Articles

Classifying Approaches to and Philosophies of Elementary-School Technology Education

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In 1974, Hoots classified historical philosophies of elementary-school industrial arts (ESIA) into four categories: *subject matter*, in which children would study technology and its social impacts (e.g., Gilbert, 1966); *arts and crafts*, consisting of what Hoots (1974) called "concrete manipulative activities" (p. 225); *method of teaching*, in which industrial arts delivered, reinforced, and enriched the traditional elementary curriculum (e.g., Henak, 1973), and *tools, materials, and processes*, focusing, as the name implies, on technological materials and processes (e.g., Miller & Boyd, 1970).

Although practioners probably employed a combination of some or all of these, the primary debate among theoreticians at the time was whether elementary-school industrial arts should be promoted as a method of teaching or a subject matter. The liveliness of this debate notwithstanding, by the time Hoots' paper was published, the ESIA movement was in a decline it was not to recover from for nearly twenty years.

Context

The past few years have seen a steady increase in interest in elementary-school technology education (ESTE). This is in part evidenced by an increase in publications and conference presentations on the topic (Pagliari & Foster, 1995). Furthermore, the quality of these publications and presentations may signal a move toward a more sophisticated view of ESTE than that of the 1980s and early 1990s. Still, there has yet to be much scholarly discussion on the variety of approaches and philosophies technology educators may advocate as the profession once again seems poised to make elementary education a priority.

The last period in which this much attention has been paid by the field to its elementary-school program was arguably the years 1962-1974. That period saw the development of the Technology for Children (T4C) program ("Industrial Arts For," 1966; Dreves, 1975) and the Technology Exploratorium (Heasley, 1974; n.d.); books by Gilbert (1966), Kirkwood (1968), Scobey (1968), and Gerbacht and Babcock (1969); and a yearbook on ESIA (Thrower & Weber, 1974) published by the American Council on Industrial Arts Teacher Education.

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Also during this time period, the American Council for Elementary-School Industrial Arts was formed (Miller, 1979), and a National Conference for Elementary School Industrial Arts was held in Greenville, NC. Participants of that conference developed this "Definition of Elementary School Industrial Arts:"

> Industrial arts at the elementary school level is an essential part of the education of every child. It deals with ways in which man thinks about and applies scientific theory and principles to change his physical environment to meet his aesthetic and utilitarian needs. It provides opportunities for developing concepts through concrete experiences which include manipulation of materials, tools and processes, and other methods of discovery. It includes knowledge about technology and its processes, personal development of psychomotor skills and attitudes and understandings of how technology influences society. (Hoots, 1971, p. 3)

As is clear from this lengthy definition, there was a fair amount of debate as to the purposes of industrial arts for elementary-school children. In fact, ESIA is not really defined here—this "definition" could be more aptly considered an "enumeration of contributions" industrial arts was thought to make to the education of children. The gravity of the content–method debate was evident in this position statement, which, for example, noted that industrial arts should (a) "deal with" technological change, although how this was to be accomplished was not immediately specified; (b) provide "opportunities for developing concepts through concrete experiences," although whether these were concepts related to the school curriculum, to industry and technology, or to both, was not explained; and (c) include "knowledge about technology" without specifying a method. In discussing the elementary level, LaPorte (1993) noted that to some extent, "the argument of whether industrial arts should be taught as content or method…continues today" (p. 9).

Purpose of the Study

The profession should be aware of the variety of philosophies and approaches to ESTE accepted by practitioners and theorists. This could allow—and might perhaps instigate—meaningful debate, enabling professionals with diverse conceptions of the field to work together toward common goals. The alternative may be for ESTE to experience the impasse faced by advocates of ESIA two decades ago.

In this study, *philosophy of elementary-school technology education* was regarded as an individual's belief as to the ideal role of technology education in the elementary school. The term *approach to elementary-school technology education* referred to an individual's opinion as to the most appropriate manner of implementing ESTE. The distinction is subtle but necessary; an educator's philosophy should influence his or her approach. In this sense, *approach* may in some cases be the practical manifestation of a philosophy.

