https://doi.org/10.21061/jte.v11i1.a.4

Journal of Technology Education *Vol. 11 No. 1, Fall 1999*

Content or Process as Approaches to Technology Curriculum: Does It Matter Come Monday Morning?

Theodore Lewis

Content, which focuses upon conceptual structure, and process, which focuses upon intellectual skills, are two preeminent ways in which technology educators conceive of curriculum (e.g., Bensen 1988). Clearly, if technology is to have validity as a school subject, its adherents must be able to say what it is uniquely about. They must be able to answer the basic question, “What do you teach?” And as the subject is taught to children, teachers must likewise be able to say to them and their parents what they will learn, different from in other classrooms. Both content and process claimants may argue, perhaps with justification, that their particular curricular approach reveals technology to students. If it is the case that these two ways of thinking are each capable of helping students acquire literacy in the subject, then perhaps there is need to view them not dichotomously, but rather symbiotically. Perhaps, then, the approach to curriculum does not really matter. Maybe it is how this all plays out in actual classrooms that counts. Still, content and process have their own particular champions, and a divergent discourse along these two distinct lines can be traced.

In what follows, these two ways of thinking about the subject are examined critically. First, the lineage of the quest for conceptual structure is traced back into the industrial arts era. Next, challenges inherent in attempting to establish technology education, in the absence of a coherent discipline structure, are discussed. How the connection between technology the school subject and technology the realm of human existence might be viewed, is explored, borrowing from the work of Stengel (1997). Process approaches and their justification are next examined and critiqued. A discussion follows in which the competing rationales, arguments, and counter-arguments are reflected upon. Whether the tensions here are of any significance come Monday morning in the typical technology education classroom or laboratory provides the basis for concluding comment.

Theodore Lewis (lewis007@maroon.tc.umn.edu) is a Professor in Industrial Education, College of Education and Human Development, University of Minnesota, St. Paul.

https://doi.org/10.21061/jte.v11i1.a.4

The Perennial Search for Conceptual Structure

The recent publication of the curriculum document *Technology for All Americans*, in which a rationale and structure for the study of technology is set forth (International Technology Education Association, 1996), is evidence that the subject matter and conceptual structure of technology education still remains an unsettled issue and a preoccupation of leaders of the field in the United States. Explaining the need for a structure for the subject, the ITEA authors asserted that technological literacy must be operationalized. The field must be able to say just what experiences, abilities, and knowledge pertaining to technology must be exhibited for one to make the literacy claim. Thus, three elements of a structure (processes, knowledge, and contexts) are proposed as universals underlying technology. Suggesting a new path for the field, content and process are shown to be inherent in its structure.

The continuing quest for clarity and specificity regarding subject matter constitutes unfinished business for the field, left over from the era of industrial arts. Very early on, industrial arts leaders at Teachers' College, Columbia University had come forward with the view that the conceptual structure of industrial arts needed to be articulated. For example, McMurry (1905) argued that "probably the most pressing need in establishing manual training more firmly is fuller evidence that the subject contains a body of thought comparable in importance to that of history, geography, or nature study" (p. 563). That way of thinking has not receded.

In his seminal work, *"A Curriculum to Reflect Technology,"* Warner (1947, 1965) suggested that content in the "new industrial arts" would be derived from socioeconomic analysis of the technology, rather than through task analysis of trades. Thus, the subject would be framed by a new schema. "Socioeconomic analysis" for Warner meant resorting to standard industrial classification rubrics. This classification yielded power, transportation, manufacturing, communication, and management, as content organizers. Warner and his students provided detailed conceptual structures for each of the content categories he proposed.

But this was not the first time that standard industrial classification had been suggested as the way to structure the field. Russell (1914) had already proposed such a schema for the subject when he suggested that "the dominant processes in the successive stages of production, manufacture and distribution, and their interrelations" (p. 11) ought to be taken into account in fashioning the subject matter.

By the mid-1960s, despite Warner's classification work, leaders of the field were still clamoring for a new structure within which to frame industrial arts content. In the theoretical work that supported the American Industry project at the University of Wisconsin-Stout, the search for structure and new content organizers was evident. In an essay titled "Industrial arts—What is its body of knowledge?" Robert Swanson (1965) pointed out that the field had traditionally adopted an eclectic approach to curriculum derivation, but that this eclecticism notwithstanding, "it seems that any subject worthy of time in the school must demonstrate that it is uniquely prepared to transmit and interpret this knowledge" (p. 58). Following Bruner (1960), he argued that structure makes the subject matter coherent and comprehensible, and that it helps clarify the

https://doi.org/10.21061/jte.v11i1.a.4

subject's relationship with others in the curriculum. Where McMurry had offered *status* as the primary reason for finding structure, Swanson was now offering *cognition*.

