Assessing Interdisciplinary Learning Outcomes

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Abstract

Assessing outcomes for interdisciplinary courses and program involves establishing outcomes that interdisciplinarians typically claim for their courses and programs, identifying four cognitive abilities that the literature on cognition and instruction suggest are hallmarks of interdisciplinary learning, and showing how these abilities may be expressed in the language of assessment and assessed on both the course and program levels.

Introduction

Outcomes assessment is a pervasive reality on college and university campuses. Some faculty and administrators applaud its arrival while others deplore it—sometimes in colorful language. For example, writing in the Chronicle of Higher Education, Fendrich (2007, June 8) charges that outcomes-assessment practices are

> grotesque...scams run by bloodless bureaucrats [whose] outcome-assessment practices force-march professors to a Maoist countryside where they are made to dig onions until they are exhausted, and then compelled to spend the rest of their waking hours confessing how much they've learned by digging onions. (p. 1)

If establishing assessable student learning outcomes for disciplinary courses and programs is as hard as digging onions as Fendrich claims, it may be even harder to achieve for interdisciplinary courses and programs where there is less agreement about what interdisciplinarity is, what outcomes should be assessed, and much less about how to measure student success. According to the authors of the Teagle Foundation White Paper (2006) on interdisciplinary education at liberal arts institutions, "the biggest challenge to interdisciplinarity, particularly at the undergraduate level," is "the lack of generalisable methods for judging interdisciplinary education and its direct impacts on student learning" (Rhoten, Boix Mansilla, Chun, M., & Klein, Executive Summary). Veronica Boix Mansilla (2005), principal investigator of the Interdisciplinary Studies Project (Project Zero), Harvard Graduate School of Education, points to a related problem: the "lack of clarity" about interdisciplinary learning outcomes and "indicators of quality" (p. 16).

The purpose of this paper is to improve the clarity and quality of interdisciplinary assessment by noting outcomes that research on cognition and instruction suggests are hallmarks of interdisciplinary learning. Integrating these outcomes into course and program assessment regimes will strengthen the claim that interdisciplinary learning offers a distinctive and proven way to learn. After examining the outcomes that interdisciplinarians typically claim for their courses and programs, the paper identifies four cognitive abilities that the literature on cognition and instruction associate with interdisciplinary learning. A primary contribution of the paper is to show how these abilities may be expressed as outcomes that are assessable on both the course and program levels and the advantages of using grading rubrics to assess student achievement of these outcomes. The paper concludes by offering insights based on this analysis.

1. Learning outcomes interdisciplinarians typically claim for their courses and programs

A survey of the interdisciplinary literature on assessment yields an extensive range of outcome claims made for interdisciplinarity. [1] In his influential study of interdisciplinary curriculum development, Newell (1990) identifies core outcomes including more sensitivity to ethical issues, enlarged perspectives or horizons, ability to synthesize or integrate, more creative, original, or unconventional thinking, more humility or listening skills, and sensitivity to bias (pp. 70-71). Other writers on interdisciplinary outcomes assessment have generally subscribed to these outcomes and have added to them. Field, Lee, and Field (1994), for example, add tolerance of ambiguity or paradox, critical thinking, a balance between subjective and objective thinking, an ability to demythologize experts, and increased empowerment (p. 70). [2] Cornwell and Stoddard (2001) include the abilities "to see new and different questions and issues," and "draw on multiple methods and the knowledge to address them" (p. 162). [3] These writers substantially agree with Newell that integration is "fundamental to any 'successful' interdisciplinary program" (Rhoten et al., 2006, pp. 3-4). The writers of the White Paper (2006) consider "the ability to synthesize or integrate" as the "hallmark of interdisciplinarity" (p. 4). [4]

Some outcomes typically claimed for interdisciplinary learning are also claimed for disciplinary and multidisciplinary learning. For example, disciplines in the liberal arts and the humanities typically claim "critical thinking" as an important outcome, as do the natural sciences, and the applied fields. [5] This collective claim to critical thinking raises the question: How do interdisciplinary approaches contribute to the development of this key cognitive skill in ways that are different from or superior to single-subject approaches? "For a learner to be truly empowered through critical thinking," says Toynton (2005), "more than one context or one discipline needs to be encountered." If interdisciplinarians insist on including "critical thinking" to the learning outcomes at the program level, he asserts, they should make clear that the development of this skill requires viewing "the approaches, products, and processes" of relevant disciplines "from a detached and comparative viewpoint" (p. 110). [6]

