DACUM as a Model for Horticulture Curriculum Development and Revision: A Case Study

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Summary. DACUM (*d*evelop *a* *c*urricul*um*) was implemented at Kent State University (KSU) to develop and revise curricular content of an associate degree program in horticulture technology. Initially, at KSU–Salem in 1990, a committee followed a typical DACUM process to develop a skills profile for the horticulture technology worker. The skills profile consisted of terminal and intermediate learning objectives that served as the content of basic data sheets for thirteen new courses in horticulture technology. This associate degree program was initiated at Salem in 1991 and offers three concentration areas: landscape management, turfgrass management, and arboriculture. Later, when a proposed new program offering was considered at KSU–Geauga, a modified DACUM process was implemented to develop a new skills profile that reflected both general knowledge areas of horticultural and business practices and industry-specific competency areas. Comparison of the two curricula revealed similarities between the two skills profiles. This led to the recommendation that the original curriculum also be offered at KSU–Geauga campus with two differences: 1) omit the arboriculture concentration, and 2) consider a new concentration in greenhouse and nursery operations in the future. The associate degree program in horticulture technology at the KSU–Geauga campus began in 1999. The DACUM process, by involving members of the horticultural industry in the curricular development process, provided several long-term benefits and a high level of cooperation between industry leaders and KSU–Geauga.

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The primary objective of a planned program of instruction in a technology area, is the preparation of individuals for employment in that technology, or for additional preparation for a career requiring other than a baccalaureate or advanced degree [Ohio Board of Regents (OBR), 1998]. For the associate of applied science degree in Ohio, about half of the total credit requirements are in courses clearly identifiable with technical skills, proficiency, and knowledge required for career competency. Technical courses should include the laboratory experience (OBR, 1998). Among the many specialized associate degree programs, there is a similarity in that the technical core of courses must provide students with a strong level of skill for them to enter the workplace. If students are to be prepared properly for employment, the curricular focus must be one that is relevant. Curriculum content should emphasize practicality through hands-on experiences in laboratory or cooperative educational settings (Finch and Crunkilton, 1992). Thus many associate degree programs include some type of on-the-job experience for academic credit. In Ohio, academic credit in associate degree programs may be earned in courses that emphasize practical and realistic work experiences, including courses entitled cooperative work experience, clinical laboratory hour, directed practice hour, practicum hour, and field experience (OBR, 1998). About 125 2-year and 4-year colleges offer associate degree programs in horticulture in the U.S. (Peterson's Guides, 1999).

DACUM as an occupational analysis tool

Curriculum development is an essential step for any new degree program. Since the 1960s, the technical-vocational part of curricula has been effectively developed through a model called DACUM. Originally developed in Canada, the DACUM process was created as a joint effort of the Experimental Projects Branch, Canada Department of Manpower and Immigration and General Learning Corporation of New York (Finch and Crunckilton, 1992). One of the first applications of DACUM was for the Women's Job Corp program in Clinton, Iowa. DACUM has since become widely used as a standardized method of determining curricular needs as it relates to the identification of duties, tasks, and skills that are performed in a particular occupation, career area, or profession (Engleberg and Wynn, 1995). The DACUM process is a particularly effective method of quickly determining, at relatively low cost, the duties and tasks expected of anyone employed in a given job or occupation (Joyner, 1994). Many occupational fields have applied DACUM methodology to develop curricula including pharmacy technology, forestry, computer security technology, and chiropractic paraprofessionals (Friedel and Kabat, 1991; Bluestein, 1993; Schou et al, 1993; Zundel and Needham, 1996).