The purpose of this study was to identify and classify prevailing philosophies of and approaches to elementary-school technology education. Specifically, the study sought to address two research questions:

1. What classification of philosophies of ESTE is ascertainable from the recent literature?
2. What classification of approaches to ESTE can be identified from existing data on the opinions of leaders in the field?

Methodology

Classification of Philosophies of ESTE

To perform the classification of philosophies of ESTE required the review and analysis of recent literature. Three literature selection criteria were established. Literature considered pertinent was (1) published since 1985, when the American Industrial Arts Association changed its name to the International Technology Education Association (ITEA); (2) widely disseminated; and (3) that in which authors stated or implied a philosophical position on ESTE which specified (1) a rationale for ESTE or (2) a position on the nature of the ideal ends of ESTE, or both (see Kneller, 1964, p. 30-31).

Items of literature were initially classified with others that advocated or reflected similar rationales for ESTE. Next, items were classified with others that advocated or supported similar ideal outcomes for ESTE. These categorization schemes yielded similar results—in other words, items of literature supporting similar rationales for ESTE were very likely to support similar outcomes for ESTE.

In the final classification, characteristics were identified which might further differentiate between the categories. These were characteristics found in many, but not all, items under analysis. They were (1) nature of contribution of ESTE to the elementary school; the (2) role and (3) identity of subject matter; and (4) the nature of teaching methods advocated. Finally, examples were selected from the literature which seemed to exemplify the philosophies.

Classification of Approaches to ESTE

The classification of approaches to ESTE was accomplished by an ex post facto cluster analysis of data collected to identify the opinions of leaders in the technology education field regarding approaches to technology education. In a prior study (Foster & Wright, 1996[1]), 131 leaders were asked to identify appropriate approaches to technology education at the elementary, middle-school, and high-school levels. Thus the data used in the present study was collected for the purposes of investigating approaches to technology education at all grade levels—not just ESTE. Nonetheless, it was clear that the elementary data could be extracted and that this existing information would be useful in addressing Research Question 2.

[1]Please refer to this article for a further discussion of the participants and procedure of the original study. Due to the very small number of leaders in ESTE, and since ESTE is being advocated as an important part of technology education as a whole, leaders in all phases of technology education (K–12 and postsecondary) were selected for this study.

Participants in the original study represented leaders among teachers, supervisors, and teacher educators. Of the 131 respondents, 123 provided opinions relative to ESTE. The data from these subjects was analyzed as part of the study at hand.

Participants were presented with a list of twelve approaches to technology education (see Table 1) and asked to select and rank the three they regarded as most appropriate at the elementary level. Two respondents employed a "fill-in" option also presented on the instrument.

Table 1
Items on survey instrument

A. applied/practical science	E. design/problem solving	I. modular approach
B. career emphasis	F. engineering systems	J. socio-cultural approach
C. constructive methodology	G. extra- or non-curricular activities	K. student-centered approach
D. computer emphasis	H. math/science/technol.	L. tech prep

Data analysis. Each participant's first choice of approach to ESTE was assigned a score of "3;" second choices were scored "2;" third choices "1." All items not selected were scored "0;" thus each of the thirteen items (twelve pre-identified approaches and one write-in) was assigned a score by each participant. Because this data was not continuous, the appropriate quantitative classification procedure was cluster analysis, "a multivariate statistical procedure that starts with a data set containing information about a sample of entities and attempts to reorganize these entities into relatively homogeneous groups" (Aldenderfer & Blashfield, 1984, p. 7).

The analysis was performed with SPSS version 6.1.1 for the PowerPC. Given the exploratory nature of this cluster analysis, several variations of each available clustering method (Ward's, between- and within-groups average linkage, furthest neighbor, nearest neighbor, centroid, and median) were run.

The final solution set was obtained via Ward's method. This set, which consisted of solutions ranging from two to five clusters, was the most interpretable. Ward's method produces clusters which are easily distinguished from other clusters and which tend to be tightly packed (Aldenderfer & Blashfield, 1984). Squared Euclidean distance, which is sensitive to both shape and magnitude, was chosen as a measure. When the data was subjected to the same cluster analysis with Euclidean distance substituted for squared Euclidean distance, the same solution set was obtained. Standardized scores (z-scores) were used because the wide variation in item scores was causing high-scoring items not to cluster when raw scores were used.