Face, Flug, and Swanson (1965) explained the American Industry project as a quest for a structure of industrial arts. The basic elements of structure were to be *concepts*. American Industry was to be an intellectual discipline, to be structured on the basis of concepts common to a variety of industries (such as transportation, processes, and materials).

Leaders at The Ohio State University also premised their landmark work on the assumption that the subject matter of the field needed to be articulated. The basic premise of their Industrial Arts Curriculum Project (IACP) was that the content of industrial arts was nested in the higher plane of praxiology or technology (Lux & Ray, 1970; Towers, Lux, & Ray, 1966). Trying to articulate the complete structure of technology would be impractical, thus the scope would be delimited to *industrial technology*. Correspondingly, manufacturing and construction became the primary content organizers and the conceptual structure for these two areas were developed. In retrospect, this decision to structure *the subject* and not *the discipline* was eminently sensible.

In his classic monograph "Come Monday Morning," William J. Micheels (1978) offered as his anchoring premise the view that "Industrial arts education is an eclectic discipline" (p. 1). He explained that by the term "discipline" he meant simply that which was to be taught to students. Come Monday morning, the typical teacher had the option of choosing from a diverse array of sources, systems, and styles. Micheels argued further that amid the diversity of approaches and choices, there were three common denominators of the subject: tools, materials and ideas. These three common themes would hold, even if the rationale for the subject was the nature of technology and its impact on society. And they would hold even as the focus of pedagogy in the subject shifted to creativity, problem solving, and design. He explained:

> Learning how to solve such problems can be an important goal of industrial arts instruction. There should be experiences in working with many kinds of tools and materials. There should be opportunities to experiment, invent, construct, create, produce, and *think* about metals, plastics, wood, electronics, energy, power, graphics, and other materials, methods and forces which can stimulate imagination and develop creative abilities. (p. 15)

Micheels had refrained from joining others in calling for a conceptual structure. Tools, materials, and ideas were, in his view, sufficient parameters to lead to comprehensive elaboration of the subject in schools. Micheels was assuming, here, the disposition of a teacher. It was the children and what they learned that mattered, not the method of deriving content or the instructional approach that one adopted. There is much wisdom in Micheels' entreaty. We may have overdone the quest for structure, forgetting the grander purpose of schooling and the educative role of the subject.

This brief historical reflection shows that the quest for discipline status and structure has been a perennial in the field, originating early in the industrial arts

https://doi.org/10.21061/jte.v11i1.a.4

era, and providing impetus for the transition to this new era of technology. Arguably, the preoccupation with discipline structure really has to do with the quest for status and power. We see this clearly in the case of accounting. Hoskin and Macve (1993) contended that the disciplinary status of accounting is central to understanding the emergence of the modern business enterprise. Once accounting had emerged from the shadows, no longer basing its legitimacy merely as a derivative of fields such as psychology and economics, what followed was the emergence of the modern business enterprise. The *disciplinary power* of accounting, combined with knowledge practices, facilitated administrative coordination. Hoskin and Macve went to lengths to trace the disciplinary metamorphosis of accounting. But they caution that the future of accounting lies not so much in it being recognized as a "pure-knowledge" discipline, but rather as "power-knowledge," that is, in terms of its indispensability to business practice.

It is useful to see that the disciplinary quest is not peculiar to the subject that we now call technology education. Attainment of disciplinary status has to be viewed as a sort of epistemological badge of honor, a sign that one's field has arrived. In the society at large, of course, technology has nothing to prove. People have been to the moon. The Internet has made the global village a reality. This power of a ubiquitous and even deterministic technology does not readily transfer to school technology however. In American schools we know that a subject has arrived when it is required, and not merely an elective, or when the universities specify it as an entry criterion. School technology is not yet there. Thus, the quest for status and power continues.

Disciplinary Status and the Validity of Subjects

The appearance of Bruner's *The Process of Education* provided a new stimulus and rationale for a conceptual structure for industrial arts in the 1960s. Bruner wrote that structure promoted discovery learning. It made learning more comprehensible, thereby promoting transfer. Thus, the reasons why structure was important were grounded in cognitive psychology. Schwab (1962) advocated structure for similar reasons. He wrote:

> The structure of a discipline consists, in part, of the body of imposed conceptions which define the investigated subject matter for that discipline and control its inquiries. (p. 199)

Structure aided inquiry. It also afforded renewal of subject matter. Facts endured, while knowledge decayed and regenerated. Each discipline had its peculiar conceptual apparatus. The body of concepts was one aspect of a discipline, the syntactical structure, focusing on the method of the discipline, was another. Schwab's positioning of conceptual structure and syntactical structure conjointly is important because it allows us to see that the method of technology—how the goals of technology are accomplished—must be integral to its discipline structure. Neither conceptual nor syntactical structure alone would be a complete conceptualization.