The main reason many vocational educators use DACUM is to establish a relevant, up-to-date, and localized curriculum base for instructional programs (Norton, 1985). DACUM has also been applied in many special applications in a broad range of education studies. DACUM has been used as a methodology tool to 1) improve continuing education programs (Cookson and English, 1997), 2) justify the need for the study of speech communication in higher education (Engleberg and Wynn, 1995), 3) specify student learning outcomes for the general education curriculum (Martin and Lillis, 1995), 4) develop competency-based training for nurses (DeOnna, 2002), and 5) compare 4-H agents serving traditional and nontraditional clientele (Borden and Harris, 1998). According to Norton, (1985) DACUM can be successfully adapted for special applications. Adams (1974) and Borden and Harris (1998) reported the applicability of DACUM for organizing and conducting training. Cookson and English (1997) applied DACUM to the construction of behaviorally anchored rating scales for continuing education administrative positions. Modifications of the basic DACUM process are also possible (Norton, 1985). For example, Martin and Lillis (1995) selected faculty members and administrators as the expert workers; Chang (1996) first constructed a duty-task profile and then developed the list of professional subjects for the program, and Mason (1984) preceded the traditional committee work with a group-building process. Klingman and Gardner (unpublished) of Daytona Beach Community College modified

the DACUM process in order to reduce the time involved in chart construction and produce a chart more adaptable to the classroom competency-based instructional mode.

DACUM processes

DACUM COMMITTEE. The DACUM process, according to Norton (1985), consists of several steps carried out by a committee. The task of the committee is to determine the duties and tasks associated with a specific occupation (Finch and Crunkilton, 1993). The committee's work generally spans 1 to 2 d. The final outcome of a DACUM analysis is a skills profile that can serve as both a basic curriculum plan and/or an evaluation instrument for occupational training programs (Adams, 1974). Before convening the committee, a person must be identified as the DACUM coordinator. This person plans the occupation analysis process, makes the necessary pre-workshop arrangements such as selection of the committee of occupational experts, and at the conclusion of the process, verifies the tasks. This or any other person may act as the DACUM facilitator whose job it is to familiarize the committee with the DACUM process and guide the committee through these steps to their conclusion. The DACUM committee should include at least five but not more than 12 people. The committee members are selected based on their technical competence in the occupation and experience as leaders in the industry. It is also important that the persons selected be articulate and able to work in a group setting. The facilitator guides the group through a series of steps that identifies required competencies, skills or behaviors for each skill area and finally structures the skills into a meaningful learning sequence. The process is referred to as the DACUM Workshop. These steps are 1) orientation of the committee—the facilitator provides an overview of the process to the committee, including the rationale for utilizing this technique, 2) review of occupation—arrive at a mutually acceptable working definition of the occupation to determine the general areas of responsibility or duties of the occupation, 3) identify general areas of responsibility—use a working definition of the occupation to determine the general areas of responsibility or duties of the occupation, 4) identify specific tasks performed—specify six or more tasks that are performed by workers within each duty area, 5) review and refine task and duty statements—each task and duty statement is individually reviewed and refined, 6) sequence task and duty statements—tasks are arranged into some logical sequence, 7) identify entry-level tasks—specify which tasks on the chart are considered entry-level skills versus those that are considered advanced skills, 8) other as desired—refine the working definition, rate the importance of each task, and/or rate how frequently each task is performed. As a final step the committee may review the completed charts for consistency with sample DACUM charts. (Borden and Harris, 1998; Norton, 1995).

POSTCOMMITTEE PROCESSES. After the workshop, the facilitator should supervise the numbering and lettering of the DACUM chart to ensure the preservation of its final structure. Duty areas should be labeled from the top of the chart to the bottom with letters (A, B, C…) and all associated tasks for each duty labeled sequentially from left to right (A-1, A-2, A-3…) to complete the appropriate structure (Norton, 1985). Verification of tasks is the final step in the DACUM process. The purpose of verification is to confirm that the tasks identified by the committee are, in fact, those that students will need to be able to do when they enter the occupation locally. This can be accomplished by submitting the task statements to current workers in the occupation locally but who were not members of the committee. A survey with one or two questions for the respondent to answer for all of the tasks is the simplest approach. Typical questions may include: "How important is the performance of this task in your job?", "How frequently do you perform this task?", or "Is this task expected of a beginning worker?". The questions should be selected based on relevance to the institution as it proceeds to organize and develop a responsive curriculum (Norton, 1985). Others in the vocational education field, notably Holland College, have suggested that verification serves no useful purpose because the original DACUM committee itself was selected from specially qualified local or regional practictioners, and subjecting the chart to review and possible change by others only makes the work of the committee seem less important, increases costs, and adds little (Norton, 1985).

