colleagues indicated that teachers who have not done D&T are poorly equipped to engage others in D&T activities. Lacking this experience, teachers have difficulty identifying the kinds of problems students will face, length of time the process requires, nature of thinking in which students must engage, and means of assessing the progress and value of the work being done.

The participating teachers are helped to learn SMT concepts and skills through their application in D&T projects. We chose this approach realizing that elementary teachers in the US are (a) poorly prepared to teach science and math, (b) have not been
helped to use real-world experience to understand these subjects, and (c) are usually intimidated by the prospect of teaching them.

With the experience gained from Project UPDATE/TEI, the PIs submitted a proposal for a Children Designing and Engineering (CD&E) Project. The CD&E Project evolved from interest by the New Jersey (NJ) Chamber of Commerce in the contextual nature of D&T units developed in Project UPDATE. CD&E will develop 12 integrated MST units based on six NJ industries (one at the K-2 and one at the 3-5 level for each company). Six- to eight-week units feature a large design project encompassing progressive sub-problems requiring application of SMT, as per national and NJ Standards.

Case Reports of Selected UPDATE Schools

Seven of the nine school-based Project UPDATE demonstration sites are operational. Of these, five have tested students who have completed some training in D&T. Three of those schools, one each from rural, urban and suburban settings, are seen as representative of the problems encountered and the progress being made in the transfer effort. All three schools have teachers who were prepared as "trainers." Two schools have a significant number of teachers using D&T in their classrooms. Two schools (Arbutus and Cook-Wissahickon) use a special D&T lab where a service teacher (also a trainer) helps classroom teachers implement D&T activities. All three schools conduct performance testing of third-grade students (age 10), which will be the focus of the following case reports. In all three case reports, data on the performance of third-grade students are shown. The testing is done each year with new classes of third graders. Comparison of data and result from one year to another can provide illustrative information only. It is also important to note that each state has developed its own standards and tests. Some states will also use other established standardized tests. Finally, there are differences in the philosophy and practice on how evaluation data are gathered and used, state by state.

Ottobine Elementary School, located in a very rural area of Virginia, spans grades Pre-K-5 (ages 4-10). It has 294 students, with 37.9% on an assisted lunch program (an index used in the US to represent level of income and poverty). Ottobine has a faculty of 25 with 17 classroom teachers and 8 resource/service teachers. Sixteen of the teachers have taken two of the three UPDATE courses, the other two, new to the school, have competed the first course. One teacher has completed the training as a "trainer". D&T has been used as a major instructional approach for two years.

The assessment of student learning is accomplished primarily through a special multiple choice test shaped by prescribed Standards of Learning (SOLs). The SOL test, developed by the State of Virginia, is used to assess how well the children have done in the core subjects of science, math, reading, and social studies. (Because social studies performance was not tested in the other two schools, that data is not considered here.)

Arbutus Elementary School, located in the suburbs of Baltimore, Maryland, also spans grades Pre-K-5 (ages 4-10). It has 473 students (with 27.5% on an assisted lunch
program) and a faculty of 33 with 22 classroom teachers and 11 resource/service teachers. Twenty of the classroom teachers have taken the first UPDATE course. Four teachers have completed the three "trainer" courses. Over the past four years, D&T type activities were taught in a special resource room. Within the past two years, D&T has become the major instructional approach used to teach science and math at Arbutus.

Student assessment is accomplished through a special multiple choice test developed by the State of Maryland to assess how well the children have done in achieving prescribed learning standards. Data are available from Arbutus for math science and reading as well as outcomes reported in composite scores for Arbutus, Baltimore County and Maryland State.

Cook-Wissahickon Elementary School, located in Philadelphia, Pennsylvania, also spans grades Pre-K-5 (ages 4-10). It has 404 students (with 79.3 % on an assisted lunch program) and a faculty of 27 (17 classroom teachers and 10 resource/service teachers). Seven of the teachers have taken the first of the UPDATE courses. Two of the teachers have completed the three "trainer" courses and one has completed two of the three "trainer" courses. Cook-Wissahickon has been involved the longest of any of the participating schools with D&T activities first introduced to the participating teachers more than seven years ago. Over the past three years, D&T activities have been taught, with classroom teachers, by a specialist teacher in a D&T Resource Lab. This specialist teacher was in the original UPDATE training and has been involved for approximately nine years.

