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Interdisciplinarity: An Operational Definition and Assessment Plan

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Interdisciplinary education has gained increased attention recently. Locally, Grinnell College has made interdisciplinarity a priority, as evidenced by a grant from the Howard Hughes Medical Institute (HHMI) for increasing the use of interdisciplinary education in the sciences. Grinnell College has undertaken a campus-wide Expanding Knowledge Initiative (EKI), which has aims similar to those in the HHMI grant but involving all of the academic divisions. Many other institutions of higher education also laud interdisciplinary work for its positive outcomes. However, these outcomes, often identified as skills such as “writing competency, oral communications proficiency, and computer literacy” (Field & Stowe, 2002, p.261) are seemingly taken as axiomatic and have not been supported with empirical evidence or appropriate assessment plans. Scholars such as Field and Stowe are actively trying to move interdisciplinary assessment out of its nascent stages by developing credible and reliable methods. In the spirit of this trend, this essay will discuss the nature of disciplines, create an operational definition of interdisciplinarity, address the ambiguity of assessment, and lastly, present an assessment plan.

Definition of Discipline

To understand interdisciplinarity, it is imperative to acknowledge that disciplines are defined in relation to one another and that they have unclear boundaries. Most broadly, disciplines are defined by their subject matter (Lattuca, 2001). For example, political science is concerned with the theory and practice of politics, whereas biology focuses on the study of organisms and their interactions with the environment. However, such a basic definition, simply based on subject matter, is insufficient for understanding the term *discipline*.

The *Missions of the College Curriculum* defines a discipline as:

A discrete subject and its characteristic regimen of investigation and analysis – geography, political science, psychology and English are examples. In most American colleges and universities, such realms are structurally accommodated in departments, which administer the teaching and research in the individual discipline. (Carnegie Foundation for the Advancement of Teaching, 1978, as cited in Davis, 1995, p. 3)

Similarly, Lattuca (2001) describes the current state of a discipline as being “comprised of smaller communities of scholars who coalesce around shared interests and/or methods of inquiry” (p. 2). Thus, for our purposes, the existence of a unique method and direction of inquiry constitutes a discipline. For example, both anatomy and physiology examine biological organisms, but anatomy explores their structure, and physiology explores their function. Each of these academic realms examines biological organisms. However, because these areas use differing perspectives and are using unique methodologies, they are differentiated as separate disciplines.

The definition of a discipline is variable between institutions (Field & Stowe, 2002). That is, what one institution of higher education considers a discipline, another may not consider as such. Most obviously, this difference is visible in the existence of a department—for example, at the University of Chicago, linguistics has its own department whereas at Grinnell College it does not. Even within a given field there are shifting lines between the outer boundaries of the discipline as well as within the discipline itself. For example, psychology has been pushing its outer boundaries, integrating with biology (as in neuroscience), as well as shifting inner boundaries, by creating new distinct fields of study (such as social psychology and abnormal psychology). Given these relativistic elements, universally excepted definitions of disciplines are difficult. Nonetheless, the term *interdisciplinary* depends upon a definition of *discipline*, and

clarifying those definitions remains important. Davis (2005) notes that “interdisciplinary connections assume... a disciplinary structure to begin with, that is a prior arrangement of knowledge according to patterns that have traditionally come to be called ‘the academic disciplines’” (p. 3). Thus, defining disciplines as “possessing a distinctive perspective and process for learning” helps clarify the meaning of the term *interdisciplinarity*.

Operational Definition of Interdisciplinarity

Given the above definition of a discipline, we drew from numerous scholars to formulate an appropriate operational definition of interdisciplinarity. For example, in her Project Zero assessment at the Harvard Graduate School of Education, Mansilla (2005) operationalizes interdisciplinarity as “the capacity to integrate knowledge and modes of thinking drawn from two or more disciplines to produce a cognitive advancement... in ways that would have been unlikely through a single disciplinary means” (p. 16). Davis (1995), who focuses on interdisciplinarity as it relates to team teaching, states that interdisciplinary work refers “to the work that scholars do together in two or more disciplines, subdisciplines, or professions, by bringing together and to some extent synthesizing their perspectives” (p. 5). The consensus suggests that interdisciplinarity exists when at least two disciplines and their methodologies are integrated via research or direct teaching in order to advance scholarship (Davis, 1995; Haynes, 2002; Lattuca, 2001; Mansilla, 2005). Additionally, and of equal importance, interdisciplinary work produces a Gestaltist outcome—the resulting scholarship is greater than the mere sum of its parts (Lattuca, 2001; Mansilla, 2005; Stryer et al., 2003). Mansilla articulates this view by suggesting “that an interdisciplinary ‘whole’ stands as more than the sum of its disciplinary ‘parts’” (p. 17). For example, a virologist often uses methods from both chemistry and biology to reach a greater level of understanding that could not be found using solely chemistry or biology.