Program development

At KSU in 1989, a new associate degree program in horticulture technology was proposed based on a joint effort of KSU administration and Davey Tree Experts Company (KSU, intra-departmental correspondence). Kent State University has a strong regional campus system that serves, in particular, a large number of students enrolled in 2-year programs. Most of these programs are offered through the College of Fine and Professional Arts and the Department of Technology. This new program, offered through the Department of Biological Sciences within the College of Arts and Sciences, represented a new trend for KSU toward "the practice of housing associate degree programs within the department and college appropriate to the discipline" (KSU, intradepartmental correspondence). This program was offered in 1991 at the KSU–Salem campus and later at the KSU–Geauga campus in northeastern Ohio in 1999. The degree in horticulture technology falls within the larger degree program known as the Associate of Applied Science.

Colleges or universities that seek to offer a new associate degree program must justify the need for such a program in their state or region. Typically, an accrediting body for each state or region oversees the administration of such programs and sets certain requirements for the academic institution to meet in order to gain approval for the new degree offering. In Ohio, OBR sets the standards for the approval of associate degree programs and coordinates the 2-year college system (OBR, 1975). If a preliminary approval for a new degree program is granted, the next step is the preparation of a formal proposal. Ohio Board of Regents lists several recommended procedures for preparation of the formal proposal including 1) formation of a local advisory committee comprised of individuals not employed by the institution who either earn their living doing what the program would prepare students to do, or would be the most likely employers of such individuals; 2) determination of the program goals; 3) conducting a local needs survey assessing the potential job opportunities for program graduates; 4) if the program is offered elsewhere in the state, consulting with another campus that offers the program; and 5) determination of curricular objec-

tives and curriculum development. The formal proposal must address and document program outcomes, rationale and need for the program, academic control, curriculum, staffing requirements, facilities and support services and financial resources (OBR, 1998).

Objectives

A DACUM committee can be convened to identify the competencies that should be delivered in an existing instructional program, just as it can be convened to identify the competencies for a new program (Norton, 1985). The DACUM process was first implemented at KSU–Salem campus to develop the curriculum for a new horticulture technology program at that campus. Several years later, DACUM was implemented for a proposed horticulture technology program at the KSU–Geauga campus with two objectives: to ensure relevance of the original curriculum to the KSU–Geauga community, and to update competencies within the skills profile.

Materials and Methods

Feasibility study: KSU–Salem campus. As a first step in seeking approval for the proposed program at KSU–Salem, a feasibility study in the form of a local needs survey was conducted in 1990 to determine the degree of support for the proposed program from the landscape horticultural industry. Survey questions were distributed by mail to about 400 businesses located primarily in northeastern Ohio. About 25% of surveys distributed were returned and survey results were compiled.

DACUM process: KSU–Salem campus. In March 1990 at KSU–Salem campus, a DACUM committee of four representatives of local horticulture industries, two members of the biological sciences department, and one member of regional campus administration met to develop the skills profile for horticulture technology. A DACUM facilitator guided the committee and a recording secretary transcribed the meeting. The committee followed a typical DACUM process, producing a student program chart of six terminal performance objectives and associated intermediate performance objectives that identified specific skills or tasks (Table 1). The DACUM coordinator did not conduct a verification process.

Feasibility study: KSU–Geauga campus. The KSU–Salem program in horticulture technology was the model for a new, similar program to be offered at the KSU–Geauga campus some years later (R. James, unpublished). In order to gain preliminary approval by OBR for the proposed KSU–Geauga program, a survey of the local horticultural industry was conducted to determine desirability of a horticultural associate degree program (R. James, unpublished). Survey questions were distributed by mail to about 100 businesses primarily in Geauga County. About 25% of surveys distributed were returned and survey results were compiled.

