Teaching Methods

Fostering Creativity in the Horticulture Classroom

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SUMMARY. Creativity is considered important for success in most disciplines. Research has shown career accomplishment to be more correlated with scores of creativity than with standard measures of intelligence. Creativity is positively correlated with one's ability to adapt to new situations and succeed in today's world. Horticulture provides a rich context for creative expression, given that it lies at the intersection of science, art, and the humanities. Yet, fostering creativity is often not emphasized in plant science curricula nor identified as a central learning objective. The goals of this paper are to help instructors identify practices that promote creative expression in their classrooms, offer examples of classroom exercises that allow students to express creativity within a plant science context, and provide direction for assessment. From the literature, we identified 10 criteria that characterize behaviors, practices, and attitudes that are considered components of creativity. Then, we shared these criteria with the horticulture faculty at Cornell University, asking for examples of classroom exercises in which these creativity criteria are reflected. Through our observations of submitted examples and comments from instructors, it is clear that class activities that promote creative thought are prevalent, but often not recognized as such by instructors. Classroom norms emphasize scientific knowledge and vocational skills, but it is not the norm to openly promote, encourage, and enhance creative skill use and development. Assessing creativity in students is challenging because there are no widely accepted criteria for evaluating it, and defining exactly what to measure can be subjective. We provide suggestions for how to think about assessing creativity in the classroom.

Analytical, practical, and creative abilities are three sets of competencies considered requisite to success in any profession (Jackson, 2004). The first two sets tend to be emphasized in the classroom, whereas the development of creative

competencies are not often explicitly taught nor listed as a learning outcome for university students. Creativity is recognized when it is seen, but it is hard to define (Mitchell et al., 2003). Csikszentmihalyi (1996) defines creativity as "any act, idea, or product that changes an existing domain, or that transforms an existing domain into a new one." Creative individuals often see concepts in novel ways or bring new interpretations to bear on what seems obvious to others. Longitudinal studies of students who scored high in creativity assessments have shown a correlation

to lifetime accomplishment that is more than three times stronger than standard intelligent quotient scores (Plucker, 1999). Creativity is an essential element necessary for all learning, and is not limited to the arts as many presume.

Educational environments often do not support creative thinking and, in fact, may actively suppress creative expression due to standardization and conformity (Kawenski, 1991). Students often lose their creative potential in traditional schools and classrooms (Cole et al., 1999). Tosey (2006) argues that the most creative individuals and organizations operate at margins far from agreement and certainty, but just short of chaotic. Many teachers strive for orderliness in the classroom and want to give the impression that the academy (or the instructor) is the repository of truth, but this is not an environment that promotes creative thinking. The stifling of creativity is also afflicting the entire community of researchers according to Ness (2015), because of the aversion to risk which is inherent in funding agencies now.

Cheung et al. (2003) assessed creativity in 859 university students from a range of disciplines including business, humanities, social sciences, and science and technology using five tasks to elicit students' novel ideas. They found a decline in creativity scores with years of study at the university and the highest creativity scores were from students majoring in the humanities and social sciences. This declining trend is troubling, given the necessity of human ingenuity is undisputed. Although other countries are making creative development a national priority, American teachers express frustration that there is no longer room for fostering creativity in the classroom (Bronson and Merryman, 2010). As a result, U.S. students are scoring significantly lower on creativity assessments with scores declining steadily since 1990 (Kim, 2011). Jackson and Shaw (2006) conducted a survey of academics on their perceived value of creativity in their discipline. They concluded that most academics believe creativity is necessary as a practitioner in a discipline, but it was not valued beyond a rhetorical level.

Jackson (2004) describes the conditions that facilitate creativity; many of these are missing from

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traditional classrooms. These include providing sufficient time and space for creative endeavors, varying the working environment, allowing freedom to work in new and interesting ways, challenging students with problems, encouraging debate and dialogue with various stakeholders, encouraging reflection, and designing assessments that do not predetermine the outcome.

