

A Platform for a Shared Discourse of Interdisciplinary Education¹

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Abstract

“Disciplinarity” and “interdisciplinarity” have become keywords for knowledge and education in the twenty-first century. This development requires that administrators, curriculum planners, and teachers at all levels of the educational system have a common understanding of both terms and their relationship. The primary case study is the school level in the United States. Yet, comparisons with other nations suggest a platform for longer-term international dialogue that bridges the discourses of interdisciplinarity across national contexts as well as school and university levels. A shared discourse and programs of teacher training require awareness of historical contexts of interdisciplinary education, major terminology for distinguishing design models, characteristic pedagogical approaches, and related learning skills.

1. Disciplinarity

For most of the twentieth century, the dominant structure of education was the discipline-based department and school subject. This prominence of disciplines in educational discourse is all the more striking since the modern system of disciplinarity is little more than a century old. The etymology of “discipline”, though, is ancient. The Latin root of *disciplina* indicated an educational setting and the instruction of disciples (Kockelmans 1979, 16). In the late nineteenth and early twentieth centuries the modern system was institutionalized as disciplines were segmented into separate academic divisions. The underlying process of “disciplining” knowledge that derives from this historical development is characterized by two sets of features.

The first feature, functional differentiation, is evident in traits that produce a distinct worldview or discourse:

- a subject matter and objects isolated for study
- a body of evidence, canon, content, laws, formalisms
- exempla, models, paradigms, and law
- concepts and theories
- methods, procedures, techniques, and skills
- explanatory modes, language and argument styles
- ontologies and epistemologies.

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The second feature, a system of power, is evident in traits that control the nature of work in a particular domain:

- departmental units of teaching and research
- institutional structures of a profession
- criteria of validity and legitimated practices
- a behavioral culture that shapes self and collective identities
- patterns of education and training, publication, and funding
- accounts of disciplinary history.
- employment and labor markets
- allocations of resources, privileges, and prestige
- economies of value with social, political, and intellectual capital.

Even with common features of disciplining knowledge, though, the results are not identical. Differences have been codified in technical distinctions such as R.D. Whitley's Restricted Sciences (with highly specific subject matter and mathematical precision) versus Configurational Sciences (social and life sciences), Thompson et al.'s Highly Codified disciplines (math, natural sciences) versus Less Codified ones (humanities, social science), Lohdahl and Gordon's High Paradigm fields (physics, chemistry) versus Low-Paradigm ones (sociology, political sciences), and Stephen Toulmin's Compact disciplines (better established physical and biological sciences) versus Would-Be disciplines (ethics, philosophy, problem-focused research initiatives) (Klein 1990, 104). Some disciplines also have a broader synoptic scope, especially philosophy, literary studies, history, anthropology, and geography. Others, such as physics and biology, have become so large they are regarded as "federated" disciplines, and some of their subdisciplines have even attained disciplinary status as autonomous domains.

The historical evolution of disciplines is an added factor. Standard models accentuate stability and natural order, consistent realities, boundary formation and maintenance, normative social values, and homogeneity, with companion images of structure, foundation, compartmentalization, and autonomous territorial regimes. Other models, especially newer ones, accentuate historical change and dynamism, with companion images of networks, webs, and systems. They call attention to boundary crossing and blurring, integration and collaboration, crossfertilization, and interdependence in epistemological and social environments characterized increasingly by complexity, nonlinearity, and heterogeneity. The current heterogeneity associated with the growth of knowledge has profound implications for the taxonomy of fields.

In the behavioral and social sciences, for instance, the "big five" disciplines are anthropology, economics, political science, psychology, and sociology. Yet, Neil Smelser reports, subareas of investigation rely on variables and explanations outside the commonly understood scope of social sciences. Geopolitics, socio-biology, behavioral genetics, and behavioral neuroscience all appeal to non-social and non-psychological explanatory variables and explanations. Another range of disciplines could be labeled behavioral and social-scientific, although not entirely. Demography might be considered a separate social science or part of sociology, economics, and anthropology. Archaeology might be classed as part of anthropology or an independent social science. Geography, history, psychiatry, law, and linguistics present similar taxonomic complications. So do relations with the "intersection fields" of genetics, behavior, and society, behavioral and cognitive neurosciences, psychiatry, health, gender studies, religious studies, expressive forms, environmental/ecological sciences and technology studies, area and international studies, and urban studies and planning public policy (Smelser 2004, 48. 60 f.).