DACUM process: KSU–Geauga campus. As stated earlier, DACUM can be successfully adapted for special applications. In May 1999, at KSU–Geauga campus, a modified DACUM process was utilized to identify industry-specific job responsibilities and tasks performed to complete these responsibilities (R. James, unpublished). The DACUM coordinator and facilitator was also the same person who acted as consultant to the campus in guiding the process of program development (R. James, unpublished). Modifications from the traditional DACUM methodology as described by Norton (1985) included 1) the committee was broken into three smaller focus groups, 2) the facilitator provided a question format to initiate the discussion, 3) the responsibility and task statements were not prioritized, and 4) verification of task statements was completed by mailing these statements to the participants. Three focus group interviews, with a total of 23 participants, were conducted in July 1999. Each focus group represented a major commodity area of the ornamental horticulture industry in Geauga County including turf installation and maintenance, greenhouse and nursery operations, and landscape installation and maintenance. The focus groups met individually to identify industry specific job responsibilities and related task performances (James, 1999). Focus group participants were asked 1) "After your company's initial training period, what broad areas of responsibility or duties would you expect from an individual with a 2-year associate degree in horticulture?" and 2) "What tasks are necessary to successfully perform each of these responsibilities?" The questions were discussed and responses recorded on a flip chart. The group then came to a consensus on responsibility and task statements. The statements were then organized into six focus areas that represented terminal performance objectives in general horticulture and business and three specific competency areas that represented terminal performance objectives in landscape, turf and greenhouse/nursery operations.

Results and Discussion

KSU–Salem campus. Results of the feasibility survey were generally positive (65% to 95%) towards the proposed program in horticulture technology (Table 2). Among the six questions asked, the percentage of positive responses with the highest percentage (95%) supported the program offering. The lowest percentage of positive responses (65%) suggested that there was some interest among current industry employees in enrolling in the proposed program. These positive indicators from the industry enabled the next step in the process of program development to proceed. Results of the DACUM committee process led to a DACUM student program chart. This chart included a list of terminal performance objectives and intermediate student learning objectives (Table 1). This skills profile was the basis for development of the curriculum and was ultimately formulated into basic data sheets for the thirteen new courses that comprised the core of the horticulture technology curriculum, including cooperative work experience courses (Table 3). Within the core curriculum, a student may elect to specialize in two of three concentration areas: landscape management, turfgrass management or arboriculture.

KSU–Geauga campus. Results of the feasibility survey were generally positive (70% to 90%) towards the proposed program (Table 4). Among the four questions asked, the highest percentage (90%) of positive responses was in support of the proposed program offering. This result was similar to the KSU–Salem results (Table 2). The lowest percentage of positive responses (70%) indicated some interest in hiring of technicians in the next 5 years among employers. These positive indicators from the industry enabled the next step in the process of program development. The skills profile developed by the DACUM committee

Table 1. DACUM student program chart of terminal and intermediate performance objectives for horticulture technology curriculum, Kent State University–Salem campus (Salem, Ohio) in 1990.

