

Teaching Methods

Proposed Learning Outcomes for Four-year Horticulture Programs in the United States

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SUMMARY. Most institutions that offer a degree in horticulture have established a set of learning outcomes for the major or are in the process of doing so. Because horticulture programs are being subsumed into larger entities, and because there is no process for providing consistency of expectations for horticulture majors, a group of horticulture administrators from across the United States initiated an effort to develop a common set of learning outcomes that would be appropriate for any four-year horticulture program. The intent was to identify learning outcomes that could be made more specific for an institution's local conditions and capacities, or expanded to accommodate broader plant science-type majors. Five outcomes with specific goals were identified. An increasing level of higher-order thinking skills is associated with later learning outcomes. The outcomes are knowledge acquisition; knowledge integration; synthesis, creativity and problem-solving; communication; and demonstration of professionalism and proficiency. Adopting these learning outcomes can provide students with guidance in choice of major, faculty with a tool for curriculum development and program assessment, and employers with expectations for new horticulture graduates.

Learning outcomes are an expected component of most academic majors at U.S. universities [Association of Public and Land-grant Universities (APLU), 2009; U.S. Department of Education, 2006]. Students are expected to learn as a result of instruction based on a predetermined set of measurable outcomes (Krathwohl, 2002). Having documented outcomes creates expectations for students and aids in their choice of major (Burden and Byrd, 2003;

Krathwohl, 2002). They provide a roadmap for curriculum development and a framework for assessment of student learning (Association of American Colleges and Universities, 2010). Learning outcomes are usually developed for specific institutions based on available resources, current personnel, and the local context. However, students interested in a horticulture career must be broadly educated and prepared for a myriad of opportunities that exist throughout the country and world (APLU, 2009). In addition, employers increasingly indicate students are showing a dearth of skills in key areas, such as communication, and ability to engage and interact with others (VanDerZanden and Reinhart, 2009). Horticulture involves not only science, but also aesthetics, public education, business

practices, and considerable human interaction. For this reason, learning outcomes developed for other scientific disciplines may not be sufficiently broad for a horticulture curriculum.

Learning outcomes should incorporate multiple levels of learning, ranging from lower- to higher-order thinking skills (Anderson and Krathwohl, 2001; Bloom et al., 1956). The original taxonomy of learning objectives includes knowledge, comprehension, application, analysis, synthesis, and evaluation (Bloom et al., 1956). Fink (2003) described a new "taxonomy of significant learning," emphasizing not just acquisition of knowledge, but also the search for meaning and coherence inherent in the human dimension, and the need to go beyond content mastery to include personal and social implications of what has been learned.

Learning outcomes, as defined by the Cornell University Center for Teaching Excellence (2012), are "measurable statements that articulate what students should know, be able to do, or value as a result of taking a course or completing a program." Learning outcomes are recommended for guiding overall educational programs, whereas leaving ample space for individualized decisions about more specific learning objectives. For example, a learning outcome might indicate students should understand plant physiology. Depending on individual courses, professors, or universities, a course may focus student learning on specific plants as models of physiology, such as tulip (*Tulipa* sp.), corn (*Zea mays*), or sequoia (*Sequoia* sp.).

More practically, horticulture departments across the country are disappearing as stand-alone units and are being merged and integrated with other plant-related departments. Many horticulturists fear that horticulture as a major and career track will be lost with organizational changes in academic institutions, and acknowledge the challenge of adapting the major in ways that are appealing to the current generation of students, many of whom are unfamiliar with the major, or associate it with low pay and physical labor. A discussion was started among academic leaders about the need to develop learning outcomes with wide applicability for four-year horticulture programs in the United States. Broadly accepted

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learning outcomes would help maintain a horticultural identity, lend credibility to programs, and ensure some common knowledge, skills, and understandings among horticulture graduates or horticulture programs.