https://doi.org/10.21061/jte.v11i1.a.4

Curriculum leaders in industrial arts now had a mainstream rationale for their quest for the articulation of subject matter. DeVore (1969) adopted the notions of Schwab and Bruner, arguing that, “A curriculum based on organized knowledge fields is better learned and retained than knowledge which is specific and isolated” (p. 41). Reviewing extant approaches to industrial arts, he opined that the field should adopt the stance that the industrial arts curriculum should be based upon “the study of man and technology” (p. 43). His reasoning was that by claiming technology, the field “identifies a knowledge area meeting the criteria of a discipline in the truest sense of the term” (p. 43). Technology was “an area of human knowledge, as are the sciences and the humanities” (p. 42). The sphere of study would include “the modes of thinking, the problem solving and the solution of technical problems together with the socio-cultural relationships involved” (p. 42).

In drawing attention to the need for both a body of knowledge and for identification of modes of thinking, DeVore had articulated for the field how it needed to think about conceptual and syntactical structures simultaneously. Content and process went hand in hand. This is the line of thinking we now see in *Technology For All Americans*. DeVore (1970) subsequently proposed a research program designed to yield both discipline structure and process.

In this era of transition from industrial arts to technology education, the disciplinary claim has been a recurring theme in the literature (e.g., Dugger, 1988; Lewis, 1991; Lewis & Gagel, 1992). And as indicated above, the ITEA (1996) has returned to the idea of creating a rationale and structure for the study of technology.

Why Calls For Structure Have Been Problematic

In calling for conceptual structure, the first problem for the field was that the claim that technology is a realm of knowledge went against the grain of epistemological tradition. Technology did not conform to the received view of what constituted valid knowledge (see Lewis, 1993). It was not one of the forms of knowledge identified by Hirst (1975). In fact, it seemed to align more closely with what Hirst referred to as “fields,” being derived from practical interests. To be a discipline in Hirst’s schema, a subject had to have a distinguishing mark—a particular test of experience. For example, science depended on empirical tests, mathematics upon deductions. But could not technology claim its own test of experience? Such a test would be whether or not a particular tool or device or process worked (e.g., Skolimowski, 1966). If it is the case that technology does possess its own central concepts (which it must), and indeed lends itself to a peculiar test of experience, then a strong disciplinary claim could be made for it, using Hirst’s criteria. Technology’s absence from Hirst’s schema can probably be better explained in terms of a Platonic reflex. Some types of knowledge are more equal than others. Thus disciplines are superior to fields. But if we could forego the sociological problem here, Hirst’s concept of “field” does allow much possibility for the coherent organization of technological concepts and practices. Fields are imbued with a built-in elasticity that seems perfect for technology,

https://doi.org/10.21061/jte.v11i1.a.4

given its dynamic nature. We should expect that knowledge in technology would decay and regenerate more rapidly than in other subject areas.

Whether discipline or field, a universally accepted knowledge structure for technology had not been articulated by the 1960s when innovative curricula were being proposed in the bid to reform industrial arts. Beyond epistemological inertia, there was the fact that much remained unsettled about the nature of technology. Was technology skill? Was it applied science? Was it like science or was it a system of thinking unique onto itself (see Bunge, 1966; Feibleman, 1966; Layton, 1974; Skolimowski, 1966)? With desperately important issues such as these still occupying the minds of scholars, and still the object of contestation, articulation of subject matter of the discipline could not properly proceed. It is true that Warner, DeVore, and the project leaders of IACP had taken it on their own to try to create the outlines of the discipline of technology. But such an undertaking, given its gravity, required at least an interdisciplinary project. Technology teacher educators simply did not have the standing in academia to take this on alone and have it validated. As a consequence much of the work on the structure of technology that has been done in the field is known only within the field and is rarely cited outside of it.

Also in the 1960s, the field of history of technology germinated, and like technology education, advocates found themselves wanting of an articulated discipline structure. For example, Ferguson (1974) observed that while the history of technology had "all of the appearances of an academic field, yet it is difficult to find in it a discipline or conceptual framework that guides the work being done in its name" (p. 13). The fledgling field of philosophy of technology also had the same need. Rapp (1989) asserted that:

> What is lacking in the philosophy of technology is precisely a well elaborated state of the art. The situation is different from other fields of philosophical inquiry. In such areas as the philosophy of history, ethics... philosophy of language or philosophy of science, there has been long standing discussion; there is a well established, systematic conceptual framework of basic concepts, questions, theses and arguments...For philosophy of technology a similarly detailed and elaborate theoretical frame of reference is mainly desideratum. The field is still in the making. (p. ix)

This is exactly what McMurry (1905) was saying about industrial arts in the first decade of this century. Thus, historians and philosophers of technology, much like technology educators, were lamenting the absence of a conceptual structure. Technology educators were not alone.