Student assessment is accomplished primarily through the Stanford Achievement Test (SAT) #9, which is a commercially developed multiple choice test. A basic level of proficiency has been set that 95% of students in a school are expected to reach or exceed a basic level of proficiency.

Impacts and Results

As a report in progress, it is too early to make more than preliminary statements concerning the results of the projects and the transfer effort. It is possible, however, to make some general observations as to the reactions and perceptions of teachers and students and to share some results of students scores on selected performance tests.

- The general response of teachers to the CLUs and the supportive materials and resources has been very positive. They report that the materials help them link the learning activities to the school curriculum and provide meaningful contexts within which children can pursue D&T projects.
- Teachers report that they have become more confident in their own knowledge and skills related to science and math and are more confident in teaching these subjects.
- Teachers report that they have become more confident in their own knowledge and skills related to D&T. Similarly, the are more confident in their knowledge of structures, mechanisms, pneumatics/hydraulics, electricity and control, but feel less confident about teaching these subjects.
- Teachers report that students show more interest and will spend more time engaged in their math and science studies when linked to D&T activities.
• In all three schools, students who have been involved in D&T activities have done better on the prescribed tests than students who have not had D&T experience.

• The two schools that have a D&T Lab had significantly more students who reached or exceeded the established performance levels in reading, math and science.

• In addition to the science and math learning as measured by test scores, students have appeared to have acquired holistic, context-based understanding that are not available through traditional math and science learning experiences.
Virginia Context: The data provided in the charts that follow indicate the percentage of third graders in the State of Virginia, Rockingham County and Ottobine Elementary School that reached or exceeded the required level of the Standards of Learning test for the school years of 1997-98 and 1998-99.

Chart 1
Percentage of Third Graders State-Wide Reaching or Exceeding Required Level of Virginia SOL Test
The data indicate that student performance has improved in all subjects in the County and the State.
As shown in the chart below, Ottobine Elementary School showed a modest increase in the percentage (1%) of students passing the state-required “standards” test in English/reading and a decrease in the percentage (5.9%) passing the math test.

Chart 3
*Percentage of Ottobine Third Graders Reaching or Exceeding Required Level of Virginia SOL Test*

It appears that Ottobine third graders are not performing as well as third graders in the County and State in English/reading and math. However, the Ottobine third graders appear to be doing as well as their counterparts in science; the percentage of students in Ottobine passing the test for science increased by five percent.
Maryland Context: The charts below provide data on the student performance in reading, math and science for the State of Maryland and Baltimore County. There was little difference noted in the three subjects from 1997-98 to 1998-99.

Chart 4
Percentage of Third Graders Reaching or Exceeding Required Level of Maryland Standards Test
Chart 5
Percentage of Baltimore County Third Graders Reaching or Exceeding Required Level of Maryland Standards Test

The percentage of students in the County reaching or surpassing the basic level of competency decreased in reading by .7%, in math by 2.0% and increased in science by .9%. These are very small changes indeed and fit well into the baseline curves for nearly the past 10 years. Across the State the basic level of competency decreased modestly in all three subject, while still fitting into a similar steady baseline pattern.
On the other hand, as portrayed in the chart below, Arbutus Elementary showed an increase from 1997-98 to 1998-99 in all three subjects.

Chart 6

Percentage of Arbutus Third Graders Reaching or Exceeding Required Level of Maryland Standards Test

The percentage of students reaching or surpassing the basic level of competency, identified by the state, increased by 9.3% in reading, by 17.1% in math and by 19.9% in science.
**Philadelphia Context:**

The results for third-graders in the City of Philadelphia and the Roxborough Cluster are shown below. Schools across the City shows a smaller percentage of children reaching or surpassing the desired level of performance when compared to the schools in the Roxborough Cluster. The goal, set by the Philadelphia Board of Education, is to have 95% of the students reach a set proficiency level (described as “basic or above”) in each subject.