Results

Research Question 1: What classification of philosophies of ESTE is ascertainable from the recent literature?

Three philosophies of ESTE were evident from the literature. They were labeled *content*, *process*, and *method*.

Technology education as content. Proponents of the *content* philosophy see ESTE primarily as providing students with knowledge about technology. To these writers, technology (or alternately, technology education) is a discipline. Not all examples of literature supporting the view of ESTE as content identified the same content structure. One frequently cited structure was DeVore's (1980) three-dimensional matrix representing technological endeavors (communication, transportation and production), technological resources (tools, machines, etc.) and cultural contexts (prehistoric, craft era, mechanization, etc.).

The DeVorian view is clear in *Teaching Technology to Children* (Minton and Minton, 1987), a book intended for pre-service elementary schoolteachers. ESTE is viewed as having its own content; indeed, technology is defined as "technical *knowledge*" (p. 4; italics added), divided into DeVore's (1980) content areas of production, communication, and transportation. Peterson (1986) also applied the DeVorian content formula to the elementary program.

Kieft (1988) summarized the view that although ESTE was to be integrated with other subjects, it involved certain content of its own—content organized per the popular Jackson's Mill curriculum (Snyder & Hales, n.d.). He described ESTE as taking the form "of units of study with activities to introduce, reinforce, or clarify some of the technology concepts…The content usually focuses on an aspect of transportation, communication, manufacturing, construction, or energy" (p. 29).

Thode's (e.g., 1989, 1996) works also represent the *content* philosophy, although they do not rely upon traditional content structures. "The curriculum must cover the fashionable current technologies as well as basic technologies and the emerging technologies" (Daiber, Litherland, & Thode, 1991, p. 193). To Thode, "technology education is a defined discipline" (1996, p. 7).

Technology education as process. A second philosophy identified in this study regards ESTE as a process or skill which should be taught to children, and which has attendant content related to replicating the process. But the exact identity of the process seems to be in question. Two related but distinct variations of the *process* philosophy are evident in the literature.

In one variation the process being taught is "design." In this conception students design solutions to problems. ESTE is considered "children's engineering" (Dunn & Larson, 1990, p. 37). As a form of engineering, it eventually becomes concerned with the physical sciences and their laws. Todd and Hutchinson (1991) expressed the ideas involved in the conception of ESTE as "design and technology." To them, design and technology was not a separate subject, or even an integrated one—but a "new paradigm" for education itself.

A second variation of the *process* philosophy regards problem solving as the process of technology education. Here, problem solving is a broad skill which should be taught to all children. ESTE is viewed as supporting the larger elementary program—not the larger technology program (Forman & Etchison, 1991; Sittig, 1992).

Advocates of the problem solving variation regard the process of ESTE as more important than the content of the problem being solved; advocates of the design variation view the content of the whole school and of the design processes as primary. This distinction is illustrated in Figure 1 below.

Technology education as method. In the final philosophy, *method*, ESTE "begins with three things in mind. The first and certainly the most important is the child, the second is the elementary school curriculum, and the third is an appropriate technology activity" (Kirkwood, 1992, p. 30). Often, as LaPorte (1993) suggested, the content has an industrial or technological nature. Nevertheless, the content is drawn from the existing elementary curriculum—math, social studies, language, and science—not a technology education curriculum.

As Braukmann (1993) wrote, "enough goals *already* exist in the areas of reading, communication, math, science, and the social studies to fill a curriculum." (p. 23) Even though it might be important to treat the subject of technology separately, he wrote, "little time is left for it" (p. 23). ESTE, in Braukmann's view, does not exist for its own sake; rather, it should support "existing goals in science, math, and communication skills" (p. 23). Supporters of this philosophy are typically as unapologetic about slighting technology content as champions of technology-as-subject-matter are about having to lecture occasionally to deliver that content.

Elements of the philosophies

Figure 1 is a tabular representation of the final classification of philosophies of ESTE evident from the literature. Six characteristics of each philosophy are specified to facilitate comparisons among the philosophies. In addition, an example from the literature is identified for each philosophy. Brief descriptions of the characteristics follow.