Increased heterogeneity also has implications for how disciplinarity and interdisciplinarity are represented in the classroom. In the past, they were regarded as a dichotomy, and disciplines as the major obstacles to interdisciplinary studies. Impediments and disincentives persist. However, when Joan Fiscella and Stacey Kimmel compiled the first annotated bibliography of the English-language literature, they found the "contemporary life" of disciplines and school subjects to be a major topic of discussion (1999, 10). Interdisciplinarity is a key factor in their contemporary life. School- and university-level subjects are intersecting with a host of interdisciplinary fields, from international studies to environmental studies. Heightened demands for problem solving have fostered greater interest in collaboration and the ability to work with multiple sources of knowledge. Educators are also incorporating new research into their lessons. Literature teachers are adding a new plurality of cultural texts while drawing on social history and new theories of language and meaning. Social-science and sociology teachers are infusing new understandings of behavior into the traditional curriculum. Geography teachers are using both scientific and humanistic approaches to studying the interaction of humans and their environments. Science teachers are incorporating new knowledge of genetics, evolution, and geoscience.

2. Interdisciplinary Historical Context

The promise of interdisciplinarity is widely touted. Yet, in studying interdisciplinary teaching in Brazil, Ivani Fazenda discovered the greatest contradiction lies in indiscriminate proliferation of intuitive practices. Her findings are echoed across North America and Europe. The number of educational projects with the word "interdisciplinary" in their titles has increased dramatically, a development affirmed in comparative studies of the English, French, Spanish, and Portuguese literatures (Lenoir, Geoffroy, Hasni 2001). Yet, Fazenda lamented, many projects arise from intuition or trendiness, without rules or clear intentions: "In the name of interdisciplinarity, established routines are condemned and abandoned, and slogans, nicknames, and working hypotheses are created which many times are improvised and ill-considered" (1995, 7). Lenoir, Larose, and Geoffroy concur in their critique of pseudo-interdisciplinary or "pluri-disciplinary" approaches that amount to a "destructuring eclecticism" and hodgepodge of "trial and error" techniques that are often a caricature of the interdisciplinary approach. Techno-instrumental models in the form of tricks, recipes, and routines do not substitute for a genuine synergy of contents of subject areas. Nor does the embrace of interdisciplinarity as a social need, a politically correct concept, or a justification for organizational and management strategies and pedagogical practices that do not respect educational outcomes, disciplinary structures, or learning processes (2000, 94-97, 103 f.). A fuller understanding of historical context, definition, and patterns of practice is required.

Interdisciplinary education has a long and rich history that is linked closely in schools with the concepts of "integrated" and "integrative" approaches. In 1855, Herbert Spencer used the term "integration" in *Principles of Psychology*, and, in 1896, William James used it in the first volume of *The Principles of Psychology*. Alexis Bertrand also developed a theory of integrated instruction in *L'Enseignement Integral*, published in Paris in 1898. The acknowledged "germ" of the modern integration movement was the correlation theory of German educator Johann Herbart, sometimes referred to as "integration of studies". The movement known as Herbartism was based on a set of philosophical and psychological ideas applied to instructional method that promoted connections across related subjects. Any one part could be understood in relation to the whole and to other parts (Ciccorico 1970, 60; Beane 1997, 2).

Over the course of the twentieth century, "integration" was associated with added interests and imperatives. In the 1920s, the Progressivists' social democratic vision of integration placed students' personal and social concerns at the center of educational experience. The term "integrated curriculum" also appeared in conjunction with the project approach in the 1920s, the core curriculum movement in the 1930s and problem-centered core curricula in the 1940s and '50s. In addition, "integration" was linked with the psychological process of holistic learning, personal integration, social integration, moral education, merging learning and work, a more relevant student-centered curriculum, teacher-student planning, preparation for participation in a democracy, a child-centered activity curriculum, an experience-based curriculum, and a broad-fields approach. During the 1980s and 1990s, use of the term "curriculum integration" proliferated indiscriminately as a generic term for a variety of innovative approaches that draw on more than one subject or discipline. Major examples include "thematic studies", "multidisciplinary" and "multisubject" designs, integrated units, skills across the curriculum, a social-problems approach to science education, and integrated constructs such as "social studies" and "whole language" (Clarke, Agne 1997, 13; Beane 1997, 2 f. 7. 28 f.).