One of the key facets of a successful class that fosters creative exploration is integrating a thoughtful approach to assessment into the course. Torrance and Safter (1986) assert that teachers are often poorly prepared to develop, support, or evaluate creativity in their students. Berensen and Carter (1995) describe traditional assessment as a component in the educational environment that prevents students from taking risks. Traditional methods of assessment contribute to students' pursuit of grades instead of learning. Many current educational systems avoid elements of risk to make students feel comfortable, thereby avoiding creativity as well. Changes to traditional assessment methods can cause anxiety in students (Fink, 2003), because it is not what they are accustomed to experience. James and Brookfield (2014) address how to engage students in imaginative thinking about assessment and the importance of clear expectations when making changes to the curriculum. For example, although many instructors may grade participation, few define participation and precisely how students will be evaluated based on this participation.

Science curricula often emphasize convergent ways of thinking such as logic, reasoning, analysis, and judgment. McKim (1980), Jackson (2004) and many others have argued that creativity also involves divergent ways of thinking that include openness, subjectivity, intuition, and sensory and imaginative processes. Unlike many scientific disciplines, horticulture provides a rich environment for both divergent and convergent thinking involving art, aesthetics, design, social interactions, and science. We were curious to know to what degree creative exercises were embedded into a typical horticulture curriculum. Our prediction was the horticulture curriculum is rich in creative activities, but these may not be recognized as such by the instructor or

deliberately deemphasized as not contributing to scientific rigor because of the perceived value of the analytical and practical competencies.

The goals of this paper are to provide horticulture and plant science faculty with a framework for developing and/or identifying creativity in the classroom, offer examples of projects and exercises that can encourage creative expression, and share ideas for assessment. Once instructors become more aware and comfortable with classroom activities that promote creativity, it can be made explicit in learning outcomes for the class and curriculum. For example, a learning outcome might be able to demonstrate how knowledge acquired in this class, in other classes, and from your own experience can be organized, integrated, and synthesized in a way that generates new insights or questions about the subject of study.

Materials and methods

Csikszentmihalyi (1996), Sternberg (2000), and Andreasen (2005) mostly agree on the characteristics and behaviors of people engaged in creative expression. Using the 10 specific behaviors and characteristics for creative activity identified by Sternberg (2000) (Table 1), the authors surveyed the horticulture faculty instructors at Cornell University. Fourteen faculty instructors with undergraduate teaching responsibilities were solicited, including input from the authors. Each of the faculty taught at least one course within the last 2 years with the teaching appointment responsibilities ranging from 10% to 50% with classes ranging from the introductory to advanced level. Each instructor was verbally informed about the study, after which an e-mail was sent asking the participant to identify any classroom activity that matched the 10 criteria. Three faculty instructors could not identify any classroom activity that matched the criteria, whereas the others provided one or more examples.

Results

We modified the description of Sternberg's (2000) 10 criteria to place them in the context of student behaviors in the plant sciences. Following each criterion and a brief description are examples provided from

our solicitation and from our own classroom experiences.

REDEFINE PROBLEMS. Students take what most people see in one way and present it in another way, often in a way that will enable others to understand better. They may spend as much time redefining a problem as they do thinking about a solution.

Students often take for granted the shape and growth habit of a plant. In an introductory horticulture class, students learning about anatomy and morphology are asked to draw a plant and its important traits upside down on the paper. By seeing the plant from a different perspective, students must pay close attention to scale and detail in a way they would not have appreciated from a normal perspective. This can lead to new insights into the relationship among the plant and its components.

In several classes, students are asked to develop questions for their own final exam following a set of guidelines. They are graded on both the quality of their questions and the answers they provide. Developing questions encourages students to approach the subject of study from a different perspective, and often leads to new insights since the typical test-taking role of the student is reversed.