Nature of contribution to elementary-school content. Unlike the other identified philosophies, the *method* philosophy does not regard its contribution to the content of the elementary curriculum as necessarily unique. In this view, ESTE is a method for delivering the traditional curriculum. It does not offer unique knowledge. The remaining philosophies regard ESTE as an ideally integrated, yet essentially distingusihable, subject in the curriculum.

Rationale. As a result, the rationales advanced by advocates of the *content* and *process* philosophies point out ESTE's unique aspects. Both rationales imply that the elementary curriculum would be essentially incomplete without technology education.

Nature of ideal outcome. Both variations of the *process* philosophy view specific skills as the ideal outcome of an elementary program of elementary education; in the *content* philosophy, knowledge is the primary outcome. In the *method* philosophy, ESTE is viewed as only one means of helping students acquire the skills and content in question.

Role and identity of subject matter. The literature indicates that design technology has associated and necessary knowledge relating to the process of design, as well as to scientific principles. There seems to be little indication that problem solving, as a conception of ESTE, has unique content directly related to problem solving (although problem solving strategies abound and are occasionally taught to elementary-school students).

Teaching methods. While all of the identified philosophies appear to support hands-on learning, it should be noted that in the *method* philosophy, ESTE *is* a method, and as a term is essentially synonymous with "constructive methodology"—what Bonser and Mossman (1923) referred to as making "changes in the forms of materials to increase their values" (p. 5).

Philosophy of ESTE	**Nature of Contribution to elementary school content**	**Rationale**	**Nature of ideal outcome**	**Role of subject matter**	**Identity of primary subject matter**	**Nature of teaching method(s)**	**Example**
Content	unique	students need to know about technology to understand their world	new knowledge is gained	primary	technology	various; usually including construction, lecture, etc.	Peterson (1986)
Process design	unique	students need transferrable skills to thrive in a technological world	new skills are gained	primary	design processes; whole school	primarily manipulative and/or constructive	Todd & Hutchinson (1991)
problem solving				secondary	(varies)		Sittig (1992)
Method	enrichment	most students learn better by doing	traditional knowledge and skills are reinforced	primary	subjects in the elementary curriculum	constructive	Kirkwood (1992)

Figure 1. Selected characteristics of various philosophies of elementary-school technology education.

Research Question 2: What classification of approaches to ESTE can be identified from the opinions of leaders in the field?

As aforementioned, the solution set consisted of four possible solutions generated via cluster analysis. Since Research Question 1 had already been addressed when these solutions were examined, it was theorized that three basic philosophies of ESTE were evident in the literature. Thus, a three-cluster solution of approaches to ESTE was sought. However, the four-cluster solution (Table 2) was found to be most interpretable.

Table 2
Four-cluster solution classifying approaches to ESTE

	Cluster 1: Secondary		Cluster 2: Progressive
A.	applied/practical science	C.	constructive methodology
B.	career emphasis	J.	socio-cultural approach
G.	extra- or non-curricular activities	K.	student-centered approach
L.	tech prep	M.	[write-in item]

	Cluster 3: Modern		Cluster 4: Design/Science
D.	computer emphasis	E.	design/problem solving
I.	modular approach	F.	engineering systems
		H.	math/science/technology

The clusters were output in an arbitrary order. The first cluster, *secondary*, consisted of the four items on the instrument which most clearly illustrated the view regarding elementary-school technology education as appropriately implemented employing traditionally secondary-school means, such as the applied-science view (exemplified on the instrument by the high-school Principles of Technology curriculum), extra- or non-curricular activities, tech-prep, and an emphasis on careers.

The second cluster, *progressive*, seemed to represent the ideals of the founders of industrial arts—the progressives Bonser and Mossman (e.g., 1923)—and later exemplified by Maley (e.g., 1973, 1979) and others. Items in this cluster included constructive methodology, the socio-cultural approach, and the student-centered approach.

The third cluster was labeled *modern*. In contrast to the more traditional *progressive* approach, it was comprised of two items—modular technology education and computer emphasis—which have only recently been advocated in the literature for ESTE. Both items refer to systems of organizing technology education (e.g., Neden, 1990; Hornsby, 1993).

