Best Practices Guide for Developing Educational Programs:

Environmental and Energy Technology

Advanced Technology Environmental and Energy Center

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- ATEEC Defining the Field forums and occupational analyses
- Eastern Iowa Community Colleges and their environmental technology students and graduates
- PETE Tribal College Fellows Institutes
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PART I

Introduction

ABOUT US

The Advanced Technology Environmental and Energy Center (ATEEC, www.ateec.org[1]) was established in 1994 as an NSF Advanced Technology Education (ATE) Center of Excellence. Our mission is to advance environmental and energy technology education through curriculum, professional, and program development. ATEEC provides professional development, guides program improvement, designs and develops curriculum and instructional materials, and much more. Our vision is to foster a network of educational communities, supported through public and private partnerships, which ensure human health, safety, and global sustainability. (See the diagram inside the back cover of this guide.)

STARTING YOUR PROGRAM

The most successful environmental and energy programs, many of which are referenced throughout this guide, have one major best practice in common—administrative "buy-in." The success or failure of any new or updated program rests on up-front support from the college president, deans, directors, etc. Creating or revising a program is a difficult and time-consuming challenge; without a strong commitment from top administrators, the program may not be allowed the time and resources necessary to achieve its full potential. One of the surest ways to achieve administrative buy-in is to create a solid program management plan. Background research and analysis should align with and reinforce the program goals.

"It is important to have support from the college administration on any new program development, including the president. When the president is representing the college in the community, they will be the champion of the new program."

Colleen Jorgensen; VP of Instruction; Red Rocks Community College; Lakewood, CO

A proven best practice is a written plan shared with administration, faculty, and staff. This is a critical tool for effective **program management**. It should list steps, personnel, and a timeline for plan implementation. In addition to organizing the project, the plan is a highly effective, credible, and convincing tool for reporting to administrative personnel and for gaining and keeping their support.

Systematic program planning is critical to developing any program. ATEEC has found great benefit in employing the well-researched and widely used planning method of instructional systems design (ISD). There are many highly effective ISD models from which to choose. Due to its straightforward and easy-to-understand principles, ATEEC uses the ADDIE design model, encompassing the following key steps:

Analysis
Design
Development
Implementation
Evaluation

These steps follow a natural progression, but are seldom strictly linear. The areas often cross over and steps should be revisited and repeated whenever necessary throughout a project. Best practices in program management employ a continuous loop of formative (ongoing) evaluation throughout the effort, in order to re-evaluate and revisit the different steps and to adapt and rework as necessary.

Part of this constant evaluation is to ensure that all steps are aligned with each other. For example, if a necessary skill is identified in the analysis stage, that skill will be repeated as a performance objective in the design/development stage, will be taught and assessed in the implementation stage, and the evaluation process will indicate that these areas have aligned to ensure the skill has consistently been addressed. Summative (comprehensive) evaluation is usually performed when a project is finalized, such as the end of a program year or the end of a special project. The written program management plan will be a living document, constantly evolving to meet new situations and needs.

For links to more information about the ADDIE model, refer to this guide's Supplemental Resources.

Best practices for program **analysis** include garnering an objective understanding of the targeted environmental

and/or energy field, program possibilities, labor market assessments, and workforce needs of the local, regional, or national labor market. ATEEC works with new and existing programs to stay abreast of current research and practice. Instructional designers work with content experts and instructors to:

- Develop labor market assessments (LMAs).
- Perform needs analysis.
- Perform occupational analyses.

These important elements of program development will be expanded upon later in this guide.

Designing and developing a program includes using best practices for:

- Curriculum development,
- Facilities, supplies, and equipment, and
- Partnerships

Curriculum and instruction best practices are based on well-developed performance-based learning objectives and authentic assessment. Keep instruction relevant to student experience and workforce options. Contextual teaching and learning methods create a simulated work environment in which to develop essential skills. Individualized accommodation and integration of knowledge and skills is vital to a successful program. Work towards creating curriculum that promotes seamless articulation agreements, and be sure to include internship opportunities. During the major stages of curriculum development, you will:

- Review the data you've collected in the analysis stage, including your LMA, needs analysis, and job task analysis.
- Gather as much existing research data on industry competency models and curricula/occupational analysis as possible (e.g., from the U.S. Department of Labor's Career One Stop program, ATEEC's online Resource section, schools with similar existing programs).

- Develop and align specific objectives and assessment instruments. Determine what competencies and measurable or observable evaluation criteria are necessary. Best practices for student assessment include fostering higher order thinking skills, stating objectives in measurable terms, using objectives to evaluate progress, and measuring student achievement regularly.
- Design appropriate content, learning activities, and delivery methods, utilizing contextual teaching and learning strategies whenever possible.

As part of the curriculum development, employing best practices in facilities, equipment, and supplies is not only necessary to promote student learning, but also indicates sound financial and administrative management. Check into opportunities for funding through private, state, and federal programs. Regular application of procedures for inspection, maintenance, and security of facilities, equipment, and supplies keep a technical program operational. These items can be expensive, but are vital to the success of the program.

The American Chemical Society (ACS) has done excellent research into defining partnerships and strategic alliances, with helpful ideas from successful national programs. Formation of active advisory committees align curriculum and job placement with existing local and regional business opportunities. Partnership networks share best practice models for new and emerging institutions. Clearly defined articulation programs are the key to student transition from high school to community college and four-year institutions. These items will be explored further later in this guide.

During the **implementation** stage, instruction is presented to the students. There are many materials and training opportunities for educators in this phase, both at educational institutions and on the Internet. Basically, this is when the teaching occurs and when formative (ongoing) program evaluation is performed. During implementation, continually determine if the content is being presented successfully to promote student learning.