Clarifying a question is another way to encourage students to change their perspective. In an advanced physiology class, students are asked to precisely define the elements of a question rather than accept the premise of the question or accept the question as stated. Terms such as vigor, crop load, balance, flavor, color, and quality are vague but frequently used terms in horticulture. By defining terms more clearly, more progress can be made in understanding what is occurring within a system. In a class on plants and human well-being, students were asked to examine a sentence, looking at each word, one at a time, to avoid reading quickly and superficially. Students express surprise at the many layers of meaning revealed when they read and consider each word. This approach encourages them to dig deeper and think carefully about the authors' meaning and to reflect on how their word choice impacts what readers learn from their writing.

ANALYZE ONE'S OWN IDEAS. Students analyze their own ideas and

Table 1. Brief description of 10 competencies and behaviors exhibited by individuals engaged in creative expression (Sternberg, 2000).

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1. Redefine problems
 2. Analyze one's own ideas
 3. Sell an idea
 4. Be aware of the limits of a particular knowledge paradigm
 5. Surmount obstacles
 6. Take sensible risks
 7. Willing to grow intellectually, professionally, and engage with different perspectives
 8. Believe in yourself
 9. Tolerate ambiguity
 10. Do what you love to do
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hypotheses, and question their assumptions from an objective perspective.

Near the beginning of the term, students in a plant physiology class are asked to develop a hypothesis and a set of experiments to test that hypothesis. At the end of the term, students are asked to revisit their experiment and revise the protocol in light of what they have learned in class. A similar approach can be used for a landscape design, a farm business plan, or a number of other projects in which the students have some knowledge when they enter the class, but expect to have greater knowledge about the subject when the class is over.

In a viticulture class, a professor shows the students a photo of a vineyard and asks them to describe what they see. At the end of class, the same photo is shown again and new observations are made after considering the content of the lecture material. Students realize how much more was in the photo after they understood the course content and they have the opportunity to reevaluate their initial impressions. In these examples, students analyze and critique their own ideas and assumptions over the semester.

SELL AN IDEA. A novel idea or hypothesis is not automatically accepted by the public or by the discipline. It must be tested and presented strategically and creatively to persuade others of the validity of a new idea. Students take a new idea and develop a plan for acceptance by a larger group.

In the Creating the Urban Eden (Bassuk and Trowbridge, 2010) course, students are divided into groups and given a section of campus to develop a landscape design. Often these locations are next to a building that has just been renovated or constructed.

Students work together in groups to develop a landscape plan using their knowledge of soils, light and shade patterns, and plant characteristics. Students then present their ideas to a panel of judges and attempt to persuade them of the value of their ideas. The most suitable ideas from each group are then selected, integrated into a new design, and the planting is installed with the help of all the students and the university grounds department. The authors cite improvements in student confidence and stronger connections between design activities and understanding of horticultural principles.

A similar process is used to teach students how to develop a farm business plan. The instructor in a fruit production course identifies a relatively new farmer who has the potential to expand. Students are placed in groups and they develop a business plan for the farm based on what they know about the location, soils, water source, and area demographics. Students then present their plans to the grower at the end of the semester and the grower provides feedback from a real world perspective. In a public garden management class, the students work collaboratively with a start-up public garden to identify those areas where assistance and guidance are most needed. For example, the director of the public garden might have varying needs in collections, fundraising, displays, outreach, sustainability, and/or marketing. The class works in groups to develop a series of recommendations and these are incorporated into a master plan. This master plan is shared with the public garden administrators and feedback is solicited.

BE AWARE OF THE LIMITS OF A PARTICULAR KNOWLEDGE PARADIGM. One has to be knowledgeable to

generate relevant hypotheses or push forward the frontiers of a discipline. Knowing what has been done before and understanding the concerns and methods of other researchers allows one to build upon success. But experts can become entrenched in ways of seeing things and reluctant to accept new perspectives.

In an advanced physiology class, students are asked to state a well-known and accepted theory about plant growth and development, physiology, genetics, or ecology. They are put in groups and asked to speculate on why this theory might not be correct and propose a set of observations that, if made, would refute the theory.