Terminal performance objective	Intermediate performance objective	
01	Use math skills to solve problems.	
	0101	Properly price, give cost estimates and keep records.
	0102	Analyze/solve problems using elementary algebra skills.
	0103	Compute and interpret averages, percentages, and ratios.
	0104	Ability to do mathematical calculation to solve use of supplies with fixed area.
02	Use effective verbal and written communication.	
	0201	Listen effectively.
	0202	Read and interpret reports.
	0203	Use appropriate language.
	0204	Use effective questioning.
	0205	Give and receive effective feedback.
	0206	Write reports.
	0207	Explain problems and solutions.
	0208	Organize thoughts and ideas in a manner easily understood.
	0209	Write legibly.
03	Perform sales and general business functions.	
	0301	Conduct and close sale.
	0302	Complete business forms.
	0303	Determine customer needs.
	0304	Identify potential buyers.
	0305	Provide customers with technical assistance.
	0306	Plan work objectives.
	0307	Organize the resources to meet work objectives.
	0308	Provide effective leadership for fellow employees.
	0309	Effectively resolve complaints.
04	Prepare, maintain, and improve soil conditions.	
	0401	Identify types and textures of soil.
	0402	Properly take soil samples.
	0403	Read and interpret soil samples.
	0404	Apply soil report recommendations.
	0405	Prepare soil and planting media.
	0406	Determine pH of soils for proper correction procedures.
05	Manage plant and tree environment.	
	0501	Make plant selection according to the requirements of the site.
	0502	Plan planting schedules and planting procedures.
	0503	Properly prune, water, aerate, fertilize and spray.
	0504	Identify and describe the effect of insects, diseases, and physiological problems.
	0505	Plan for proper control of physiological problems.
	0506	Demonstrate approved techniques in pruning, removal and climbing.
	0507	Demonstrate cabling, bracing and guying techniques.
	0508	Demonstrate procedures for wound cavity treatment.
	0509	Properly control growth rate of plant/tree environment.
	0510	Recognize and identify common ornamental plants.
06	Apply pest management planning principles in the best long-term interest of society.	
	0601	Recognize and identify pests through proper plant diagnosis.
	0602	Control insects and diseases in a socially acceptable manner.
	0603	Select and use pesticides properly.
	0604	Select proper timing for prevention and treatment.
	0605	Evaluate results of treatment.
	0606	Demonstrate knowledge for state pesticide licensing exam.
07	Demonstrate safe operation of equipment.	
	0701	Identify tools and their functions.
	0702	Follow daily maintenance schedule.
	0703	Recognize and report malfunctions.
	0704	Set up and prepare equipment for proper use.
	0705	Operate safely landscape, tree and ground maintenance equipment.
	0706	Demonstrate knowledge of OSHA[z], ANSI[y], and state safety rules/regulations.
08	Establish and maintain grasses according to the principles of turf management.	
	0801	Recognize and identify turf grasses.
	0802	Grow and care for turf grasses.
	0803	Recognize common abiotic problems caused by insects, diseases and weeds.
	0804	Demonstrate knowledge of watering, aerification and mowing requirements.
	0805	Evaluate and properly use fertilizers.
09	Use research and information gathering skills.	
	0901	Write reports.
	0902	Use microcomputer hardware and software.
	0903	Construct graphs, charts, and tables.
	0904	Determine data needed.
	0905	Determine location of primary and secondary data sources.

[z]Occupational Safety Health Administration.
[y]American National Standards Institute.

Table 2. Attitudes of horticultural industry leaders towards a proposed associate degree program in horticulture technology for the Kent State University–Salem campus in Salem, Ohio.

Survey question	Response (%)[z] Yes	No	No response
Would you encourage offering the proposed program?	95	1	4
Do you have current employees who might be interested in such a program?	65	32	3
Would you encourage your employees to enroll in the program?	81	8	11
Do you intend to hire technicians in the next five years?	75	13	12
Would your organization be interested in participating in an intern program to provide on-the-job cooperative work experience for students in this program?	83	7	10
Would you be willing to write a letter of support which we could forward to university and state officials?	84	6	10

[z]Percentages calculated based on 110 respondents.

Table 3. Kent State University horticulture technology core curriculum for the associate of applied science degree programs at Salem (Salem, Ohio) and Geauga (Burton, Ohio) campuses.

Technical course	Credit hours	Lab
Introduction to Horticulture	1	no
Horticultural Botany	3	yes
Ecological Principles of Pest Management	3	no
Plant Identification and Selection I	3	yes
Plant Identification and Selection II	3	yes
Occupational Regulations and Safety	2	no
Soil and Horticultural Management	3	yes
Horticultural Chemistry	4	yes
Landscape Management	3	yes
Turfgrass Management	3	yes
Arboriculture[z]	3	yes
Cooperative Work Experience in Landscape Management	3	na
Cooperative Work Experience in Turfgrass Management	3	na
Cooperative Work Experience in Arboriculture[z]	3	na

[z]Offered only at the Salem campus.

Table 4. Attitudes of horticultural industry leaders towards a proposed associate degree program in horticulture technology for the Kent State University–Geauga campus in Burton, Ohio.