The earliest proactive interdisciplinary initiatives in education date to the opening decades of the twentieth century, in the core curriculum and general education movements at both school and university levels. By the 1930s and 1940s, one of the most visible phenomena was apparent – the formation of new interdisciplinary fields. Area studies and American studies were emerging and earlier interests in comparative literature solidifying. By the 1960s and 1970s, worldwide education reforms spawned new experimental structures and approaches to teaching and learning. The new fields of ethnic, women's, environmental, urban, and science, technology, and society studies also arose. Later into the 1980s and 1990s, interdisciplinary approaches appeared more widely across the undergraduate post-secondary curriculum and the fields of cultural studies, cognitive sciences, information sciences, and communication and media studies expanded. Even this thumbnail sketch of history illustrates the plurality of activities and knowledge formations associated with interdisciplinary education.

Conceptions of interdisciplinarity also differ across school and university levels. Many interdisciplinary curricula developed at elementary- and middle-school levels, Boix-Mansilla, Miller, and Gardner caution, are actually "pre-disciplinary" since they are organized around common-sense themes that draw little on disciplinary ways of knowing. At various levels, organizational questions often dominate as well, resulting in less time devoted to questions regarding the natures and use of disciplinary and interdisciplinary knowledge as well (2000, 22 f. 32). At the school level, Grossman, Wineburg, and Beers report, the motivation and emotional concerns of students often dictate curricular choices (2000, 11). In a review of the francophone literature, Lenoir makes a further distinction between the content of "school disciplines" and "scientific disciplines." They

follow a different internal structural logic, are constituted on the basis of distinct referential systems, rely on different modes of application, and pursue different aims. In primary school, for example, “school subjects” are neither exact copies nor the result of a simple transposition of scientific knowledge. The emphasis is on the most appropriate conditions for development of integrative process and appropriate of knowledge as cognitive products in students. That aim requires arranging school knowledge into curriculum, instructional theory, and teaching strategies. The learning subject, rather than research, becomes the point of reference (1997, 78 f. 83).

Based on his experiences teaching interdisciplinarity to school teachers in Brazil, Joe Garcia (2001) identified additional differences in the emphases of theorists and teachers. Teachers share common views with theorists, agreeing on the need for disciplinary competence, systematic rethinking of practices, a view of interdisciplinarity as something to be applied, and emphasis on the role of shared projects, collective work, and integration of disciplines. Yet, they portray disciplines and the integration process differently. Theorists pay more attention to epistemological aspects of integrating disciplines as universes of knowledge that include methods and rationalities. Teachers treat disciplines more as avenues to be explored and associate them with people. They also emphasize the role of the teacher in broadening and transforming students’ worldviews. Theorists stress the design process, while teachers focus on the daily work of hands-on experience in implementing projects, including interpersonal aspects.

3. Interdisciplinary Definition

Given the variables discussed above, it is not surprising to find differences in form and definition. Metaphorically speaking, differences may be imagined as poles of a spectrum suggested by the Nuffield Foundation, bridge building versus restructuring. Bridge-building is more common and less difficult, since it preserves disciplinary identities and treats disciplines as the primary tools for interdisciplinary work. Restructuring is more radical and often embodies a critique of not only the disciplines involved but, either implicitly or explicitly, the prevailing structure of knowledge. It is not additive but transformative in an act of reinventing and refiguring (The Nuffield Foundation 1975, 42 ff.). Lenoir, Larose, and Geoffroy distinguish three levels for integration in “school interdisciplinarity” – curricular, didactic, and pedagogical. The conception of curricular organization is first and, from the point of view of training, is a matter of joining programs of study and their contents (Lenoir, 1997, 82-85; Lenoir, Larose, Geoffroy, 2000, 105).

A number of terms describe the different models of interdisciplinary curriculum design. Indeed, terminology was one of the primary issues Fiscella and Kimmel identified in the literature on foundations of interdisciplinarity (1999, 9). Differing terms reflect differing models of integration and strategies for organizing integrative curricula. The most widely used terms emanate from the typology proposed in 1970 for the first international conference on interdisciplinary teaching and research in universities, co-sponsored by the Organization for Economic Cooperation and Development (OECD) (Interdisciplinarity 1972). The most extensive international comparison of typologies has emanated from the work of the Centre de recherche sur l'intervention éducative (See especially in French: Lenoir, Geoffrey, Hasni 2001; in English: Lenoir 1997 and Lenoir, Larose, Geoffroy 2000). Lenoir, Geoffrey, and Hasni depict major forms in terms of their location along spectra of conceptual versus instrumental formulation and conservation versus dissolution of disciplines (2001, 98 f.). Numerous other technical terms have also emerged, though three keywords constitute a basic vocabulary for both a shared international and cross-level discourse as well as teacher training: multidisciplinary, interdisciplinary, and transdisciplinary.