In a leadership class, students are asked to write a paper about a scientist who developed a unique hypothesis that went against the conventional thinking of the day. Students reflect not just on the hypothesis, but on how the scientist must have felt while interacting with skeptical colleagues and how the scientist's theory eventually came to prevail. Did the scientist do anything to promote the new paradigm? Well-known examples could include G. Galileo, J. Salk, B. McClintock, J.D. Watson, F.H.C. Crick, C. Darwin, A. Einstein, and S. Hawking.

SURMOUNT OBSTACLES. Individuals who propose new ideas, especially those that challenge the status quo, are likely to encounter resistance. Knowing how to overcome obstacles is a key to success. Students are put into situations where they have to reconsider their approach or overcome obstacles.

In a fruit physiology class, students are asked to consider why a certain set of trees without fruit grow larger than those with fruit. The obvious hypothesis (e.g., carbohydrate competition) is intentionally rejected by the professor who presents additional data and students are asked to come up with an alternate explanation. The following week, this alternative explanation is intentionally rejected by the professor and the students are asked to consider yet another explanation based on new knowledge and data the professor presents. The students experience rejection in a safe environment, learn how to integrate new knowledge, and develop new ways of understanding the system. They also learn how to

defend a hypothesis if data supported it or abandon a hypothesis if the data were not supportive.

In a course on agroecology, the instructor provides groups of students with a set of cards drawn at random from a larger set. Each card describes an agriculturally related resource they will have on a hypothetical farm. On the basis of the resources they are given, students brainstorm what enterprise they would choose and why. Students are asked to generate ideas that would make their farm unique. In another example, the instructor developed a crop and greenhouse gas management game called "Cropopoly," where student teams must come up with optimum solutions to run a multicrop farm for several years with two goals—maximize yields and reduce the farm's carbon footprint. Unlike the real world, the game provides some modest economic incentives for soil carbon sequestration, reducing nitrous oxide emissions, etc., but students learn that even with these incentives, decisions are not straightforward. The game goes for 5–10 rounds (years), and in each round, there is a "weather event" card and a "market event" card drawn and all teams must deal with the implications of unpredictable events. These cards can have different effects (positive or negative) depending on how the farm has been run. This adds to uncertainty and mimics to some extent the risk-taking farmers must face in the real world. The winning team is the one with the most cash at the end. After the game is over, the instructor offers a written assignment with questions that facilitate a discussion about what aspects of the game are realistic and what aspects of farm management are missing. These examples teach students how to deal with new data, assumptions, and contexts, thereby learning how to be flexible in changing circumstances.

TAKE SENSIBLE RISKS. Students are encouraged to evaluate trade-offs between the probability of reward and the probability of incurring costs, criticism, or failure. Certain types of risk assessment involve mostly analytical skills. However, horticulture encompasses many politically charged issues that involve human emotions and social norms. As such, a strict analytical approach to trade-offs and

risk assessment may not lead to a good outcome. Creativity is required to assess the situation, decide on a direction, and negotiate the path forward when economic, political, scientific, and social factors play a role.

To develop a higher level of social consciousness, students in a human issues class are asked to argue for a position in which they do not believe either in a debate format or in a paper. Being able to see a situation from someone else's perspective and state the position publicly is a measured risk that has little practical consequence, but can help the student grow in confidence as they explore how to handle emotional and political tension. Horticultural topics for debate include issues around immigration, genetically modified organisms, genetic editing, food safety, climate change, crop subsidies, organic agriculture, and biodynamic farming.