This greater whole is achieved through an integrative process wherein aspects of each discipline are used to mutually inform the research or teaching process. Furthermore, differing levels of fluency and expertise can be implied by interdisciplinarity—one does not need multiple graduate degrees in order to be interdisciplinary, but, some level of fluency in a second discipline is needed to understand the methodologies encountered. This level of fluency can perhaps be determined by whether or not an individual is able to think intelligently within both disciplines (Haynes, 2002; Mansilla, 2005). Mansilla describes this level of fluency by suggesting that:

Interdisciplinary understanding is highly ‘disciplined’ – that is, *deeply informed by disciplinary expertise*. In our formulation, interdisciplinary understanding builds on knowledge and modes of thinking that are central to the work of experts in domains like biology, history, literature, or the visual arts.

An interdisciplinary explanation of a phenomenon like autism, for instance, differs from a naïve or ‘commonsense’ explanation in that it builds on insights that have survived the scrutiny of expert communities such as neurology or psychology using commonly agreed upon methods and validation standards. And while such disciplinary insights are clearly open to further revision, they embody the most reliable and up-to-date accounts of the natural and cultural world available. (p. 17, italics in original)

For example, a project employing chemistry to further biological research is interdisciplinary only if the student or researcher understands the chemistry and biology involved, the basis for integrating the two disciplines, and how that synthesis furthers knowledge.

Interdisciplinarity can be achieved in varying ways as the obstacles to it may differ depending on whether one is attempting research or instruction. When scholars do research, interdisciplinarity is often explicit—combining methods of inquiry requires active forethought

and often communication with experts in differing disciplines. In the classroom, however, it is quite possible for two different disciplines to be presented, and the integration of the differing methodologies and information bases can then be either a task for the students or overtly guided by the instructor.

Epistemological Development

The term *interdisciplinary* implies the active integration of methodologies and perspectives from multiple disciplines in the course of furthering knowledge beyond the confines of any individual discipline. Many scholars believe that interdisciplinary learning leads to a higher cognitive capacity to understand knowledge. That is, interdisciplinary learning effects the epistemological development of the learner. Specifically, Field and Stowe (2002) suggest that:

Because we believe interdisciplinarity more authentically represents the domains of knowledge and the intricate if not ineffable connections among them, we offer a hypothesis that interdisciplinarity provides a superior way to achieve desired cognitive outcomes in the areas of critical thinking as well as a variety of affective and developmental outcomes. We further contend that there may be many serendipitous and positive outcomes of interdisciplinary education that have not been completely identified or placed in the canon of desired outcomes. (p. 261)

Field and Stowe develop themes similar to those discussed by Perry (1968/1999), Baxter Magolda (2001), and King and Kitchener (1994), who predict epistemological growth during the college years. Following Field and Stowe, we hypothesize that interdisciplinary education will result in a greater increase in epistemological growth than a non-interdisciplinary education.

An early influential scholar to study epistemological development among college students was William Perry (1968/1999), whose work at Harvard University presented the first

developmental stage model of undergraduate maturation. He posited that, when confronted with the type of pluralism common at most universities, undergraduate students are forced to alter their cognitive schemata to incorporate the “limits, uncertainties, and the dissolution of established beliefs” (Perry, 1968/1999, p. 58) that they face. Following in Perry’s work, Marcia Baxter Magolda (2001) formulated the Epistemological Reflection Model (ERM), which outlines an individual’s path towards “self-authorship,” a stage in which an individual is “reshaping what they believed (epistemology), their sense of self (intrapersonal), and their relationships with others (interpersonal)” (p. 119). Mark, a participant in Baxter Magolda’s longitudinal study, articulately displays the move to self-authorship:

Making yourself into something, not what other people say or not just kind of floating along in life, but you’re in some sense a piece of clay. You’ve been formed into different things, but that doesn’t mean you can’t go back to the potter’s wheel and instead of somebody else’s hands building and molding you, you use your own, and in a fundamental sense change your values and beliefs. (p. 119)

Baxter Magolda developed the ERM during a longitudinal study, which began when the participants were undergraduates in college and progressed until they were in their thirties. The data resulting from the study indicated the existence of four ways of knowing: absolute knowing, transitional knowing, independent knowing, and contextual knowing.