It is sobering and quite instructive that the quest for an articulated structure of technological knowledge has not impeded actual teaching of the subject in schools. The metamorphosis of technology education in American schools began in the 1880s, and while it is the case that there has been perennial search for structure, such a search has essentially been a preoccupation of advocates in the universities. But at the primary site where the subject is enacted—schools—the subject has proceeded and has evolved. The work that has gone on in schools, at the grass roots, needs to be recognized and validated, since that work

https://doi.org/10.21061/jte.v11i1.a.4

is a truer reflection of what the subject is about than what campus-bound advocates might profess. The subject has proceeded as if it was oblivious to the absence of structure. In light of the seeming disconnection between the quest for discipline structure and actual school practice, we have to look again at the supposed relationship between academic disciplines and school subjects in the particular case of technology education. Does school technology have to be a mirror image of the discipline of technology?

Stengel (1997) pointed out that the relationship between school subjects and academic disciplines is complex. She sets forth a typology that, among other things, allows for the prospect that school subjects can *precede* academic disciplines. What this would mean in practice is that the curriculum is not externally controlled by subject-matter experts. In the case of technology education it means that we do not bring in the engineers, doctors, systems analysts, and agriculturists to lay down curricular tracks for technology teachers. Rather, the curriculum is dictated by the accumulated experiences of children and their teachers.

Stengel indicated that when the discipline precedes the subject, traditional academic goals and assumptions go untested, as teachers strive to create connections between disciplinary knowledge and the lives of children. This analysis is quite breath taking. As we look at technology education and the perennial, almost ritualistic quest for structure, it should be sobering that a cost of such quest might be the neglect of the needs and experiences of children. Perhaps it is because the field is highly masculinized and is consequently taken in by technological gadgetry. But especially in the U.S. context, where the subject is rarely taught in the elementary grades, focus on children and on learning is minimal in our discourse. Technology *per se* has been our consuming passion and we forget that the enterprise we are about is schooling. We take too seriously the view that without our field technology would not be purveyed. That of course would be highly presumptuous, although it is true that without the subject in the curriculum one can point to a clear epistemological void. The fact is that in societies such as the United States, where people are so immersed in technology in day-to-day life, we can assume that their functional knowledge of technology—that knowledge acquired from commonplaces—would contribute substantially to their literacy. There are means beyond schooling by which societies retain memory of their technological store. Thus, the focus of the field has to be upon the children, not the technology. If the advocates begin to think in this way, how we view curriculum will change.

One critic of the discipline quest has suggested that the field does not have a clear grasp of the nature of technological knowledge (Herschbach, 1995). According to Herschbach, technological knowledge is unlike other forms of knowledge. It is not just a storehouse of facts, laws, and theory. It is alive. It has meaning only when enacted in laboratories. Technology, he argues, “is not only content to be learned but the vehicle through which the intellectual processes embedded in technological activity can themselves be learned” (p. 39). Herschbach ties content to process. There is much in favor of this view. Others

https://doi.org/10.21061/jte.v11i1.a.4

have come to view process *per se* as content, and a reason to call off the quest for structure.

From Content to Process

Though discipline structure has been a preoccupation, the process approach to technology has also had sway. While the origins of the process approach are difficult to pin down on the American scene, if we go back to the critical period of innovation in the 1960s and early 1970s, we find that Donald Maley was a strong advocate. Maley separated himself from other curriculum leaders by focusing his educational philosophy upon children rather than on content. Thus, he did not become entangled in calls for discipline structure.

Maley (1963) described a research and experimentation approach to industrial arts. The program would provide challenges for all students, including the academically gifted. It would emphasize problem solving. He explained:

> America needs people capable of problem solving, capable of making decisions, and capable of using sound procedures in arriving at decisions. Herein, the research and experimentation program has one of its greatest strengths in that the principal vehicle of the activity is the scientific approach which forms the backbone of each experiment or research problem. (p. 26)

Maley made an assumption about the existence of content, and chose to concentrate his efforts on having children experience the act of technological creating. In a subsequent work (Maley, 1972), he declared industrial arts to be the interpreter of technology. The subject would accomplish this by focusing upon major problem areas such as pollution, power generation, conservation, transportation, and communication. It would focus on "the application of technology in the solution of major problems facing mankind in the future" (p. 58).

This research and development approach was evident in Delmar Olson's version of what the new industrial arts ought to be. Olson (1972) wrote that:

> The new industrial arts confronts the student with challenges to attack real problems and issues consequential of technological advance impacting on man and culture. It is relevant to the student in his time. (p. 37)

There was need for a "Creative pedagogy" according to Olson, that would include "Employment of the processes of research and development in the search for truth and authority in technology" (p. 37). Along with presenting new organizers for the subject, Olson was also suggesting a new method. He had looked analogically to science for a model for thinking about technology. Research and experimentation, and the "search for truth," were to give way to problem solving and the technological method.