A safe way to learn to take risks is to role-play. In a vegetable production class, students are placed in a situation in which they must ask questions of another person (often playing a farmer) to determine what is wrong with their crop. The "farmer" is given a scenario before the encounter to ensure the situation is real, and is asked to respond to questions the way an actual farmer might be expected to do. This promotes critical thinking while not placing the questioner at risk of drawing erroneous conclusions or asking what is perceived to be a foolish question in front of the rest of the class. The farmer can feign anger because, for example, she believes a company's product damaged her crop and her anger is directed at the student playing the role of the company representative. This teaches students to deal directly with human emotions, rather than attempt to avoid any sort of confrontation, and places them in a situation to experience risk without consequences.

WILLING TO GROW INTELLECTUALLY, PROFESSIONALLY, AND ENGAGE WITH DIFFERENT PERSPECTIVES. Students are encouraged to expand their field of expertise and seek to create linkages with related fields. Students appreciate the contributions from other fields and will seek out different perspectives.

As part of a 3-week international study trip to a developing nation, domestic students are asked to partner

with students who they met from the host country to write a paper about an issue the developing country faces (e.g., water availability, access to germplasm, nutrition, labor supply, markets, pesticide use). This project provides an opportunity for domestic students to consider the perspective of others who are more familiar with the personal impacts of the issue and broadens the students' perspective.

In the Art of Horticulture course, students are asked to collectively create a substantial piece of plant-based artwork involving a large investment of time and effort. Such projects invariably require integration of other disciplines. A math major used high-level network theory to develop a plan for a piece of turfgrass art to create a powerful optical illusion. In another example, a 1-acre (0.4 ha) piece of natural artwork was created near the airport flyway to be viewed by approaching planes. This required the use of calculus and trigonometry to scale up the paper design and knowledge of ways to create color on a large scale, for example, covering grass with black plastic for 2 weeks to create yellow and use of different colored mulches. A viticulture professor partnered with a classics professor to offer a course on how wine has affected the development of various world cultures from ancient times to the present.

These examples provide opportunities for students to consider perspectives from various fields of study. Opportunities to conduct interdisciplinary work abound for horticulture as natural affinities exist with many other fields of science and engineering as well as disciplines involving art, history, sociology, government, politics, and business. Universities with professional schools such as restaurant management, medicine, and law also have opportunities to partner with horticulture for interdisciplinary courses.

BELIEVE IN YOURSELF. Students develop self-confidence and are persistent in sharing and promoting a good idea even if it goes against the status quo.

In a course on plants and human well-being, students are asked to write a letter to the editor about a controversial subject related to a horticultural subject. The letter is expected to contain a critique of the status quo

or the old idea, and propose a solution or alternative approach to address the problem. In another class, students write a letter to the university vice president advocating for a specific action that would make plants more visible and present in students' lives on campus. Students have to explain why they think this is important and write persuasively. This assignment encourages them to consider administrators as real people, and engage in ways that will motivate the vice president to act.

TOLERATE AMBIGUITY. Students avoid assuming the world is black-and-white and appreciate the nuance inherent in most situations. Students are able to work within sometimes unpredictable conditions, and are willing to make adjustments in the presence of new data.

Responses to treatments that are predictable in a controlled environment may not be the same in the field. Students in a fruit physiology class are asked to draw a model involving a simple treatment and a response. An example might be the relationship between mite numbers [e.g., two-spotted spider mite (*Tetranychus urticae*)] and fruit size in apple (*Malus × domestica*). Under controlled conditions, mite numbers can increase until a threshold is reached, then fruit size may be affected by increasing numbers. But, this is not always the case as fruit size is affected by the number of fruit on the tree which, in turn, is affected by fruit set, pollination activity, temperature, light levels during flowering, thinning, and last year's crop. Students are asked to incorporate these components into a model, and then propose conditions under which the original relationship might not hold. Similarly, in a plant taxonomy course, students are presented with a set of morphological traits within a related group of plants, and are asked to develop the phylogenetic relationships among these groups based on these traits and their knowledge of evolution. Their phylogeny is compared with one published in earlier literature. Later in the course, molecular sequencing data are provided for this group of plants, and students are asked to revise their phylogeny accordingly and then compare it to the latest understanding of the phylogenetic relationships.