2. Cognitive abilities attributable to interdisciplinary learning drawn from research on cognition and instruction

From the literature on cognition and instruction, it is possible to identify four cognitive abilities that interdisciplinary learning fosters. These include the ability to (1) develop and apply perspective-taking techniques, (2) develop structural knowledge of problems appropriate to interdisciplinary inquiry, (3) integrate conflicting insights (i.e., expert views) from two or more disciplines, and (4) produce a cognitive advancement or interdisciplinary understanding of the problem.

Develop and apply perspective-taking techniques

One result of repeated exposure to interdisciplinarity is the ability to apply perspective-taking techniques. [7] Perspective-taking or the use of multiple perspectives involves understanding alternative viewpoints—including disciplinary-based viewpoints—on a given issue (Baloche, Hynes, & Berger, 1996, p. 3). Perspective-taking is an approach commonly suggested for assembling new sets of potential solutions to a given problem (Halpern, 1996, pp. 1, 21; Galinsky & Moskowitz, 2000). [8] Interdisciplinarity helps students to

> move developmentally from a clear understanding of the differences between disciplines and their perspectives on a problem to distinguishing the essential characteristics of disciplines—to understanding their discrete domains of

usefulness, what kinds of questions they ask, and their rules of evidence. (Baloche, Hynes, & Berger, 1996, p. 3)

By contrast, discipline-specific approaches to learning frequently fail to demonstrate how a particular discipline interfaces with another when they focus on the same problem (Ivanitskaya et al., 2002, p. 96). Researchers caution that students presented with information in disciplinary isolation tend to acquire knowledge in disparate categories (Humpreys et al., 1981). The result, they say, is that they "may fail to perceive, or even question, the overlapping values or questions raised by different disciplines" or knowledge formations when addressing a particular problem (Ivanitskaya et al., 2002, pp. 96-97).

Develop structural knowledge of problems appropriate to interdisciplinary inquiry

By focusing on a problem or core theme as is typical of interdisciplinary courses, interdisciplinary learning readily facilitates the development of structural knowledge which is an understanding of higher-order relationships and organizing principles (Goldsmith & Johnson, 1990). Structural knowledge is developed by acquiring declarative knowledge (factual information) and procedural knowledge (process-based information) that is used for problem-solving or step-by-step task completion (Anderson, 1982). In interdisciplinary terms, structural knowledge is developed from different knowledge domains as students focus on a particular problem or topic. For example, students studying the roots of animosity between Palestinians and Israelis will need declarative knowledge of both cultures such as key events and the defining elements of the faith traditions of Islam and Judaism to understand the several points of conflict between the two societies. But students will also have to develop adequacy in the procedural knowledge of relevant disciplines whose experts have written on the subject. The structural knowledge essential to interdisciplinary courses promotes learners' ability to assess critically the relationships among the relevant disciplinary perspectives "and evokes a deeper cognitive analysis of the core theme" of the course (Ivanitskaya et al., 2002, p. 99).

Interdisciplinary learning leads to "complex, internalized organization of knowledge" (p. 99). Goldsmith and Kraiger (1996) call this organization of information a "knowledge structure" or "schema," or "mental model," or "conceptual framework." A knowledge structure is an "internalized framework of all the relevant perspectives, concepts, ideas and methods of inquiry making up the knowledge domain [i.e., discipline] and giving it meaning" (Ivanitskaya et al., 2002, p. 99). These constructs represent a central tenet of cognitive science: that the organization of knowledge is at least as important as the quantity of knowledge acquired in helping the individual to determine when and how a set of declarative facts applies to a particular situation (Dorsey, Campbell, Foster & Miles, 1999, p. 32). Students who have good knowledge structures when confronting a practical and/or complex problem tend to recall larger blocks of integrated knowledge rather than smaller subsets of information (Wyman & Randel, 1998, p. 252).