The final cluster, *design/science*, appears representative of the British design and technology movement (e.g., Dunn & Larson, 1990; Williams & Jinks, 1985) and its variants in the U.S. The items comprising this cluster were design/problem solving, engineering-systems approach, and math/science/technology integration.

Discussion

Approaches and Philosophies compared. Although one-to-one correspondence was not identified, there were some strong relationships between certain approaches to and philosophies of ESTE. For example, the *design/science* approach strongly reflected the *process* philosophy while having little in common with either of the other philosophies. This approach subsumed math/science/technology integration, design/problem solving, and engineering systems—which as a whole reflect the philosophy, described above, of ESTE as a process.

The *progressive* approach had a perceptible connection to the *method* philosophy; witness Kirkwood's (1992) aforementioned statement that the hierarchy of concern in ESTE was (1) the child, (2) the curriculum, and (3) the technology activity. Two of the constituent parts of the *progressive* approach were student-centeredness and constructive methodology. The third aspect of the approach, a socio-cultural focus, does not appear to be incompatible with the *method* philosophy, but is not strongly brought out in the literature supporting this philosophy.

Less firm is the relationship between the *modern* approach and the *content* philosophy. The *modern* approach consisted purely of delivery systems—modular and computerized—and from the analysis, no content was implied. Nonetheless, the modular approach in this context itself implies technical content, and further implies that this content is important enough to justify the purchase of modules (see Petrina, 1993). Given Petrina's (e.g., 1993, 1994a) definition of modular technology education, several commercial programs for modular ESTE are available, such as Time-Travelers, a "technology education system designed especially for the elementary level" (Applied Technologies, 1996, p. 1), and the Techno-Train (Bedford Science Supply, n.d.).

The *secondary* approach to ESTE may have some relation to both the *content* and the *method* philosophies, as its constituents include both delivery systems and content areas. While this approach may well reflect a specific philosophy of technology education, it might be suggested that the *secondary* approach shares no special relationship with any philosophy of ESTE found in this study. This approach is supported by very little of the literature reviewed in addressing Research Question 1.

This brings up an important point. Those who wrote the literature exemplifying philosophies, and those whose responses were analyzed here to identify approaches, were not samples of the same population. This is to be expected—theoreticians make philosophies; practitioners take approaches. So those advocating a *secondary* approach to ESTE may simply be advocates of secondary technology education.

Relationship between the findings of this study and Hoots' classification system. Hoots' (1974) aforementioned historical philosophies were discerned from the literature of the preceding semicentury (approximately 1923-1973).

This system seems to be an expansion of the more traditional classification of content and method (see Miller, 1979). "The Industrial Arts Issue" (1958) of the

California Journal of Elementary Education referred to two groups of educators with different emphases for ESIA. One group emphasized studying the technical aspects of industry, while another emphasized a more liberal study of technology. Both are content-driven views. The former represents Hoots' "tools, materials, and processes" philosophical category; the latter his "subject matter" category. Together these may be asserted to comprise a single "content" philosophy.

Gerbracht and Babcock (1959), whose arguments that "industrial arts is not another 'subject'" and that "industrial arts justifies its existence on the basis of the help it gives the school" (p. 1) identified them with the *method* philosophy, provided a range of emphases for ESIA. As Hoots (1974) noted, Gerbracht and Babcock epitomized not only the "method" philosophy, but the "arts-and-crafts" as well. Thus these two may be considered as constituents of one larger "method" philosophy.

It is rather straightforward, then, to associate the findings of Research Question 1 with Hoots' historical philosophies. The *content* philosophy of this study subsumes Hoots' "subject matter" and "tools, materials, and processes;" *method* includes his "arts & crafts" and "methodology." There is no analog in his system to the *process* philosophy identified here.

Associating the findings of Research Question 2 with Hoots' categorization was more difficult. This difficulty, however, further demonstrated the lack of parallelism between approaches and philosophies.

To some degree, the *progressive* approach identified in Research Question 2 was similar to Hoots' "methodology," which, he (1974) notes, argues that ESIA's contribution to the school "is in the psychological and sociological areas of child development and in the area of cognitive learning in other subject matter disciplines by providing realistic and concrete experiences related *to those disciplines*" (p. 226; italics added). Further, the *modern* approach to ESTE resembles, to a degree, Hoots' "tools, materials, and processes" philosophical category of ESIA. Hoots' (1974) criticisms of this category echo modern concerns about modular technology education, especially when he discusses the ease with which a teacher can overlook pedagogical concerns and "get into implementation—the actual classroom activities—and end up with a tool- and material-centered [program]" (p. 227).