Survey question	Response (%)[z] Yes	No
Would you encourage offering the proposed program?	90	10
Do you have current employees who might be interested in such a program?	85	15
Would you encourage your employees to enroll in the program?	90	10
Do you intend to hire technicians in the next 5 years?	70	30

[z]Percentages calculated based on 20 respondents.

represented the recommendations for the core program curriculum to be established at the KSU–Geauga campus. Six focus areas and 3 industry-specific competency areas and associated student learning objectives were identified (Table 5). The core program curriculum recommendations were then compared to the existing basic data sheets for the courses offered at KSU–Salem. This analysis led to the conclusion that the original curriculum should be revised, in part, for the proposed program at KSU–Geauga. Revisions recommended were to 1) provide concentration areas of landscape management and turfgrass management but not arboriculture, and 2) consider a new concentration area in greenhouse and nursery management at some future time. The new skills profile (Table 5) was found to be similar enough to the original skills profile (Table 1) that the remainder of the curriculum was unchanged. Both campuses now offer the same core program courses (Table 3) and have the same degree requirements, with the exception that only KSU–Salem offers the arboriculture concentration. While the two campuses used slightly different approaches to the DACUM process, it is interesting to note that there was a high degree of consistency in the student program charts that each developed independently (Tables 1 and 5). This reinforces what Norton (1985) says about the DACUM process as a tool that can be modified to suit different circumstances without sacrificing its validity.

Long-term benefits. Use of a DACUM process has been shown in this study to be an effective model for curricular development or revision in a horticulture technology program. DACUM may offer other, less obvious, benefits to program development. Implementation of a DACUM process has the potential to bring a long-term, public relations value to the educational institution (Norton, 1985). DACUM committee members who are industry employers report positive feedback because they perceive that their expert opinions have been taken seriously. This positive attitude of industry employers can lead to a high level of cooperation between the employers and the educational institution once the DACUM process has been completed and the program is underway. Many colleges that have used the DACUM process report the following long-term benefits: industry gifts of equipment or supplies; industry persons offering to teach or serve as resource persons; requests for in-service training programs to meet local industry needs; increased enrollments in adult upgrading programs; and increased support of the educational institution in a variety of ways by local business, industry, labor and management (Norton, 1985). In the KSU–Geauga program, one of the most beneficial outcomes of using the

Table 5. DACUM student program chart, Kent State University–Geauga campus (Burton, Ohio). Student learning objectives organized by focus areas within the core program curriculum and industry specific competency areas.