Following this research path, King and Kitchener (1994) formed a comparable seven-stage model, called the Reflective Judgment Model (RJM). King and Kitchener’s RJM was influenced by over seventeen hundred interviews, specifically by the interviewee’s basis and rationale for “knowing” things. From these interviews King and Kitchener “abstracted seven distinct sets of epistemic assumptions and concepts of justification” (p. xvi). In the RJM,

reflective thinking is an essential tool by which an individual arrives at a conclusion about ill-structured problems, problems that “cannot be described with a high degree of completeness, cannot be resolved with a high degree of certainty, [and that] experts often disagree about the best solution [to]” (p. 11). King and Kitchener interviewed individuals about the way that they know and think about ill-structured problems and, subsequently, assessed their level of epistemology through the seven-stage model. According to this model, individuals progress through the seven stages, becoming more thoughtful and careful thinkers.

Each of these theories suggests a developmental progression of epistemology, yet none has suggested an event or moment which allows for the shift from one stage to another. We hypothesize that interdisciplinary learning, via its active integration of methods and perspectives from more than one discipline, can serve as a catalyst for the progression from one stage of epistemological development to another. Given this hypothesis, an assessment plan is needed to address the changes in an individual’s epistemology during the period of time during which he or she is participating in interdisciplinary learning.

Assessment

Unfortunately, proper assessment procedures have not been established to secure our, Field and Stowe’s (2002), or other scholars’ encouraging hypotheses concerning the positive outcomes of interdisciplinary learning. However, Field and Stowe have focused on addressing the difficulties of interdisciplinary assessment by identifying several of the key inhibitors: a lack of a universal definition for *interdisciplinary*, inconsistent or ill-defined expectations for learning outcomes, and an inability to define or assess a student’s level of integration and synthesis.

The following method of assessment addresses the three inhibitors of assessment identified by Field and Stowe (2002). Our assessment plan uses the operational definition of

interdisciplinarity provided above as an initial guideline for the assessment. We expect students to experience direct cognitive learning outcomes from an interdisciplinary education experience beyond those resulting from a disciplinary education. Specifically, our assessment plan aims to measure a student's epistemological development; it assumes that the positive benefits of interdisciplinary learning can be displayed directly through the student's epistemological development. Drawing on Perry (1968/1999), Baxter Magolda (2001), and King and Kitchener's (1994) theories on the development of critical thinking skills through the college years and beyond, our theory, which was indirectly suggested by Julie Thompson Klein (1996), advocates that an interdisciplinary education is a more effective way to reach positive learning outcomes and higher stages of epistemological development. While Thompson Klein only indirectly draws the connection between the benefits of interdisciplinary education and the theories of epistemological growth, she does parallel our claim by stating that:

The basic skills needed for all integrations are familiar ones: differentiating, comparing, contrasting, relating, clarifying, reconciling, and synthesizing" (Klein 1990b, p. 183). Multilogical thinking occurs in defining the task at hand, determining how best to use available approaches, and devising a working meta-language. The worldview or perspective embedded in each discipline must be extracted; its underlying assumptions must be identified, then compared when they conflict. The definition of intellectuality shifts from absolute answers and solutions to tentativeness and reflexivity.... Good interdisciplinary work requires a strong degree of epistemological reflexivity. (pp. 213-214)

Thus, we plan to bridge the gap between scholars such as Thompson Klein and epistemological theorists such as Baxter Magolda and King and Kitchener. We hypothesize that the expected

learning outcome of interdisciplinary education is that interdisciplinary students will attain higher levels of epistemological development as compared to students who do not experience interdisciplinary education.