The disposition of the field here could be gleaned from a contribution in the 1988 yearbook of the Council on Technology Teacher Education, in which Hatch (1988) articulated the dimensions of problem solving. He asserted that:

https://doi.org/10.21061/jte.v11i1.a.4

> The technologically literate adult must also have a capacity for higher problem solving skills. The content of technology education should address technological problems and problem solving techniques through a variety of settings. (p. 97)

He charged the field to proceed in that direction.

The problem solving approach as described by Hatch foreshadowed a significant event in the curriculum history of the field. This event was marked by a consensus curriculum document, published in two parts, in which the content of the field was now to be framed by “the technological method” (Savage & Sterry, 1990a; 1990b). The technological method was essentially a problem solving model. Savage and Sterry deemed this as a “new departure” (Savage & Sterry 1990b, p. 10) in technology education. They wrote: “The new departure for technology education is ‘process education’ using the technological method. It requires students to think and act in a systematic fashion when solving problems” (p. 10). The authors continued:

> Process education using the technological method *encourages major shifts from content or subject matter based teaching and learning* (emphasis added) to a variety of educational opportunities and experiences for students such as thematic learning, problem solving, modular instruction, integration learning and cooperative learning. (p. 10)

Because this entreaty had the imprimatur of the ITEA, and because it was the result of the consensus among the top leaders of the field, it assumed great validity. In keeping with this new departure, Hutchinson and Hutchinson (1991) called for the field to break away from the content approach in favor of process. In a special JTE issue on curriculum approaches in the field, Johnson (1992) described an “intellectual processes” approach to the technology curriculum. He explained that an intellectual processes curriculum would be ineffective if it does not include a substantial amount of content knowledge. But indeed, this type of curricular approach invites the criticism that it goes against the grain of situated cognition by conceiving of learning as a decontextualized enterprise.

The fact that the ITEA stood behind the technological method as motif for the subject seemed to set technology education in the United States on a course quite familiar to British adherents, for whom process has traditionally been the primary curricular approach. “Design” has been a strong idea in British curricular theorizing related to technology. There is no attempt to articulate conceptual structure (see Department for Education, 1995; Eggleston, 1992, Jarvis, 1993; Roberts, 1994).

Whether through design or problem solving, the idea is to fashion pedagogy in keeping with the nature of technology. Of course there are difficulties with this line of thinking, especially when it means that design and problem solving are viewed formulaically or in linear fashion. Custer (1995) showed that all technological process are not of the same degree of complexity; but his view is not yet widely accepted. There is no question that intellectual process approaches can be eminently educative if executed *in the context of technology.*

https://doi.org/10.21061/jte.v11i1.a.4

These processes try to capture technology in action. They ask the question, "What do technologists do as they go about their work?" If the answer is that "they think" or "they solve problems," then the curriculum can proceed reasonably from there. The difficulty is that these answers are also true for what mathematicians or scientists do.

The truth is that we really do not know enough about the act of technological creation. And one very questionable premise of the field is that there is "the" single best technological method. Because technologies vary so much, originate from very diverse contexts, and respond to quite diverse circumstances, to posit that there is "the" method is mistaken. In practice many technological problems take years of toil to solve. The processes are more likely to be messy than clean. Critique along these lines is offered by Chidgey (1994), Hennessy and McCormick (1994), and Lewis, Petrina and Hill (1998).

The notion of "the" technological method is inspired by the quest to mimic science. But there is some contention as to whether there is even "the" single best scientific method. Bauer (1997) raised many issues in this regard, pointing out that within science there are several modes of inquiry depending upon a host of factors. Some sciences are young while others are old; some are data rich, others are data poor; some are observational, others are experimental; some are data driven while others are theory driven. The geologist proceeds in inquiry quite differently from the astrophysicist, who proceeds quite differently from the chemist.

In a scathing critique of laboratory-based science teaching, Hodson (1996) argues that process approaches such as discovery learning and constructivism misconstrue the real nature of science. He questioned whether a content-free approach to science, where students learn skills such as classifying, hypothesizing, inferring or predicting, and recording data, were transferable. The processes of science are not separate transferable skills, he argued. Thus:

> If we claim to assess the processes of science as separate skills, we are claiming that skill acquired in one context can be effectively used in another quite different one. If we made that kind of assumption in medicine, we would happily submit to a brain operation carried out by a specialist in obstetrics or psychiatry. In reality, the context in which skills are acquired is crucial to the proper performance of that skill and to our confidence in the practitioner. (p. 126)

Hodson argues that while it is true that science may have distinctive phases such as design and planning, performance, reflection and recording, and reporting, "doing science is an holistic and fluid activity, not a matter of following a set of rules that requires particular behaviors at particular stages" (p. 129). But this is a trap some have fallen into in technology education (e. g., Pucel, 1995). Problem solving is set forth as a series of steps to be followed by the student. But the process leading to the invention of a pacemaker for diseased hearts is not the same as trying to trouble-shoot an engine that would not start. In the one instance an algorithm might suffice, while in the other heuristics would be necessary. Problem solving processes are dictated by the nature of the problems,

https://doi.org/10.21061/jte.v11i1.a.4

and by the ingenuity of the inventors and other technologists who pose and tackle them. We would be trivializing the idea of technology if children at least are not taught that.