Area of competency and student learning objectives
Core program curriculum focus areas
Basic business skills
Perform basic math, accounting, record keeping.
Work effectively by organizing time, planning and completing projects.
Purchase supplies.
Demonstrate ethical business practices.
Prepare sales presentations including basic design, plant recommendations, estimating and budgeting with customer relations in mind.
Set up sales areas and displays.
Display understanding of and commitment to the industry.
Operate a computer and computer programs.
Conform to appropriate government regulations.
Manage risk through compliance to workers compensation, insurance requirements and injury prevention.
Safe operation and maintenance of tools, equipment, and vehicles
Operate equipment and tools utilizing protective devices and clothing. Select, use and mix fuels and oils properly.
Select, evaluate and use appropriate hand tools and equipment for the job.
Properly sharpen, store and apply preventative maintenance to tools and equipment.
Use a sight level.
Practice basic first aid and cardiopulmonary resuscitation (CPR).
Determine and prevent potential employee outdoor health hazards (frostbite, sunburn, stings etc.).
Operate vehicles safely and courteously and obtain commercial driver's license.
Communication and people skills
Demonstrate leadership skills.
Write in an understandable and legible manner utilizing proper grammar and spelling.
Demonstrate oral communication skills in person and on the telephone.
Communicate company image through positive personal attitude and appearance.
Demonstrate knowledge of conversational Spanish.
Identifying and controlling insects, disease, wildlife and weed pests
Pass the Ohio Department of Agriculture Pesticide Certification Examination.
Schedule integrated pest management practices.
Maintain pesticide records and documentation.
Use protective safety dress and equipment.
Diagnose common problems and treat those problems by accurately selecting and safely applying pesticides.
Use laboratories and other educational and diagnostic services.
Read and interpret pesticide labels.
Read and understand material safety data sheets and government regulations.
Determine pest thresholds.
Soils and soil amendments
Take soil samples.
Read and interpret soil test results.
Apply fertilizer, lime and other soil amendments properly and prepare soil for planting.
Time fertilizer applications properly.
Recognize and correct nutrient induced plant problems.
Plan composting and other organic waste utilization systems.
Correct drainage and grading problems.
Plant identification and characteristics
Identify plant varieties, including turf, and recommend varieties for end use.
Apply knowledge of plant species, including turf, by characteristics, type, hardiness zone, growing habits and environmental tolerances.
Apply appropriate cultural practices to ensure plant health.
Industry-specific competencies
Landscape installation and management
Install hardscapes by reading and interpreting blueprints and other design principles.
Plan and install drainage, irrigation, fence and other hardscape systems.
Perform proper landscape planting techniques.
Perform proper pruning techniques based on the needs of individual plants.
Perform edging, mulching, watering and other basic bed establishment and maintenance tasks.
Apply basic landscape design principles and interpret designer's intent.
Diagnose, research and correct landscape problems.
Make decisions on renovation vs. replacement of landscape plants and beds.
Turf installation, renovation and maintenance
Implement best management practices for intended turf use.
Irrigate, mow, repair, aerate and thatch turf.
Determine best turf planting time.
Protect grass seed with various mulching materials.
Compare seeding and sod installation.
Schedule after-planting irrigation, fertilization and other care.
Greenhouse and nursery management
Select and use appropriate trimming and pruning tools and techniques and time pruning operations.
Apply flower dead heading techniques.
Understand and practice principles of plant division, seeding, cutting, grafting and tissue culture.
Use appropriate planting medium.
Apply proper plant handling practices to minimize damage including selecting proper storage structure and techniques for over-wintering, loading trucks and transporting plants around the nursery.
Schedule and adjust irrigation by plant requirements, sight, soil mix, and water absorption rates.
Evaluate and inspect performance of automated irrigation systems.
Evaluate irrigation performance through visual and tactile inspection.
Identify and correct irrigation and drainage induced plant problems.
Determine proper container size, soil medium, soil amendments and mulch for transplanting operations.
Perform proper potting techniques.
Ball and burlap ornamentals.
Design plant-holding areas.
Perform heeling-in, staking and other planting techniques.

DACUM process was the high level of involvement of the focus group participants with the campus. Among the 21 original DACUM panel members, eight became members of the advisory board; one became an adjunct faculty member; several have hired our students as cooperative work experience students; and a small group from within the advisory board developed a master plan for landscaping the campus grounds including donations of plant material and design work. These experiences at KSU–Geauga certainly concur with Norton's (1985) assessment that while the public relations value of DACUM is secondary to its main purpose, it is an added benefit that can promote stability to the program long after inception.

DACUM CAVEATS. DACUM is an occupational analysis procedure that is used world-wide (Norton, 1985; Finch and Crunkilton, 1992). DACUM is ideal for researching the competencies that should be addressed in development of new educational programs, the competencies that should be delivered by existing educational programs, and the current relevance of existing DACUM charts (Norton, 1985). DACUM has also become a successful tool in content determination because it offers a useful variant to the more traditional, introspective model of teacher-determined curricular content (Finch and Crunkilton, 1992). The DACUM process relies on experts employed in the occupational area to determine curriculum content and allows them to be guided through a systematic content-determination process. This was demonstrated effectively in the study conducted at the KSU–Salem campus as presented here. A basic assumption is that committee members are close to the occupation and can determine what content is most relevant and therefore should be included in the curriculum. Therefore, the DACUM process is only as effective as the composition of the committee members. Norton (1985) warns that the experts include only people who are on the job daily and not include college teachers, personnel directors, or textbook writers. Ideally, the role of the educator in this process is to participate after the skills profile has been produced by the industry experts. At this point, the teacher's technical expertise is applied toward organizing, sequencing and detailing the curriculum content (Finch and Crunkilton, 1992).