**Chart 7**

*Percentage of Philadelphia Third Graders Reaching or Exceeding Required Level of SAT #9s Test*
The percentage of students in the Cluster reaching or surpassing the basic level of competency in reading increased by 19%, in math by 21% and increased in science by 30%. On the other hand, across the City, the basic level of competency increased modestly in reading (1%) and math (4%) but decreased by 11% in science.

As indicated in the chart below, Cook-Wissahickon Elementary School in the Roxborough Cluster, showed a marked increase in the percentage of students achieving or exceeding the established basic proficiency level in all three subjects.
Chart 9  
*Percentage of Cook-Wissahickon Third Graders Reaching or Exceeding Required Level of SAT #9 Test*

Comparing the percentage of students scoring at the basic level and above for 1997-98 with 1998-99 indicate an increase of 35% m 42% m and 59% for reading, math, and science respectively.

A comparison of the data in the three charts indicates that the percentage of students who reached or surpassed the established Index of the SAT#9 test has increased more for Cook-Wissahickon than for its parent Cluster. During this same period of time when a greater percentage of Cook-Wissahickon students reached the established level, there was little change in the percentage of third graders reaching the standards city wide. It is interesting to note, that although the Roxborough and city-wide scores in all areas were higher than those in Cook-Wissahickon in 1997-98, in the following year Cook-Wissahickon exceeded both Roxborough Cluster and Philadelphia in all subject areas.

**Reflections and Observations**

Although the effort to transfer good D&T practice in the UK to the US is in its infancy and much is yet to be learned, some general reflections and observations are appropriate. For example, teachers report that they as well as their students are excited by the inclusion of D&T activities into their classrooms. They also report that parents are overwhelmingly supportive of having such activities provided for their children.

Further, teachers report that student school attendance as well as their engagement in learning improved, particularly in science and math. This type of observation is very important, especially when students tend not to find math and
science as very exciting. The research is clear that if students are to learn, they must first become seriously engaged in what they are learning, something that D&T appears to do rather well.

Interest and support from most of the teachers, who received training in D&T, appears to be growing. However, administrative support for D&T practice in the US varies considerably from school to school. The number of school principals and superintendents who understand and support the implementation of D&T in their classroom is very small. Consequently, the reported outcomes are fragile and can change with a new administration and a different philosophy of schooling and practice.

The results of the student testing and levels of performance also bear comment. In the first instance, the differences between the mode of testing and the mode of learning must be kept in mind. While the testing draws on semantic memory, the D&T process supports learning that is holistic and contextual. It is possible, therefore, that more learning occurs than is reflected in the test results.

In two of the three cases reported, there has been an increase in student scores, while the scores and performance of students overall present a mixed picture. The most dramatic changes emerged from Cook-Wissahickon Elementary School. Although D&T has become one of the major instructional approaches for introducing and revisiting science and math content and skills, it remains unclear as to what caused the marked improvement of student performance. Further attention needs to be given to such influences as the:

- closer collaboration between the classroom teachers and the specialist D&T teacher
- apparent increase in the follow-through on D&T activities by the classroom teachers, and
- continued shift of writing and portfolio work to the classroom from the Lab to ensure that time in the D&T Lab is available for designing and making activities.

In conclusion, the reported results emerged during a time of intensive attention to improve the test performance for all students, with the reality in all three states that poor student performance could lead to the reassignment of teachers and replacement of principals. The time span of this study could rightly be described as high energy and high anxiety, and especially high expectations for the improvement of student performance. Although, the observations made here must be seen as tentative, the results suggests that D&T might play an important supportive role in improving instruction and performance in US elementary schools, and that the transfer effort is well worth pursuing further, with additional vigor and hopefully with more support.
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