Integrate conflicting insights (i.e., expert views) from two or more disciplines

A third result of interdisciplinary learning is that it "enhances students' capacity to integrate conflicting insights from two or more disciplines" (Boix Mansilla, 2005, p. 16). Integration, a hallmark of interdisciplinary learning, involves identifying and blending knowledge from relevant disciplines to produce a more comprehensive understanding of a particular problem or intellectual question that is limited in time to a particular context that would not be possible by relying on a single disciplinary approach (Repko, 2008, pp. 23, 343).

As a distinctive approach to learning, interdisciplinary study guides students beyond simpler forms of knowledge acquisition to "a deeper assimilation of cross-disciplinary concepts" (Ivanitskaya et al., 2002, p. 97). [9] Brain research, says Lake (1994), "points to interdisciplinary learning [and] thematic teaching" (p. 6). For example, students in an interdisciplinary program are more likely to recall a particular historical period if they do the work of integrating insights

from the visual arts, musical expression, cinema, poetry, and philosophical and political events of the period. Of course, the extent and quality of integration achieved will depend on the level of the course and the instructor's command of the interdisciplinary research process.

Produce a cognitive advancement or interdisciplinary understanding of a problem

A fourth result of interdisciplinary learning is that it develops students' ability to use integrated knowledge and modes of thinking to "produce a cognitive advancement." This, explains Boix Mansilla (2005), is the ability to explain a phenomenon, solve a problem, create a product, or raise a new question "in ways that would have been unlikely through single disciplinary means [italics added]." Interdisciplinary integration, she says, is a means to an end, not an end in itself. This "end" or result or product is an "interdisciplinary understanding" or "cognitive advancement" (p. 16). Four core premises underlie this concept. First, "it builds on a performance view of interdisciplinary understanding—one that privileges the capacity to use knowledge over that of simply having or accumulating it [italics added]" (pp. 16-17). Second, the understanding is highly disciplined, meaning that it is "deeply informed by disciplinary expertise [italics added]." Third, the understanding is achieved through the integration of disciplinary perspectives. These perspectives are not merely juxtaposed but "actively inform one another, thereby leveraging understanding." Finally, interdisciplinary understanding is purposeful in that it produces a cognitive advancement such as explaining a phenomenon, creating a product, raising a new question, generating a new insight, proposing a solution, providing an account, or offering an explanation (pp. 16-17).

3. These four cognitive abilities expressed as learning outcomes

These four cognitive abilities may be expressed as learning outcomes at the program level as follows: The student will

- demonstrate the ability to engage in perspective-taking
- develop structural knowledge pertaining to the course problem or theme
- integrate knowledge and modes of thinking drawn from two or more disciplines
- produce an interdisciplinary understanding of a complex problem or intellectual question

These same four cognitive abilities, slightly modified, may be expressed as learning outcomes at the course level. For example, in an introductory course, students would be challenged to

- view the course theme, issue, problem, or question from the perspective of two disciplines (i.e., use disciplinary-based [and conflicting] perspectives to better understand a problem)
- perceive connections between the two knowledge (i.e., disciplinary) domains that pertain to the course problem or theme
- integrate conflicting disciplinary insights and viewpoints
- produce a more comprehensive understanding of the course problem or theme and test it by proposing a holistic solution

These outcomes should be integrated with other learning outcomes appropriate to an introductory course. These may include explaining what interdisciplinary studies is, identifying the skills and traits characteristic of interdisciplinarians, tracing the origin of interdisciplinary studies, describing the role of the disciplines in interdisciplinary work, explaining how the perspectives of different disciplines interpret and influence understanding of a problem, identifying the defining elements of disciplines and explaining how these are of interest to interdisciplinarians, demonstrating oral competency through participation in a group project, demonstrating active involvement in learning, and demonstrating the ability to cope with a new, complex, or difficult problem by writing an integrative essay.