There seem to be no strong relations between the remaining approaches identified here—*design/science* and *secondary*—and Hoots' categories. Figure 2 is an illustration of the relationships among the three categorization systems.

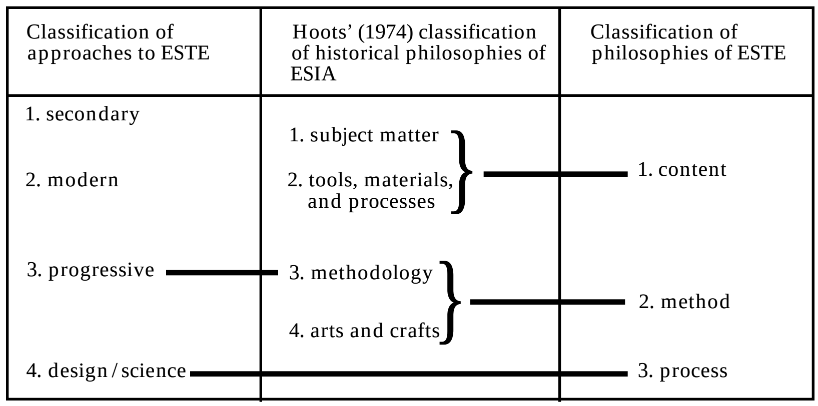

Figure 2. Relationships among the three categorization systems.

Directions for Further Research

In reviewing the literature to address Research Question 1, several articles were found which described ESTE programs or activities. Some of these were rich descriptions of the learning which can take place in the elementary classroom. Few of these articles simply reflected a single philosophy of ESTE. However, upon further inspection, it became clear that many reflected a single approach to ESTE. Hornsby's (1993) description of an ITEA-award winning ESTE program in Kentucky makes it clear that program implementors have taken a *modern* approach; Kirkwood's (1992) approach was *progressive*. An appropriate extension of this research may be to analyze ESTE program-implementation articles in an effort to challenge or validate the results of the cluster analysis described herein.

In a prior study (Foster & Wright, 1996), it was found that technology-education leaders advocated different approaches for ESTE than they did for secondary programs. Nonetheless, research by Zuga (1989), Petrina (1994b), and others who have categorized or discussed categories of curricular approaches and philosophies of technology education, may shed some light on the findings reported here. Further investigation is needed associating approaches to and philosophies of ESTE with their counterparts in secondary technology education.

Final Thoughts

At the 1996 annual conference of the International Technology Education Association, two attendees, presumably secondary-school teachers, were overheard bemoaning the overabundance of elementary sessions in the conference program. Fewer sessions appropriate to high-school technology education—the profession's longtime bread-and-butter—were being offered, it seemed, to make room for ESTE presentations.

Scholarly productivity in ESIA seems to have dropped off in the mid-1970s when it became clear that the content–method issue wouldn't be easily reconciled. A decade later, with the acceptance of technology education, scholarly focus was being placed firmly on subject matter, not children, so conditions weren't right for a resurgence in interest in ESTE. Since then, the conditions seem to have improved considerably.

One may infer from the comments overheard at the ITEA convention that ESTE may not be welcome for long if it remains solely a topic of discussion at conferences. One also may infer from historical example that as ESTE moves from theory to practice, a variation of the content-method debate will almost certainly emerge.

This would be a dangerous combination: lack of support from rank-and-file technology teachers paired with infighting among ESTE advocates, most of whom are university faculty. Perhaps this can be avoided if supporters of ESTE can reach some degree of genuine philosophical agreement. Clearly a "kitchen sink" compromise such as the aforementioned 1971 definition from the National Conference for Elementary School Industrial Arts will not suffice.

This study identified a variety of approaches to and philosophies of ESTE. Unfortunately, no debate has emerged regarding their relative merits. And until one does, a vast majority of elementary school children are unlikely to experience technology education.

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