Discussion

All school subjects have distinctive subject matter, though because of a longer tradition some have clearer structure and definition. All subjects can lay claim to arousing student imagination. Problem solving and critical thinking are integral processes in pedagogy related to science and mathematics, and probably to many other subjects. Design is a central aspect of art education. Hence, technology education has no special claim to generic intellectual processes. What distinguishes technology may be *the circumstances* that prompt design, problem solving, or critical thinking. Borrowing from Micheels (1978), it is the interplay of tools, materials, and ideas that gives the subject its distinctiveness.

Just as it is a mistake to try to position technology education next to academic subjects by claiming intellectual processes, it is also an error to think that it is the existence of a conceptual structure *per se* that legitimizes such subjects. Those subjects that have gained acceptance over time as school subjects have done so because of the perception that they are culturally significant; that is, they are consistent with civic ideals (Reid, 1992) or they are consistent with theories of progress (Kamens & Cha, 1992). Kamens and Cha (1992) pointed out that the non-academic subjects of art and physical education were able to diffuse the curriculum because beauty and fitness were ideals that were synchronous with theories of Western racial superiority.

Subject matter is only partly a technical concern. It is more than a mere compilation and classification of what there is to be known in a disciplinary area. Rather, subject matter is substantially a political concern, requiring contestation, negotiation, and compromises. Reid (1992) points out that subject matter must be filtered through several screens. National, local, and classroom concerns ought to be taken into account, as well as factors such as gender and race. Technology education in a poor country cannot be premised on the same content as in an affluent country.

If a subject were deemed to be a national priority, advocates would have little difficulty in installing it into the curriculum and teaching it in the way they wished. Technology is now a required, examinable subject for all children in England and Wales. The curriculum that has been agreed upon was a matter of negotiation among interest groups (see Department for Education, 1995). Subject matter was determined by debate. In Minnesota, the scope of technology education *in the schools* has now been dictated by a political process in which the technology education association of the state was able to make aggressive representation for the subject in discussions leading to state graduation standards (see Lindstrom, 1998). If school subjects are freed from the proprietary grasp of their advocates and their content released to a common pool, a result would be the dismantling of artificial barriers, increasing the possibility that coherence and meaningfulness in the curriculum will occur. Teachers would spend less

https://doi.org/10.21061/jte.v11i1.a.4

time patrolling the borders of their subjects, and more time seeking to facilitate border crossings.

School subjects are not the same as the forms of inquiry that produce the knowledge their advocates seek to purvey (Reid, 1992; Stengel, 1997). Technology education is not technology as it is played out in Silicon Valley. Thus school technology does not have to be a mirror image of societal technology. It is of course desirable that the school subject bear authentic resemblance to its alter ego, but technology in schools should really be concerned most with exciting and delighting children. A preoccupation with running on the technological treadmill and keeping up with the latest equipment and software should be diminished.

Intellectual processes and subject matter are complementary curricular ideas. Both are important to understanding technology. However, there is a danger that both might be status driven, preoccupied with academizing the subject. These ideas seem far away from the center of what technology teachers do. It may be that they mask our shame. In a quest for status, we want to erase the blue-collar origins of the subject in favor of the white collar. But technology is an enterprise of practical intelligence and *making* is its essence. I would argue that pouring hot metal into molds is more representative of the subject than following a set of commands as a computer controls the movement of a robot arm. There is need for a curricular language that gives power back to that which makes the field unique. Cutting and bending and shaping and fitting, things that children do as they learn the subject, need to be given greater space. Curricular theorists resist the gritty aspect of technology education, retreating instead to a sanitary world. This is not the case in the schools, however.

Come Monday morning in technology education classrooms, teachers and their students meet once more to enact the subject. The better teachers make arrangements to allow for the varying interests and abilities of their charges. And once classes got going, the onlooker sees a hive of activity. In this milieu we find the essence of the subject. Content and processes are important of course, but they are not kept in separate compartments. Rather, these teachers see the subject as a whole. There is fluidity and curricular decisions will be made on the spot (see Holt, 1996 for how we might view this dynamic).