NONTECHNICAL PROGRAM REQUIREMENTS. College programs offering associate degrees must balance degree requirements that ensure students gain technical competence in order to be ready to enter the workplace after graduation, with those that will allow students to pursue a four-year degree (Lehman and Suber, 1987). Therefore, incorporated in the curricula are general education courses that differ in topic but share the common goal of developing the student's communicative and quantitative competence, critical thinking, problem-solving, flexibility and life-long learning skills (Martin and Lillis, 1995). Associate degree programs must meet certain national standards (American Technical Education Association, 1991). Various external agencies, however, may also impose requirements on community colleges and universities including accrediting agencies and the state boards of education, thus general education requirements will vary among states and types of programs. According to OBR, graduates of these programs who aspire to extend their studies to other baccalaureate programs may need a substantial amount of advanced lower division coursework. For this reason, about one-half of each associate of applied science curriculum is devoted to nontechnical studies (OBR, 1998). The remaining course requirements for most associate degree programs are specific to the program/occupation and are classified as technical courses. DACUM has been shown in this study to be an effective tool for developing the horticulture technology portion of an associate degree program.

PROGRAM ACCREDITATION ISSUES. In the United States, an educational institution may be granted full accreditation status only by an institutional or specialized accrediting body that is recognized by the United States Department of Education (DOE). These accrediting bodies, which consider each institution as a whole, include six regional associations of schools and colleges, each of which is responsible for a specified portion of the U.S. and its territories (Peterson's Guides, 1999). Specialized accrediting bodies in over 40 different fields are also authorized by the DOE to accredit specific programs. Within each state, an educational board administers the associate degree programs for all higher educational institutions. Most states have some type of statewide general requirement for one or more associate degree programs (Sullivan and Suritz, 1978). Ohio Board of Regents has adopted the federal Classification of Instructional Programs (CIP) code classification for its taxonomy of technical program titles that are used to classify all associate of applied business and associate of applied science degrees (OBR, 1998). Under OBR guidelines, a proposed technical program is expected to meet the following criteria in addition to complying with specific curricular standards: 1) employment of at least one full-time faculty member to give leadership to the program; 2) a minimum projected enrollment of 15 first-year students; 3) a minimum projected enrollment of 12 second-year students; 4) a minimum of eight students expected to graduate by the end of the fourth year of the program's operation; and 5) a minimum projected average placement of 75% of its graduates who are available for employment in jobs which are related to the technology (OBR, 1998). Feasibility survey data, as demonstrated in this study, are useful in showing that the proposed program can meet the requirements of the accrediting body.

PROGRAM REEVALUATION. According to Finch and Crunkilton (1992), "Technical curriculum soon becomes outdated when steps are not taken to keep it from remaining static. Thus the contemporary vocational curriculum must be responsive to a constantly changing world of work. New developments in various fields should be incorporated into the curriculum so graduates can compete for jobs, and, once they have jobs, achieve their greatest potential. Technical curriculum must be data-based, dynamic, explicit in its outcomes, fully articulated, and future-oriented. Administrators, curriculum developers, and teachers must constantly examine the curriculum in terms of what it is doing and how well it meets student's needs. Provision must be made for curricular revisions, and if necessary to redirect, modify, or even eliminate an existing curriculum". As seen by the results of this study at the KSU–Geauga campus, a DACUM committee of industry experts can be convened to examine instructional materials to determine whether the materials address all of required tasks currently and locally. Based on this assessment, modifications of the educational program can then be made,

where necessary, to ensure relevance (Norton, 1985). Certainly, in the field of horticulture there are rapid technological advancements that have occurred, and will continue to occur as the industry advances. The task for educators in horticultural technology is to provide relevant, future-oriented curricula to our students. DACUM is a tool that can be used to meet that goal.

Conclusion

DACUM is a flexible curricular development and revision tool that can be effectively applied in horticultural education practice, as demonstrated in this study. As a content-determination process for curricula, DACUM's inherent advantage is that it relies on occupational experts to identify the skills profile needed by student graduates, whereas more traditional methods of curriculum development are too introspective because they rely on those who do the teaching to develop the instructional materials (Norton, 1985). Therefore, the DACUM process can easily be corrupted if the committee process involves educators. The educator's role in this process is best applied after the content-determination process has been finished and involves shaping the skills profile into a working curriculum. With these caveats in mind, the educator can implement DACUM with reliability and efficacy.

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