Students in a course on ecosystems are assigned readings about the

relationships between humans and ecosystem services. Students are split into groups and each group develops a concept map showing how system components could fit together systematically. Copies of the maps are distributed to each student and they are asked to develop an integrated map considering all group concept maps. Students find there is no single way to show how concepts relate to one another, relationships can be nuanced and ambiguous, and considerable compromise is required to integrate group concept maps. These examples help students move forward with some ambiguity as there is no one correct answer.

DO WHAT YOU LOVE TO DO. Students are encouraged to explore the wide range of opportunities within a discipline to find a specific component from which they gain personal satisfaction.

After spending time learning about the discipline of horticulture, students in an introductory horticulture class are asked to write an essay on what they would like to do with their lives if earning money were no object. In a class on career explorations in the plant sciences, students select a career of interest and conduct research on it, interview a practitioner if possible, then present to the rest of the class what having such a career would entail including what is most satisfying about it. In addition, the class includes a panel of presenters with diverse occupations who shares information about jobs and interests. Students indicate they are inspired not just by the careers, but by the circuitous paths and passions that led to them. These activities demonstrate to students that many people can and do love their work. People are most creative when they do what they most enjoy (Amabile, 1996).

Discussion

Conditions that foster creativity are likely present in many horticulture classes and curricula, but may not be recognized or identified as such. The examples above demonstrate many facets of creativity can be present in a single curriculum even when fostering creativity is not an explicit learning outcome. We argue that if fostering creativity were made a formal learning outcome for a program or major, then this would encourage the development of additional creative

competencies in classes, stimulate faculty to think about how they could modify their classroom experiences, and ultimately enhance the adaptability and problem-solving capacities of students.

In many disciplines, research is held in high regard and is considered the ultimate creative undertaking of faculty. Mansfield and Busse (1981) caution that following the scientific method itself is not a creative process, but rather is a tool used to examine the order of a new paradigm which was conceived by a creative mind. An emphasis on following a particular method or research protocol may enhance technical and analytical competencies, but will not encourage the development of the full range of creative competencies. The examples we provide demonstrate that understanding scientific principles, formulating good hypotheses, and engaging in creative activities are not mutually exclusive. The stronger one's knowledge about the subject, the more nuanced one's creativity can be in addressing a new problem (Brown et al., 2014).

Assessing creativity of student work is challenging because there are no widely accepted criteria for judging it, and defining exactly what to measure can be subjective. To reduce the subjective element in evaluating scientific creativity, two broad classes of measurements have been considered: citation counts and expert ratings. The merits and shortcomings of these measurements have been reviewed at length (Stumpf, 1995), and even if one is convinced of their merits, it is difficult to see how these could be applied to classroom projects unless the instructor is the only expert.

In our opinion, identifying specific behaviors with relevant examples is the best way to create an environment that fosters creativity and positive interactions among students. Sharing these explicit behaviors with students also allows the instructor to provide some degree of objective assessment. For example, on the first day of class, the instructor in Art of Horticulture provides students with instructions (modified from Brookfield, 2014a) that describe behaviors that lead to quality participation and help stimulate creativity in the classroom (Table 2). Students are given

Table 2. Instructions for students that describe behaviors that lead to quality participation and help stimulate creativity in the classroom.