4. How to assess these four hallmark abilities

The challenge for instructors, of course, is how to assess these four hallmark abilities. There are at least two ways of doing this. The first is to administer an Entrance Survey and an Exit Survey at the beginning and end of each course. The surveys are identical except for the title and may profitably use a likert scale. These surveys ask students if they are able to demonstrate each of the four cognitive abilities. Other abilities may be included. For example, students beginning an introductory course typically admit being unable to demonstrate these four abilities. However, at the end of the course, these same students taking the same survey (but labeled "Exit Survey") typically affirm that they are able to demonstrate these abilities. The value of this data is that they are derived from student perceptions of their abilities measured against the learning outcomes for the course. Student perceptions may also be compared to actual student performance.

The student survey approach may be used in tandem with a second and more sophisticated approach which involves developing grading rubrics for each course assignment. Rubrics are explicit sets of criteria and expectations (Vars, 2002, p. 69). There are several advantages to using grading rubrics: They specify the course learning outcomes that apply to a given assignment or project, they provide a detailed list of performance expectations for students to follow (if the rubric is provided to students beforehand) when doing the assignment, they help faculty to apply these criteria and expectations more consistently, they provide feedback to students that is far more granular and uniform compared to letter grading, and, most importantly, they provide the data that are essential to perform meaningful assessment of course outcomes.

Once course outcomes have been established, developing grading rubrics for interdisciplinary assignments is a relatively easy task. Their development involves making two decisions: how each assignment addresses one or more of these hallmark abilities or outcomes, and the weight (i.e., points) that should be assigned to each hallmark outcome compared to other learning outcomes. For example, the instructor of an introductory course may use the first assignment to develop and assess students' perspective-taking ability. This assignment may involve students viewing a problem such as the causes of rising gasoline prices from three disciplinary perspectives. After reading about authoritative insights (i.e., expert views) into the problem from, say, environmental science (that addresses the risks to the environment of drilling in ecologically sensitive areas), geology (that identifies the location and types of oil deposits), and economics (that examines the rising global demand for oil), students may be asked to write an essay explaining how viewing this problem from these different and conflicting perspectives broadens their understanding of it. The grading rubric for this essay may weight the ability to demonstrate understanding of perspective taking at, say, 25% of the total value of the assignment with the remaining points allocated to other abilities such as writing conventions, critical thinking, and so forth. A rule of thumb is to assess each hallmark outcome at least twice during a course so that the progress of the class (and even of individual students) can be measured. Comparing student scores on work performed early in the course with scores near or at the end of the course should indicate whether the course is fostering these key abilities (Vars, 2002, p. 69). More advanced interdisciplinary courses will approach each of these hallmark outcomes with greater sophistication and in different ways, but the process of assessing them is essentially the same. Student performance on the comprehensive assignment at the end of the course constitutes a valid assessment of overall student success in developing the four hallmark abilities.

Assessing the interdisciplinary program as a whole involves, primarily, working with two sets of data. The first is the Exit Survey data from each course in the program. For example, Exit Survey data from a senior level course should show a very high level of confidence in student ability to demonstrate these cognitive abilities as compared to introductory level students. The second set of data is from the grading rubrics. For example, if a program includes an introductory, an intermediate, and a capstone course, the grading rubrics used in each course should show the progressive development of students' ability (as a whole) to demonstrate these cognitive abilities in increasingly sophisticated contexts.

5. Insights that emerge from this examination of learning theory research

Four insights emerge from this discussion of interdisciplinary learning outcomes and how to assess them. First, the literature on cognition and instruction shows that interdisciplinary learning promotes higher order cognitive abilities that are its hallmarks. [10] Second, translating these cognitive abilities into the language of assessment (i.e., as learning outcomes) is relatively easy. Third, these hallmark outcomes can be integrated with outcomes typical of interdisciplinary learning on the course and program levels. Fourth, it is now possible for interdisciplinarians to develop assessment measures that are more interdisciplinary than disciplinary, and produce data that shows that interdisciplinary learning is a valid and distinctive approach to student cognitive development, and thus deserving of a secure place in the Academy.

Endnotes

[1] According to Lattuca, Voigt, and Fath (2004), there is a notable "lack of empirical evidence to support claims about interdisciplinary courses" and "little theorizing about how interdisciplinarity might encourage learning" (p. 24).