Multidisciplinary approaches juxtapose disciplines, adding breadth and available knowledge, information, and methods. Yet, they speak as separate voices in an additive and encyclopedic mélange. Moreover, disciplinary elements retain intact. Applebee, Burroughs, and Cruz link the Multidisciplinary approach with other forms of “Correlated Knowledge”, including “complementary”, “juxtaposed”, “parallel”, “sequenced”, “webbed”, and *passive* “thematic” approaches. The defining characteristic is related concepts (2000, 95). The lowest degree of integration occurs in sequenced designs that leave students to identify connections by themselves. Team teaching does not occur typically, either. A classroom unit on climate change might be taught simultaneously in separate literature and language, geography, and science classes. Students might take separate courses dealing with urban or other issues. More intentional integrative models of studying a theme, a problem, or a question create what Rebecca Crawford Burns calls an integrative “overlay” for separate concepts and activities (1995 and 2002). This model, too, has limits. Students gain breadth of knowledge, but they do not engage in explicit analysis of disciplinary perspectives or interdisciplinary synthesis. When team teaching occurs, individuals work separately in “turn” or “tag” teaching. Exhibiting Heidi Jacobs’s notion of the “potpourri problem”, bits and pieces of knowledge are also put together from different disciplines, diminishing integrative focus and conceptual clarity (2002).

Interdisciplinary designs go further in models that Burns associates with the key actions of focusing and blending (1995 and 2002). Applebee, Burroughs, and Cruz associate the interdisciplinary approach with the active “thematic” approach, “broad-field curriculum”, and “integrated” designs (2000). Content is revised, Burns’s notion of a new “connective depth” created, and team teaching may occur. Subjects and disciplines become tools for studying a theme, a problem, a question, or an idea. Structures vary, from engaging two subjects in a single unit or course to a year-long program, or a student’s entire educational experience in an “academy”, “whole school”, or “school-within-a-school”. Likewise, a single teacher may be involved, a large team, or an entire school, department, or program.

Themes vary as well, from personal issues of identity and the body to abstract intellectual questions. For younger children, teachers often select themes related to animals and marine ecology, the planetary system, and space exploration. At varying levels of complexity across school and college, students explore themes in history (e.g. immigration, genealogy, exploration, and war), social problems (e.g. conflict, hunger, poverty, racism, AIDS, drug use, ethnic tensions, and pollution), institutions (e.g. family, community, and government), systems (e.g. transportation, the economy, and ecology and the environment), and abstract concepts (e.g. conflict, change, democracy, responsibility, and globalism). Many of these themes, as the list suggests, address cross-curricular issues in the social, political and economical world, heightening students’ understanding of the complex challenges they will face as they mature across levels of the educational system and as they become workers, citizens, and parents themselves.

The greatest degree and scope of integrative restructuring is typically associated with “transdisciplinary” approaches. In schools, this level is embodied in the historically informed model of “curriculum integration”. Disciplinary and subject boundaries are blurred and connections magnified in a new organizational framework that Robin Fogarty likens to kaleidoscope, a child’s toy in which varied and shifting images produce a new complexity of design (1991, 64). Models of “integrated curriculum”, “unified studies”, and “fusion” exhibit this commitment. Integration becomes the purpose of education, not simply a tool. In student-centered curricula, the students’ worlds, not a school- or government-mandated syllabus, become the heart of learning. Students even participate in selecting the themes and problems they will study, and they often work together collaboratively. In research and university programs, transdisciplinary approaches are also linked with new comprehensive frameworks that transcend the narrow scope of disciplinary worldviews through an overarching synthesis, such as general systems, policy sciences, feminism, cultural critique, and ecology and sustainability.