As teachers and their students interact, there is dialogue, give and take between them. In the midst of these dialogues and interactions, the curriculum comes to life. Machines are turned on and materials cut to length. Holes are drilled. Jigs and fixtures are proven out. Teachers are on constant alert for safety infringements. Students are free to talk, as in few other classes. Computers are turned on. Drawings are pored over.

Until we can capture and represent the subject as it plays out in the above scenario, come Monday morning in a typical technology education classroom, we will continue to miss the point about subject matter (see especially Holt, 1996). Admittedly, this scenario is clearly a biased version of what Monday morning might look like. It is laden with the curricular values of this author. There are certainly alternative scenarios. An increasingly common one is where, come Monday morning, the teacher gets out the curriculum supplied by one of the vendors of modular laboratories, looks up the lesson for that day, and the

https://doi.org/10.21061/jte.v11i1.a.4

children turn on their computers and follow the prescribed activities, in clean rooms.

How teachers structure what they do on Monday morning depends on a host of variables, including the values they hold about the subject. Though there is probably no right or wrong in this discussion, there are certainly varying degrees of authenticity. What we should take from the thinking of Micheels is that, process or content, there is a central ethos of the subject. We approach that ethos when tools, materials, and ideas are at the core and the children are preeminent.

References

Bauer, H. H. (1997). The so-called scientific method. In J. Hatton & P. B. Plouffe (Eds.), *Science and its ways of knowing*, (pp. 25-37). Upper Saddle River, New Jersey: Prentice Hall.

Bensen, M. J. (1988). The transition from industrial arts to technology education. In R. S. Brandt (Ed.), *Content of the curriculum*, (pp. 167-180). Yearbook of the Association for Supervision and Curriculum Development (1988), (pp. 167-180), ASCD.

Bruner, J. S. (1961). *The process of education*. Cambridge, MA: Harvard University Press.

Bunge, M. (1966). Technology as applied science. *Technology and culture*, *7*(3), 329-347.

Chidgey, J. (1994). A critique of the design process. In F. Banks (Ed.), *Teaching technology* (pp. 89-93). New York: Routledge.

Custer, R. L. (1995). Examining the dimensions of technology. *International Journal of Technology and Design Education*, *5*, 219-244.

Department for Education (1995). *Design and Technology*. London: HMSO.

DeVore, P. W. (1969). Knowledge—Technology and curriculum. Addresses and proceedings of the thirty-first annual American Association of Industrial Arts Conference, 41-53.

DeVore, P. W. (1970). Discipline structures and processes: A research design for the identification of content and method. *Journal of Industrial Teacher Education*, *7*(2), 21-31.

Dugger, W. E. (1988). Technology—The Discipline. *The Technology Teacher*, *48*(1), 3-6.

Eggleston, J. (1992). *Teaching design and technology*. Buckingham: Open University Press.

Face, W. L., Flug, E. R. F., & Swanson, R. (1966). Conceptual approach to American industry. In G. S. Wall (Ed). *Approaches and procedures in Industrial arts*, (pp. 60-72). Fourteenth yearbook of the American Council on Industrial Arts Teacher Education, Bloomington, IL: McKnight Publishing Company.

Feibleman, J. K. (1966). Technology as skills. *Technology and culture*, *7*(3), 318-328.

Ferguson, E. S. (1974). Toward a discipline of the history of technology, *Technology and Culture*, *15*(1), 13-30.

https://doi.org/10.21061/jte.v11i1.a.4

Hatch, L. (1988). Problem solving approach. In W. E. Kemp & A. E. Schwaller (Eds). *Instructional strategies for technology education,* pp. 87-98, 37th Yearbook of the Council on Technology Teacher Education, Mission Hills, CA: Glencoe Publishing Company.

Hennessy, S., & McCormick, R. (1994). The general problem solving process in technology education: Myth or reality? In F. Banks, (Ed.) *Teaching technology* (pp. 94-107), New York: Routledge.

Herschbach, D. R. (1995). Technology as knowledge: Implications for instruction. *Journal of Technology Education*, *7*(1), 31-42.

Hirst, P. H. (1975). Liberal education and the nature of knowledge. In, R. F. Dearden and P. H. Hirst (eds), *Education and reason*, (pp. 1-24). London: Routledge and Kegan Paul.

Hodson, D. (1996). Laboratory work as scientific method: three decades of confusion and distortion. *Journal of Curriculum Studies*, 2892, 115-135.

Holt, M. (1996). The making of *Casablanca*, and the making of curriculum. *Journal of Curriculum Studies*, *28*(3), 241-251.

Hoskin, K. W., & Macve, R. H. (1993). Accounting as Discipline: The overlooked supplement. In E. Messer-Davidow, D. R. Shumway, & D. J. Sylvan (Eds.), *Knowledges: Historical and clinical studies in disciplinarity* (pp. 25-53). Charlottesville, VA: University Press of Virginia.