Methods

At the 2011 American Society for Horticulture Science (ASHS) administrator's meeting in Waikoloa, HI, a group of department chairs discussed the desirability of having a common set of learning outcomes for the horticulture major that all institutions could use. Many institutions had recently developed these, were in the process of doing so, or were expected to do so. In May 2012, representatives from horticulture departments across the country met in Ithaca, NY, as part of the annual North Central Administrator's Coordinating Committee (NCAC-4) for the purpose of developing a common set of learning outcomes that would be appropriate for any four-year horticulture major program. Twenty-nine department chairs and/or teaching

coordinators (Table 1) convened for 2 d in a facilitated discussion. Representatives were from every region of the country, from land-grant and non-land-grant institutions, and from both two- and four-year programs. Learning outcomes were solicited before the meeting from many institutions who have already established them, and these were made available to the group for consideration. Input was also solicited from members of the Certified Professional Horticulturist Board.

Since representatives came from departments having various configurations (with landscape architecture and design, crop science and agronomy, plant science, forestry), a first step was to agree on a definition of horticulture. The following working definition was used to define the parameters of the work. Horticulture: using plants to provide healthy whole foods, to build sustainably designed landscapes and to promote human health and well-being.

After extensive deliberation and discussion, outcomes were developed,

edited, and then shared with the group for comment. The edited version was then presented as a poster at the 2012 ASHS meetings in Miami, FL, where meeting participants were encouraged to make additional edits directly on the poster. These edits were incorporated into the final version of the learning outcomes resulting in a final product that received input from a wide and diverse group within the horticulture community.

Results and discussion

Learning outcomes were organized into five broad topics, each building on a foundation established by the previous ones (Table 2). The first outcome considers the acquisition, integration, and application of plant-science knowledge expected for horticulturists. This knowledge is often taught in formal classes and through books. The goals under this outcome are deliberately general so appropriate location-specific subgoals can be incorporated for various sorts of programs. Knowledge acquisition, remembering facts and definitions, and understanding principles are the bottom two levels of Bloom's taxonomy (Bloom et al., 1956), yet are fundamental for communicating concepts within the discipline.

The second outcome addresses the need to show competency within horticultural systems that are, by their nature, interdisciplinary. A competent horticulturist must be broadly knowledgeable, have the capacity to integrate knowledge across a range of disciplines (e.g., business, soils, pathology), and have the ability to actually perform physical tasks that require practice and training (e.g., grafting). This is a higher-order task than knowledge acquisition, and corresponds to the third level of Bloom's taxonomy where the application of knowledge and concepts must be demonstrated.

The third outcome encourages students to develop creative skills to solve problems and improve current systems. Such higher-order thinking builds on the previous two outcomes and moves the student to a level of competence on which a career can be based. The ability to solve problems ensures that a student truly comprehends how systems work and can intervene to make improvements or correct deficiencies. The highest level of learning according to Anderson and

Table 1. List of contributors and associated institutions who convened in 2012 to develop proposed learning outcomes for a four-year horticulture program.

Representative	Institution
Auge, Robert	University of Tennessee, Knoxville
Azarenko, Anita	Oregon State University, Corvallis
Bailey, Douglas	University of Georgia, Athens
Baird, William	Michigan State University, East Lansing
Brown, Susan	Cornell University, Geneva, NY
Brown, Wyatt	California Polytechnic State University, San Luis Obispo
Collins, Michael	University of Missouri, Columbia
Compton, Michael	University of Wisconsin, Platte
Dole, John	North Carolina State University, Raleigh
Ferriss, Terry	University of Wisconsin, River Falls
Goldman, Irwin	University of Wisconsin, Madison
Hoover, Emily	University of Minnesota, St. Paul
Joly, Robert	Purdue University, West Lafayette, IN
Khalil, Aida	Morrisville State College, Morrisville, NY
Layton, Patricia	Clemson University, Clemson, SC
Marini, Richard	The Pennsylvania State University, University Park
Maynard, Brian	University of Rhode Island, Kingston
McAvoy, Richard	University of Connecticut, Storrs
Midden, Karen	Southern Illinois University, Carbondale
Nonnecke, Gail	Iowa State University, Ames
Paull, Robert	University of Hawaii, Manoa
Phillips, Jerry	Morehead State University, Morehead, KY
Pritts, Marvin	Cornell University, Ithaca, NY
Pulte, Andrew	University of Tennessee, Knoxville
Roper, Teryl	Utah State University, Logan
Sargent, Steven	University of Florida, Gainesville
Stanko, Carolyn	Niagara County Community College, Sanborn, NY
Williams, Kimberly	Kansas State University, Manhattan