Finally, the plan addresses the problem of assessing synthesis by returning to the operational definition of interdisciplinarity. Being interdisciplinary means that an individual is able to think about and understand the methods and perspectives being integrated. Additionally, the synthesized disciplines must form a product greater than that which either discipline would be capable of creating independently. For instance, a neuroscience student, who is attempting to understand the pathways related to anxiety in the brain from the orbital prefrontal cortex to the amygdala, might inject the rats with a tracer in their orbital prefrontal cortex and run the rodents through an anxiety-provoking maze. In order to be considered an active synthesizer, the student must understand the processes of all the integrated disciplines. Thus, he or she must understand the biological, physiological, and behavioral techniques he or she uses to assess the relationship between the orbital prefrontal cortex, the amygdala, and anxiety. An example of interdisciplinarity at Grinnell College is evident in one female student's integration of physics, art, and education in her attempt to create a hands-on lighting design course directed at individuals who know little about theater lighting design. This student is interdisciplinary because she understands and thinks about the physics and mechanics of positioning the lights (combinations of lights can produce complex and non-obvious effects which are most effectively understood via the direct application of knowledge of optics), as well as the art of theater, and the educational strategies for teaching lighting design to an inexperienced audience. Thus, if a student is able to understand the processes and how each contributes to a unique product, then he or she is considered interdisciplinary because he or she is integrating disciplines.

Our assessment plan is a direct measure of undergraduate student's epistemological development. Students participate in interviews designed to measure their epistemological development. During each interview the interviewer assesses the student's level of interdisciplinarity (Appendix A) and his or her domain-specific epistemological development by asking the subject to recall an ill-structured problem within their field of study (Appendix B); in addition, we will measure his or her epistemological development using pre-determined ill-structured problems created by King and Kitchener (1994; see our Appendix C, questions one through three) and ourselves (question four). A student's epistemological development is determined by cross-referencing his or her interview responses to a series of prompts (Appendix D) with a comprehensive rubric of epistemological development (Appendix E) based on King and Kitchener's (1994) and Baxter Magolda's (2001) models. By using these methods, we expect to be able to conclude that greater increases in epistemological development are a beneficial outcome of an interdisciplinary education.

Our proposal addresses Field and Stowe's (2002) concerns (see p. 8 of this essay) by creating an operational definition of interdisciplinarity, determining expected learning outcomes, and formulating a method for assessing integration and synthesis. Additionally, this project links research on interdisciplinary work with research on epistemological development. Of course, this project is merely one step forward for interdisciplinary assessment. Methods of assessment must be further honed and applied to interdisciplinary learning, addressing the concerns cited by Field and Stowe, and clarifying whether interdisciplinary education is a more effective way of improving critical thinking skills.

References

- Baxter Magolda, M.B. (2001). *Making their own way: Narratives for transforming higher education to promote self-development*. Sterling, VA: Stylus.
- Carnegie Foundation for the Advancement of Teaching. (1978). *Missions of the College Curriculum*. In J.R. Davis (Ed.), *Interdisciplinary courses and team teaching: New arrangements for learning* (p. 3). Phoenix, AZ: Oryx Press.
- Davis, J.R. (1995). *Interdisciplinary courses and team teaching: New arrangements for learning*. Phoenix, AZ: Oryx Press.
- Field, M. & Stowe, D. (2002). Transforming interdisciplinary teaching and learning through assessment. In C. Haynes (Ed.), *Innovations in interdisciplinary teaching* (pp.256-274). Westport, CT: Oryx Press.
- Haynes, C. (2002). *Innovations in interdisciplinary teaching*. Westport, CT: Oryx Press.
- King, P.M., & Kitchener, K.S. (1994). *Developing reflective judgment: Understanding and promoting intellectual growth and critical thinking in adolescents and adults*. San Francisco: Jossey-Bass Publishers.
- Lattuca, L.R. (2001). *Creating interdisciplinarity*. Nashville, TN: Vanderbilt University Press.
- Mansilla, V.B. (2005). Assessing student work at disciplinary crossroads. *Change*, 37, 14-21.
- Perry, W.G. (1999). *Forms of intellectual and ethical development in the college years: A scheme*. San Francisco: Jossey-Bass Publishers. (Original work published 1968)
- Stryer, L., Breslow, R., Gentile, J., Hillis, D., Hopfield, J., Kopell, N., et al. (2003). *Bio 2010*. Washington, DC: The National Academies Press.
- Thompson Klein, J. (1996). *Crossing boundaries: Knowledge, disciplinarity, and interdisciplinarity*. Charlottesville, VA: University Press of Virginia.