[2] The study by Field, Lee, and Field (1994) draws heavily on the work of Newell & Green, 1982, p. 29, Newell, 1990, pp. 70-71, and Newell, 1992, pp. 217-220. In his extensive writing on curriculum and assessment, Newell consistently advocates linking curriculum development with identifying and assessing learning outcomes characteristic of interdisciplinary learning (1994, p. 50; Klein & Newell, 1997, pp. 406-411; Newell, 1999, p. 19; 2001, pp. 196-199).

[3] They also include "radical revaluing [of] one's own inquiry to incorporate the questions, methods, and perspectives of others, to perceive the partiality of disciplinary practices," development of a "Creole language and culture," and "a new set of discourses and practices which draws on the original ones but is not reducible to them" (p. 162). Newell (2001) adds the ability to shift "from concrete, either/or, authority-based thinking, through simple relativism, to a more critical relativism with commitment," and confront "the tension between conflicting perspectives" (pp. 199-200).

[4] However, this typically professed emphasis on integration contrasts sharply with actual practice: According to Vars (2002), "programs designed to promote integration or synthesis are rare" (p. 70). Newell (2001) emphasizes that interdisciplinary learning provides "synthesis that complements disciplinary analysis, breadth to accompany its depth, and real world personal application to go with its abstract theory" (p. 197).

[5] To think critically is to "see a thing clearly and truly so that only the good in it may be distinguished from the bad and the perfect from the imperfect, but also that it as a whole may be fairly judged and valued" (Webster's Dictionary of Synonyms). According to Paul and Elder (2005), critical thinking involves intellectual discipline and rigor as well as originality and productivity (p. 4). Since all disciplines lay claim to critical thinking as a learning goal, interdisciplinary studies gains little leverage by making a similar claim. This is not to suggest that interdisciplinarity should minimize its importance. Rather, it is to suggest that interdisciplinarians should be explicit about the unique ways interdisciplinarity contributes to the development of critical thinking. For a critique of the assumptions underlying the "unproblematized" view of knowledge "wherein the evaluation of claims can be undertaken using primarily 'objective' criteria pertaining to logical soundness and sufficiency of evidence," see Jones and Merritt, 1999, p. 336.

[6] For Toynton (2005), "critical awareness" refers to "explicit criticality" and also "values awareness" defined as the appreciation of the insights afforded by the philosophy of the discipline (p. 110). An example of the kind of critical thinking Toynton is advocating for interdisciplinarity involves students evaluating and integrating the conflicting epistemological claims concerning environmental issues made by disciplines and subdisciplines in the natural sciences, social sciences, and the humanities (Jones & Merritt, 1999, p. 336). Critical thinking

skills, argues Kelder (1992), "can be taught most effectively in an interdisciplinary curricula" (p. 10).

[7] I am indebted to my colleague Cindy Atha-Weldon for her insights into research on perspective-taking and how it is supportive of interdisciplinary learning.

[8] Perspective-taking may refer either to the act of role playing whereby one assumes a variety of personality traits to better understand a certain situation or to the temporary mental assessment of an alternative viewpoint about a specific issue (Wyl, 1993). Depending on the problem, the interdisciplinarian may use either conception of perspective-taking.

[9] The extensive literature on brain research supports this claim showing, for example, how the brain "actively seeks patterns and searches for meaning through these patterns" (Schomaker, 1989, p. 13). The brain integrates new knowledge on the basis of previous experiences and the meaning that has developed from those experiences. It processes many things at the same time, and holistic or integrative experiences are recalled quickly and easily (Cromwell, 1989; Caine & Caine, 1991). Caine and Caine (1991) state that search for meaning and patterns is a basic process in the human brain. In fact, the brain may resist learning fragmented facts that are presented in isolation.

[10] In 2000, an interdisciplinary team of cognitive psychologists, curriculum specialists, teacher educators, and researchers updated Benjamin Bloom's classic taxonomy of levels of learning. They identified six levels within the cognitive domain, from the simple recognition or recall of facts at the lowest level through increasingly more complex and abstract levels, leading ultimately to the highest order ability, creating (Anderson et al., 2000).

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