Table 2. Proposed learning outcomes for a four-year horticulture program in the United States.

Learning outcome 1: Acquire, integrate, and apply knowledge of plant science to managed systems
Goal 1. Use multiple sources, including current and older literature, to find, evaluate, organize, and manage information related to horticultural systems
Goal 2. Apply scientific methods to test hypotheses
Goal 3. Demonstrate competence with both laboratory and field-based technologies used in modern horticulture
Goal 4. Apply concepts of plant biology, systematics, ecology, and genetics to manage and improve plants and their products
Learning outcome 2: Demonstrate interdisciplinary knowledge and competency in managing horticultural systems
Goal 1. Assess soils, soil health, fertility, water, and site limitations
Goal 2. Recommend and use appropriate application methods, materials, and diagnostic skills for addressing soil constraints and irrigation, nutrient, stress, and pest management issues
Goal 3. Assess potential and evaluate realized interactions with the abiotic and biotic environment in which plants are grown
Goal 4. Recommend appropriate, effective and integrated approaches to produce and maintain high-quality food and ornamental crops
Goal 5. Apply principles of accounting, business law, labor, marketing, and personnel management to a horticultural business and contribute to developing the various components of a business plan
Learning outcome 3: Synthesize knowledge and use insight and creativity to better understand and improve plant systems
Goal 1. Anticipate and recognize problems, identify causes of those problems, quantify potential impacts, analyze options, identify viable solutions to the problems, and evaluate actions and consequences of treatments and interventions
Goal 2. Develop, identify, and employ best management practices that lead to sustainable solutions and outcomes
Goal 3. Understand how global issues including climate change, energy use, water availability, and/or food safety impact the sustainability of horticultural systems locally, nationally, and globally
Learning outcome 4. Appreciate and communicate the diverse impacts of horticulture on people
Goal 1. Communicate effectively with various audiences using oral, written, and visual presentation skills, and contemporary networking/social media technologies
Goal 2. Describe the various ways plants impact human well-being (mental: psychological and restorative; physical: medicinal and physiological)
Goal 3. Describe and assess the influence of plants and their management on environmental sustainability and restoration
Goal 4. Quantify the economic importance of plants in managed ecosystems and the impact of horticultural crops in food systems
Goal 5. Describe the social, spiritual, and cultural importance of plants to historical and contemporary communities of people
Learning outcome 5. Demonstrate professionalism and proficiency in skills that relate to horticulture
Goal 1. Demonstrate leadership and the ability to collaborate and work in teams
Goal 2. Demonstrate a high level of personal and social responsibility
Goal 3. Develop a plan for life-long learning as it relates to career choice and professionalism
Goal 4. Develop thoughtful, clear, and consistent perspectives on ethical and moral issues related to horticulture
Goal 5. Demonstrate knowledge of a range of cultures, values, and political perspectives relevant for living in a global community
Goal 6. Plan, engage, and learn from actions that demonstrate civic responsibility to community and society

Krathwohl (2001) is when a student can analyze, evaluate, and create a solution to a problem.

The fourth outcome sets an expectation that graduates will be able to communicate about more than just the science behind horticulture, but also about the social, spiritual, and cultural importance of plants. Students should be conversant about how plants contribute to sustainability and economic development. The audience for these communications should be much broader than the professors who teach the courses. Students should be able to communicate with audiences of varying technical expertise, and be able to relate their understandings to the larger society in which they live. Fink (2003) argued

that this dimension to learning ought to complement Bloom's taxonomy.