Transdisciplinarity effects Gérard Fourez’s notion of transversal mobilization. Knowledges, ideas, procedures, and consequences are used in a manner that activates “le transfert d’une discipline à l’autre”, opening new horizons: “Cette transversalité est le résultat d’une construction de connaissance et non un donné premier” (2001, 79. 82). D’Hainaut further distinguishes instrumental and behavioral forms. From an epistemological point of view, instrumental transdisciplinarity relies on a theory of unifying character or systems. It rests upon common organizing principles in the choice of concepts, methods, and strategies that can be applied to various disciplines or are common to them. Behavioral transdisciplinarity is concerned with teaching. It addresses the problem of determining the content of education, not so much by subject matters or themes that are objects of teaching but what children must be able to do and how they conduct themselves. It addresses, Lenoir stresses, the activity of the learner, thus pertaining to the psychological learning process that can be applied in any particular learning situation (D’Hainaut 1986, 12. 19; Lenoir 1997, 99 f.). The Centre International de Recherches et Études Transdisciplinaire (CIRET) is advancing a form of transdisciplinary education that, Basarab Nicolescu explains in “The Transdisciplinary Evolution of Learning”, takes into account all dimensions of the human being. It enacts the four pillars of learning articulated by Jacques Delors: learning to know, learning to do, learning to live together, and learning to be. The most complex challenge is the teaching of teachers and developing appropriate pedagogy. These imperatives are the focus of the March 2005 issue of the *Bulletin Interactif du CIRET* (#18). In addition to conceptual articles and discussions of pedagogy, didactics, and professional formation, the issue includes accounts of experiences in Europe, Brazil, Mozambique, and Romania.

4. Interdisciplinary Pedagogy and Skills

On the didactic and teaching levels of integration, Lenoir stipulates, interdisciplinarity is a matter of conception and execution of planning. From the trainees’ view, the learner is inserted into a process that calls on learning strategies (1997, 82-85). Integration and synthesis are widely regarded as the distinguishing traits of interdisciplinary versus discipline-based learning. The Interdisciplinary Studies team affiliated with Project Zero at Harvard University defines interdisciplinary understanding as “the capacity to integrate knowledge and modes of thinking in two or more disciplines to produce a cognitive advancement – e.g. explaining a phenomenon, solving a

problem, creating a product, raising a new question – in ways that would have been unlikely through single disciplinary means” (Boix-Mansilla 2005).

Lenoir defines the integration level of pedagogical interdisciplinarity as the point of controlling implementation of one or more didactic models of interdisciplinary curricular structure, linking the knowledges to be taught, and inserting them into learning situations within a given situation (1997, 89 f.). Even though integration is considered the primary action, there is no unique interdisciplinary pedagogy. The "best practices" affirm Clarke and Agne's premise that when teachers go beyond subject knowledge they prepare lessons based on a contemporary view of pedagogy (1997). Consequently, interdisciplinary education at all levels intersects with innovative pedagogies that emphasize exploration and active involvement in the process of making meaning. Teachers use innovative approaches that promote dialogue and community, problem-posing and problem-solving, and critical thinking.

The following structures, strategies, and activities are typically reported:

- team-teaching and team planning
- collaborative learning and learning communities
- clustered and linked courses
- core seminars at introductory and capstone levels
- theme or problem focus in courses
- proactive attention to integration and synthesis
- models of interdisciplinary and integrative process
- theories and methods from interdisciplinary fields
- projects and case studies
- dyads, triads, and small groups for discussion
- game and role playing
- inquiry- and discovery-based learning
- learning portfolios
- experiential- and service-learning, internships, and fieldwork
- residential living-learning experiences.

When instruction becomes more integrative, Clarke and Agne (1997) emphasize, it also becomes constructivist. The constructivist view emphasizes thinking skills, not just mastery of facts. Students are engaged in the actual *doing* of a subject or discipline, and they grapple with the cognitive conflict that occurs when working with alternative perspectives. For that reason, project work is common. Ellis and Stuen, in fact, identify projects and theme-based units as the two major approaches to interdisciplinary curriculum in schools. The project approach is linked historically to the Progressivists, who emphasized questions and "real-life" theme-oriented projects. In the 1950's, it was reinvigorated in the work of Jean Piaget. In recent years, it has gained new momentum because of heightened interest in problem-solving and decision-making skills and, from a theoretical standpoint, widening use of constructivist pedagogy (1998, 59 ff. 64).