Hutchinson, J., & Hutchinson, P. (1991). Process-based technology education. *The Technology Teacher*, *50*(8), 3-6, 14.

International Technology Education Association (1996). *Technology for All Americans*. Reston, VA: Author.

Jarvis, T. (1993). *Teaching design & technology in the primary school*. London: Routledge.

Johnson, S. D. (1992). A framework for technology education curricula which emphasizes intellectual processes. *Journal of Technology Education*, *3*(2), 29-40.

Kamens, D. H., & Cha, Y-K. (1992). The legitimization of new subjects in mass schooling: 19th century origins and 20th century diffusion of art and physical education. *Journal of Curriculum Studies*, *24*(1), 43-60.

Layton, E. T (Jr.). 1974. Technology as knowledge, *Technology and culture*, *15*(1), 31-41.

Lewis, T. (1991). Introducing technology into school curricula, *Journal of Curriculum Studies*, *23*(2), 141-154.

Lewis, T. (1993) Valid knowledge and the problem of practical arts curricula. *Curriculum Inquiry*, *23*(2), 175-202.

Lewis, T., & Gagel, C. (1992). Technological literacy: a critical analysis, *Journal of Curriculum Studies*, *24*(2), 117-138.

Lewis, T., Petrina, S., & Hill, A. M. (1998). Problem posing—Adding a creative increment to problem solving. *Journal of Industrial Teacher Education*, *36*(1), 5-35.

Lindstrom, M. R. (1998). *Positioning technology education in Minnesota's graduation standards*. Unpublished doctoral dissertation, University of Minnesota, Twin Cities.

https://doi.org/10.21061/jte.v11i1.a.4

Lux, D. G., & Ray, W. E. (1970). Toward a knowledge base for practical arts and vocational education. *Theory into practice*, *9*(5), 301-308.

Maley, D. (1963). Bases for organizing the content of industrial arts with emphasis on the research and experimentation program, *Journal of Industrial Teacher Education, 1*(1), 22-31.

Maley, D. (Sept/Oct, 1972). The responsibility of industrial arts for interpreting technology, *Man Society Technology*, 31, 58-67.

McMurry, F. M. (1905). How can classroom teachers be educated to the value of manual training? *Journal of Proceedings and Addresses of the Forty Fourth Annual Meeting of the National Education Association*, 563-570.

Micheels, W. J. (1978). *Come Monday Morning*. Washington, DC. American Industrial Arts Association.

Olson, D. W. (Sept/Oct, 1972) Industrial Arts: Interpreter of technology for the American School, *Man Society Technology*, 31, 34-39.

Pucel, D. (1992). Developing technological literacy: A goal for technology education. *The Technology Teacher*, *55*(3), 35-43.

Rapp, F. (1989). Introduction: general perspectives on the complexity of philosophy of technology. In P. T. Durbin (Series Ed). Philosophy of Technology: Practical, Historical and other Dimensions. *Philosophy and Technology*, Vol. 6 (Dordrecht: Kluwer), ix-xxiv.

Reid, W. A. (1992). *The pursuit of curriculum*. Norwood, New Jersey: Ablex Publishing Company.

Roberts, P. (1994). The place of design in technology education. In D. Layton (Ed.) *Innovations in science and technology*, (pp. 171-179), Vol. 5.

Russell, J. E. (1914). The school and industrial life. In J. E. Russell and F. G. Bonser (Eds), *Industrial Education* (pp. 1-19). New York: Teachers College, Columbia University, 1-19.

Savage, E., & Sterry, L. (1990a). A conceptual framework for technology education, *The Technology Teacher*, *50*(1), 6-11.

Savage, E., & Sterry, L. (1990). A conceptual framework for technology education Part 2. *The Technology Teacher*, *50*(2), 7-10.

Schwab, J. J. (1962). The concept of the structure of a discipline. *Educational Record*, 43, 197-205.

Skolimowski, H. (1966). The structure of thinking in technology. *Technology and Culture*, *7*(3), 371-383.

Stengel, B. S. (1997). “Academic discipline” and “school subject”: Contestable curricular concepts. *Journal of Curriculum Studies, 29*(5), 585-602.

Swanson, R. S. (1965). Industrial arts—What is its body of knowledge? In G. S. Wall (Ed.) *Approaches and procedures in Industrial arts* (pp. 16-59). Fourteenth Yearbook of the Industrial Arts Teacher Education, Bloomington, IL: McKnight Publishing Company.

Towers, E. R., Lux, D. G., & Ray, W. E. (1966). *A rational and structure for industrial arts subject matter*. Eric Document ED 013955.

Warner, W. E. (1947, 1965). *A curriculum to reflect technology*. AIAA feature presentation, April 1947, Columbus, OH: Epsilon Pi Tau Inc.