Please do not use your phone during class since if you are “there” you are not “here” with us. Laptops are only to be used for doing project work and are not appropriate for internet surfing, e-mail, and other personal uses.
Change seats often in an attempt to get to know every student. There is no need to go to the same place each class or sit with the same students.
Ask a question or make a comment that shows you are interested in what another person says or does and/or encourage another person to elaborate on something they have already said or done.
Alert the class to a resource (a reading, web link, video) not addressed in the syllabus that adds a new dimension or perspectives to our learning.
Make a comment that underscores the linkage between other student’s contributions and make this link explicit in your comment. Contribute something that builds on, or springs from what someone else has said or done.
Diplomatically prompt the instructor to examine the dynamics of the classroom if you feel learning is inhibited by the group process.
If you think it is appropriate, ask the group to pause to slow the pace of conversation or activity to give you and others time to think or process.
Find a way to express appreciation for the enlightenment you have gained from a discussion or from our group work together. Try to be specific about what it was that helped you understand something better.
Please challenge the instructor and others, but do so diplomatically, focusing on the issue at hand and not on the people with whom you have a differing viewpoint.
If working in small groups or involved in an in-class experience, when you have finished your work, do not simply sit in your seat waiting for class to end. Get up, move around, comment on, and learn from others’ work and conversations.

Table 3. Examples of questions that could be integrated into a rubric to assess creative elements in a class project using a developing scale for feedback and assessment (emerging, developing, exemplary).

Does the project frame the topic or question in an original manner?
Does the project aim to address or solve a novel problem?
Are idea generation, brainstorming, and/or inclusion of diverse perspectives, voices, and informed opinions used to guide action?
Does the project contain an element of healthy risk (i.e., pushes limits); yet not so much that the project fails or will likely fail to accomplish its goals?
Do the project activities and/or design demonstrate a degree of inventiveness?
Does the project connect, synthesize, or integrate from different pools of knowledge?
Does the project use media in an imaginative way?
Does the project include a component that engages the intended audience or persuades the audience to invest time or energy in the project outcome?
Is the final product, in whatever form it is presented, offered in an engaging way?

an overall score based on how well they exhibited these behaviors during the semester.

Similar criteria could be developed for evaluating creativity for a classroom project, although creativity criteria would likely be included among other criteria assessing technical aspects, writing quality, and other measures of performance. To preserve creative energy, Fink (2003) suggests using methods of assessment that are more educative than evaluative. Activities that allow opportunities for students to rehearse, practice, consult resources,

and receive feedback are essential in the creative learning experience. Thereby, student learning focuses on cycles of performance, feedback, revision and, ultimately, new performance. Fink (2003) argues that grading on a three-point developing scale (emerging, developing, exemplary) emphasizes creative development over judgment (unsatisfactory, satisfactory, outstanding or A, B, and C). Table 3 is an example of a rubric that could be adapted and used to assess the creative components of a class project that would complement more standard

analytical, technical, and knowledge-based assessments.

Brookfield (2014b) suggests using critical incident questionnaires to evaluate the classroom climate for learning. After each class, students are asked to respond to a series of questions: “What was your most engaged moment? Most distanced moment? Most affirming action? Most puzzling action?” “What surprised you the most?” The critical incident questionnaire could also ask about creativity: “Was there any point in class where you were able to express and use creative insight?” “Was there a point in class where you viewed old concepts differently than before, or were able to visualize or express what you had learned previously in a new way?”

In our experience, most students welcome opportunities to express creativity in the classroom; yet, instructors may not have built space for this to happen. Often, faculty feel pressure to “cover the material” or may be uncomfortable with a pedagogy that relates to a more open and engaged classroom and, as such, lecture for a full period. We hypothesize that the most effective classrooms provide opportunities that stimulate creativity, therefore providing an opportunity to make the classroom more engaging and experiential and students more open to new ways of seeing. An important next step will be to quantify how this approach directly impacts student learning and future success to provide evidence of the benefit and need for creativity in the classroom.

Our discipline already embraces a culture of creativity as evident from the many examples gleaned from a single academic unit. Horticulture can provide a model for how an academic department can foster creativity both within and outside of the classroom to enable graduates to solve problems, be innovative, and succeed in a rapidly changing global environment.

Literature cited

Amabile, T.M. 1996. Creativity in context. Westview Press, Boulder, CO.

Andreasen, N. 2005. The creating brain. Dana Press, New York, NY.