Interdisciplinarity reconceptualizes the roles of teacher and student alike. Group work is common, involving students in cooperative learning and collaborative problem solving. The traditional teaching functions of telling, delivering, directing, and being a "sage on the stage" are replaced by the models of mentor, mediator, facilitator, coach, and guide. Teachers in an integrated school, Rebecca Burns reports, no longer think of themselves as subject specialists but as generalists who organize learning activities around essential questions, themes, or concepts (1995 and 2002). Their subject areas become sources of knowledge and skills that can be applied to larger purposes. Teachers become "connection experts", Clarke and Agne add, not "subject experts" (2002). William Newell extends this vision to the university level, calling for a better balance of disciplinary and interdisciplinary capabilities among all teachers. He also foresees a new category of interdisciplinary experts, capable of synthesizing specialized insights of disciplinary experts into a comprehensive understanding of significant problems and their solutions (2002).

Pedagogy and skills go hand in hand, echoing an important historical shift in meaning that occurred in the 1930s. Rather than designating a specific structure or a particular teaching method, "integration" came to mean a process that occurs as people interact with their environments. Likewise, philosophical focus shifted from transmitting prior notions of a unified view of commonly-held knowledge and relationships between existing fields to the creation of new integrative concepts, pedagogy, models, structures, systems, and principles, as well as the learner's capacity

to perceive new relationships (Ciccorico 1970, 62). The implications are evident in the key skills accentuated in integrative learning.

In a student-centered model of curriculum integration in schools, James Beane highlights the skills of reflective thinking, critical ethics, problem solving, valuing, self-concepting and esteeming, and searching for completeness and meaning (1997 and 2002). At the secondary level of high school, Clarke and Agne report, the fundamental learning actions are asking questions and constructing answers in a process that entails grappling with uncertainty, working with multiple criteria, and arriving at nuanced judgments and interpretations. The fundamental learning actions are asking questions and constructing answers (2002). In college, William Newell accentuates exploration and question posing, active-experiential learning, decision making and problem solving, comparing and contrasting different perspectives and synthesizing them (2002).

Teachers echo these observations in their claims for student learning, citing greater motivation to learn and to deal with complex issues and problems, a more reflective stance and ability to grasp complex concepts, increased capability of synthesizing learning into a meaningful whole, and enhanced high-level critical thinking. They also cite greater creativity and thoughtfulness, even perhaps better retention because of connectedness. The link with higher-level critical thinking is striking. Making meaning from diverse and conflicting sources is a questioning process, not a simple transmission of codified bodies of knowledge. At later levels in the education system, students become more critically reflexive of discipline. They also develop the capacity to locate and to work with pertinent information, to compare and to contrast different methods and approaches, to clarify how differences and similarities relate to a task, to discern patterns and connection, and to create an integrative framework and a more holistic understanding of a theme, question, or problem. These competencies are all vitally important in dealing with topics of civic education, equipping students for critical analysis and action in effective and responsible ways.

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Ultimately, interdisciplinary raises the most fundamental question of all. What is the purpose of education? In its highest form, interdisciplinarity is not a finite set of skills, a simple add-on, or an adjustment in the schedule. The ultimate goal is to reconstruct what is taught and how it is taught (Panaritis 1995, 624, 628). All components of the educational system, Clarke and Agne advise, are affected: from philosophy, organizational structure, management style, institutional culture, curriculum, and instruction to scheduling, tracking and sequencing, budgets, certification and licensure, teacher education and training, and professional development. Introducing new courses and requirements into a curriculum often means running two systems at once. An older system of subject structures holds fast, while a new one struggles into being (1997, 84 f.).

Writing in 1990, the British sociologist of education Basil Bernstein foresaw greater movement toward integrated codes in education as society became more fragmented and specialized. In contrast to collection codes, integrated codes are characterized by new forms of interdependence and cooperation that do not connote unity in the older sense. They call attention to a much broader process, a world-wide changing cultural configuration that places all cultural categories and boundaries at risk, highlighting the permeability of all boundaries, meanings, and domains. Increasing de-differentiation, de-insulation, and hybridization of cultural categories, identities, and previous certainties have had direct and specific effects on the entire epistemological domain of knowledge, academic disciplines, and school subjects. The formation of new boundary-crossing knowledge regions has weakened older borders and identities across disciplines and subject matters (Klein 1996). Interdisciplinarity has become more central to knowledge. It must not be peripheral to teaching training at all points of the career life cycle. Subject training will remain crucial, but dual capacity is needed based on an informed understanding of interdisciplinary contexts, definitions, curriculum design, pedagogy, and learning processes.

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