Appendix A

Interview Protocol Aimed at Assessing a Student's Interdisciplinary State

Does your summer research utilize *methods or measurement devices* from more than one department?

No: Move on ...

Yes: How?

Why are you using multiple methods?

What is the effect of using multiple methods?

Do you think that your research is interdisciplinary? Why?

Appendix B

Interview Protocol for Finding a Domain-specific Ill-structured Problem

Is your research based on a debate within the field?

No: Are there controversies between experts related to your research? (How about within your field more generally?)

No: move to prepared ill-structured problems

Yes: Tell me about the debate.

Appendix C

Ill-structured Problems from King and Kitchener (1994) [1-3] and Internally Developed [4]

Question One

Some counselors conduct therapy with depressed clients who desire medication as a part of their therapy. These counselors believe medication is a positive, powerful force in therapy. They conduct therapy sessions with such clients and also refer them to physicians who prescribe medications. Other counselors do not believe medications are appropriate for depressed clients. These counselors argue that counseling alone is the best way to overcome depression. They believe that the benefits of medication never outweigh the physical and psychological disadvantages of “using drugs to solve your problems.”

Question Two

Some researchers contend that alcoholism is due, at least in part, to genetic factors. They often refer to results from a number of family studies to support this contention. Other researchers, however, do not think that alcoholism is in any way inherited. They claim that alcoholism is socially determined. They also claim that the reason that several members of the same family often suffer from alcoholism is due to the fact that they share common family experiences, socioeconomic status, or employment.

Question Three

There have been frequent reports about the relationship between chemicals that are added to foods and the safety of these foods. Some studies indicate that such chemicals can cause cancer, making these foods unsafe to eat. Other studies, however, show that chemical additives are not harmful, and actually make the foods containing them safer to eat.

Question Four

On June 24th, 2005, President Bush and former President Carter independently visited and supported nuclear energy plants. They claim, along with some scientists and environmentalists, that nuclear energy is safe and that it can substantially alleviate our dependence on non-renewable energy sources. However, other scientists and environmentalists, recalling the aftermath of the Three Mile Island accident in 1979, claim that nuclear energy is inherently hazardous and that nuclear energy plants will lead to widespread and long-term environmental pollution.

Appendix D

Interview protocol prompts for ill-structured problems.

What were your first impressions of these claims? Would you take a side?

If they take a side:

What led you to that point of view?

What is the basis for your viewpoint?

How confident are you that your outlook is correct? Why or why not?

What do you think about people who have an opposing opinion?

Is there a correct answer or resolution to this debate? Why?

Can you ever conclude that one side is more correct than another? How?

If they do not take a side:

Could you ever make a decision about this issue? How would you go about this?

Can you ever know if one side is more correct than the other? How?

Is there a correct answer or resolution to this debate?

Why do experts in this field disagree about this subject?

Appendix E

Rubric to Assess Epistemological Development

Stage 1:

- Knowledge is absolute and comes from authority or personal experience.
- The truth is out there and will be known when concrete data emerges. Uncertainty and personal beliefs can exist when the facts are not all “in” yet.
- There are alternate views but that those views are wrong and their own are right.

Stage 2:

- Knowledge begins to be viewed as an abstraction not limited to concrete instances.
- They claim to know what is right for them but are unwilling to make judgments about other’s behavior or ideas.
- Person passively acknowledged contradictory evidence and sees them as not problematic.

Stage 3:

- Knowledge is relative and subjective since it is filtered through a person’s perceptions and criteria for judgment thus only interpretations of events may be known.
- Nothing can be known with certainty, but we can know within a context based on subjective interpretations of evidence (usually referred to as relativism).

Stage 4:

- Knowledge is constructed into individual conclusions about ill-structured problems on the basis of information from a variety of sources.
- Knowledge is seen as a process that requires the knower to make well-justified decisions, using principles of evaluation and proper contextualization.

Stage 5:

- Conclusions are defended as representing the most complete, plausible, or compelling understanding of an issue on the basis of the available evidence.
- The individual is an active inquirer synthesizing information, sources, and interpretations of evidence into defensible conclusions that are open to change in light of new information.

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