Finally, horticulture graduates ought to have developed leadership skills, learned how to work in teams, and exhibit a high level of professionalism and personal responsibility. They need to appreciate diversity and be able to function outside of the dominant culture. They need to take principled positions on issues that have ethical implications, and be able to present their point of view intelligently and logically. Modern leadership training seeks to develop moral courage, emotional intelligence, and appreciation of diversity (Daft, 2005). Although a student in a four-year horticulture program is not likely to develop and practice all of the skills

associated with leadership in the profession, programs should seek to provide opportunities to nurture students as they seek to acquire some of the more important leadership skills. Most importantly, leaders understand that learning does not end with the four-year degree, but continues throughout one's life (Daft, 2005).

Not all graduates will meet all of these outcomes, but every student can aspire to meet them. All horticulture programs, including the smallest of programs, should be able to provide opportunities to achieve within each outcome. And, because learning outcomes are a useful tool for evaluating program effectiveness (Middle States Commission on Higher Education, 2007), all horticulture programs

could evaluate their teaching efforts with this framework of learning outcomes in mind.

We propose these learning outcomes (Table 2) be adopted by programs that have not yet established formal learning outcomes, and encourage those institutions with existing outcomes to consider if additional outcomes and goals are warranted, or if outcomes should be modified. Wide adoption of these learning outcomes, or similar ones, would help prospective students understand the field of horticulture, strengthen the value of a horticulture degree, and, ultimately, enhance the horticulture profession.

Literature cited

- Anderson, L.W. and D.R. Krathwohl. 2001. *A taxonomy for learning, teaching, and assessing: A revision of Bloom's taxonomy of educational objectives*. Longman, New York, NY.
- Association of American Colleges and Universities. 2010. *Rising to the challenge: Meaningful assessment of student learning*. 17 Feb. 2013. <<http://www.eric.ed.gov/PDFS/ED519804.pdf>>.
- Association of Public and Land-grant Universities. 2009. *Human capacity development: The road to global competitiveness and leadership in food, agriculture, natural resources, and related sciences (FANRRS)*. 17 Feb. 2013. <<http://www.eric.ed.gov/PDFS/ED519804.pdf>>.
- Bloom, B.S., M.D. Engelhart, E.J. Furst, W.H. Hill, and D.R. Krathwohl. 1956. *Taxonomy of educational objectives: The classification of educational goals*. Longmans, New York, NY.
- Burden, P.R. and D.M. Byrd. 2003. *Methods of effective teaching*. Pearson Education, New York, NY.
- Cornell University Center for Teaching Excellence. 2012. *Setting learning outcomes*. 17 Feb. 2013. <<http://www.cte.cornell.edu/teaching-ideas/designing-your-course/setting-learning-outcomes.html>>.
- Daft, R.L. 2005. *The leadership experience*. Thompson, Mason, OH.
- Fink, L.D. 2003. *Creating significant learning experiences: An integrated approach to designing college courses*. Jossey-Bass, Hoboken, NJ.
- Krathwohl, D.R. 2002. A revision of Bloom's taxonomy: An overview. *Theory Pract.* 41:212–218.
- Middle States Commission on Higher Education. 2007. *Assessing student learning and institutional effectiveness: Understanding Middle States expectations*. 17 Feb. 2013. <http://www.msche.org/publications/Assessment_Expectations051222081842.pdf>.
- U.S. Department of Education. 2006. *A test of leadership: Charting the future of U.S. higher education*. 17 Feb. 2013. <<http://www2.ed.gov/about/bdscomm/list/hiedfuture/reports/final-report.pdf>>.
- VanDerZanden, A.M. and M. Reinert. 2009. Employer attitudes and perceptions of job preparedness of recent Iowa State University horticulture graduates. *HortTechnology* 19:647–652.