Bassuk, N. and P. Trowbridge. 2010. Creating the urban Eden: Sustainable

- landscape establishment in theory and practice. *HortTechnology* 20:485–486.
- Berensen, S.B. and G.S. Carter. 1995. Changing assessment practices in science and mathematics. *J. School Sci. Mathematics* 95:182–186.
- Bronson, P. and A. Merryman. 2010. The creativity crisis. 29 Mar. 2016. <<http://www.newsweek.com/creativity-crisis-74665>>.
- Brookfield, S. 2014a. Class participation. 29 Mar. 2016. <http://www.stephenbrookfield.com/Dr._Stephen_D._Brookfield/Workshop_Materials_files/Class_Participation_Grading_Rubric.pdf>.
- Brookfield, S. 2014b. Critical incident questionnaire. 29 Mar. 2016. <http://www.stephenbrookfield.com/Dr._Stephen_D._Brookfield/Critical_Incident_Questionnaire.html>.
- Brown, P.C., H.H. Roediger, and M.A. McDaniel. 2014. *Make it stick: The science of successful learning*. Belknap, Cambridge, MA.
- Cheung, C., E. Rudowicz, X. Yue, and A.S.F. Kwan. 2003. Creativity of university students: What is the impact of year and field of study? *J. Creat. Behav.* 37:42–63.
- Cole, D.G., H.L. Sugioka, and L.C. Yamagata-Lynch. 1999. Supportive classroom environments for creativity in higher education. *J. Creat. Behav.* 33:277–293.
- Csikszentmihalyi, M. 1996. *Creativity*. Harper-Collins, New York, NY.
- Fink, L.D. 2003. Creating significant learning experiences: An integrated approach to designing college courses. Jossey-Bass, Hoboken, NJ.
- Jackson, N. 2004. Creativity in higher education. 29 Mar. 2016. <<http://imaginativecurriculumnetwork.pbworks.com/f/Imaginative+Curriculum+Network+Information+Note+2004.pdf>>.
- Jackson, N. and M. Shaw. 2006. Subject perspectives on creativity, p. 150–178. In: N. Jackson, M. Oliver, M. Shaw, and J. Wisdom (eds.). *Developing creativity in higher education*. Routledge Press, New York, NY.
- James, A. and S. Brookfield. 2014. *Engaging imagination: Helping students become creative and reflective thinkers*. Jossey-Bass, Hoboken, NJ.
- Kawenski, M. 1991. Encouraging creativity in design. *J. Creat. Behav.* 25:263–266.
- Kim, K.H. 2011. The creativity crisis: The decrease in creative thinking scores on the Torrance tests of creative thinking. *Creat. Res. J.* 23:285–295.
- Mansfield, R.S. and T.V. Busse. 1981. *The psychology of creativity and discovery*. Nelson-Hall, Chicago, IL.
- McKim, R.H. 1980. *Experiences in visual thinking*. PWS Publ., Boston, MA.
- Mitchell, W., A. Inouye, and M. Blumenthal (eds.). 2003. *Beyond productivity: Information technology, innovation, and creativity*. Natl. Acad. Sci., Washington, DC.
- Ness, R. 2015. *The creativity crisis: Reinventing science to unleash possibility*. Oxford Univ. Press, New York, NY.
- Plucker, J. 1999. Is the proof in the pudding? Reanalyses of Torrance's (1958 to present) longitudinal data. *Creat. Res. J.* 12:103–114.
- Sternberg, R.J. 2000. Identifying and developing creative giftedness. *Roeper Rev.* 23:60–64.
- Stumpf, H. 1995. Scientific creativity: A short overview. *Educ. Psychol. Rev.* 7: 225–241.
- Torrance, E.P. and H.T. Safter. 1986. Are children becoming more creative? *J. Creat. Behav.* 20:1–13.
- Tosey, P. 2006. Interfering with the interference, p. 76–102. In: N. Jackson, M. Oliver, M. Shaw, and J. Wisdom. *Developing creativity in higher education*. Routledge Press, New York, NY.