Program evaluation includes an annual program review (summative assessment), using formative evaluation

gathered in the implementation stage in order to determine adjustments needed and goals for the following year. A comprehensive program evaluation should be conducted every three to five years.

Finally, remember that you **don't need to reinvent the wheel**—that's what best practices are for. Through ATEEC's experience assisting numerous colleges with program development, you can take advantage of learning from others' mistakes and successes. Additionally, ATEEC's online, no-fee, downloadable resource section provides various curricular materials, including core curricula for 2-year and high school environmental technology programs.

The following sections in this guide provide more detail (including supplementary resources) for helping you through the process of starting your new program or revising your existing program.

Analyzing Your Program

LABOR MARKET ASSESSMENT

With the rise in popularity of environmental and energy programs, many schools want to join this movement to enhance their enrollment and the variety of programs they can offer to their students. However, this motive can easily backfire on a school's good intentions and can potentially do a huge disservice to the students if the proper analysis isn't performed for the program's occupational focus. For example, wind energy has recently become an extremely popular program. But without the proper research, specifically a labor market assessment (LMA), the program may fail due to a lack of availability of local jobs for program graduates.

Your institutional research office is a good place to start to check for existing information or assistance with labor market assessments in the community.

Some questions to consider are:

- Who are the companies connected to the industry, and what is the status of the applicable industry in the region? Are they hiring? Are they stable companies?
- Will there be community or regional jobs for program graduates?
- If not, are potential graduates of the program willing to travel or relocate? If applicable, are students willing to leave the area after graduation?
- Does the school have the resources to develop a program of this type? Where does the funding come from, and what are the expectations of the funders?

An LMA may be done on a large or small scale. In the context of instructional programs for community colleges, the LMA is usually a local endeavor and is essential to:

- Assess the need for a program in a specific community.
- Assess the extent and type of education and training needed.

There are two primary methods for conducting an LMA:

- Distribute a survey instrument to potential employers, either the entire population or a representative sample.
- Convene a focus group of potential employers to collect information through a strategic group interview.

The information payback of a survey is valuable because of the number of employers included. It is necessary to be realistic, however, about the effort and cost that goes into such a survey. Depending on the size of the market, a survey might be mailed to several hundred potential employers. Identifying who should receive the survey and collecting their addresses is time-consuming.

Focus groups may provide a smaller picture of the community market, but can be easier to implement. Arrange a one- to two-day meeting with approximately 15 to 20 industry leaders whose reputations indicate they are knowledgeable about the field as well as the community. The main cost of the focus group consists of refreshments, which includes continental breakfast, lunch, and morning/afternoon snacks.

Regardless of the strategy for collecting data, the following types of information should be requested:

- Type and size of the organization as well as its products and/or services
- Type of applicable jobs and number of those personnel employed by the organization (both full- and part-time)
- Wage for entry-level personnel
- Minimum level of education required for employment
- Required work experience for employment
- Degree of difficulty finding qualified personnel
- Projected number of full-time and part-time job openings in the next one to five years

- Types of skills and training the organization needs for entry-level personnel
- Future trends in the industry

Whichever data-gathering method is used, keep in mind that some participants may be willing to get involved with the program as advisory committee members (eventually helping in the development of curricular goals and objectives), to partner in training, or to donate equipment.

A sample *Labor Market Assessment (LMA) Survey*[ii] for environmental and energy careers is available on ATEEC's website. The survey instrument can be customized to suit individual needs.

Additionally, ATEEC has national workforce development "Defining the Field" reports and charts for environmental technology[iii], energy technology and services[iv], and water management[v]. These documents are available on ATEEC's website and provide an overarching view of the fields, including categories, job titles, and general job functions.

NEEDS ANALYSIS

The needs analysis encompasses anything affecting what students need to learn and what resources instructors need to facilitate that learning.

Targeted Occupational Analysis

Occupational analyses are intended to be quick, efficient ways to determine job tasks, knowledge, and skills for a targeted occupation. The goal of the occupational analysis is to develop competency- and performance-based learner-centered curriculum and instructional materials. The results are then analyzed and systematically translated into a program curriculum. The occupational analysis is used by educators, trainers, instructional designers, curriculum developers, or human resource professionals to:

- Identify instructional needs and gaps.
- Plan an instructional program or validate and revise an existing program.
- Design and develop or revise curriculum.
- Design and develop or revise instructional materials.

- Provide teachers and trainers with valuable feedback on emerging and future trends in a career field.
- Provide career guidance for students and trainees.
- Ensure that students and trainees will have real-world skills to bring to the workforce.
- Provide administration/management with qualitative data on curriculum validity.
- Promote business and industry "ownership" in a school or training organization's goals.
- Assure employers that students meet business and industry job criteria and performance standards.
- Network with business personnel who may agree to collaborate with a program by:
  - Joining an Advisory Committee
  - Becoming an adjunct faculty member
  - Donating needed equipment
  - Providing speakers
  - Funding, etc.
- Use as a public relations tool to show effectiveness of college-business-community partnerships.

There are many different methods to conduct occupational analyses; most commonly used are:

- Developing A CurriculUM (DACUM)
- Job Task Analysis (JTA)
- Observation

ATEEC has experienced facilitators in each of these processes. The methods have very similar outcomes; the main difference is that the DACUM and observation processes gather job task information strictly from current expert workers in a specific occupation and the JTA relies on garnering the information from content experts in the field. The DACUM and JTA are most common. The following information on occupational analysis references the DACUM process as an example, in addition to providing a sample DACUM chart. (The full sample DACUM profile[vi], including chart, knowledge and skills, tools and equipment,

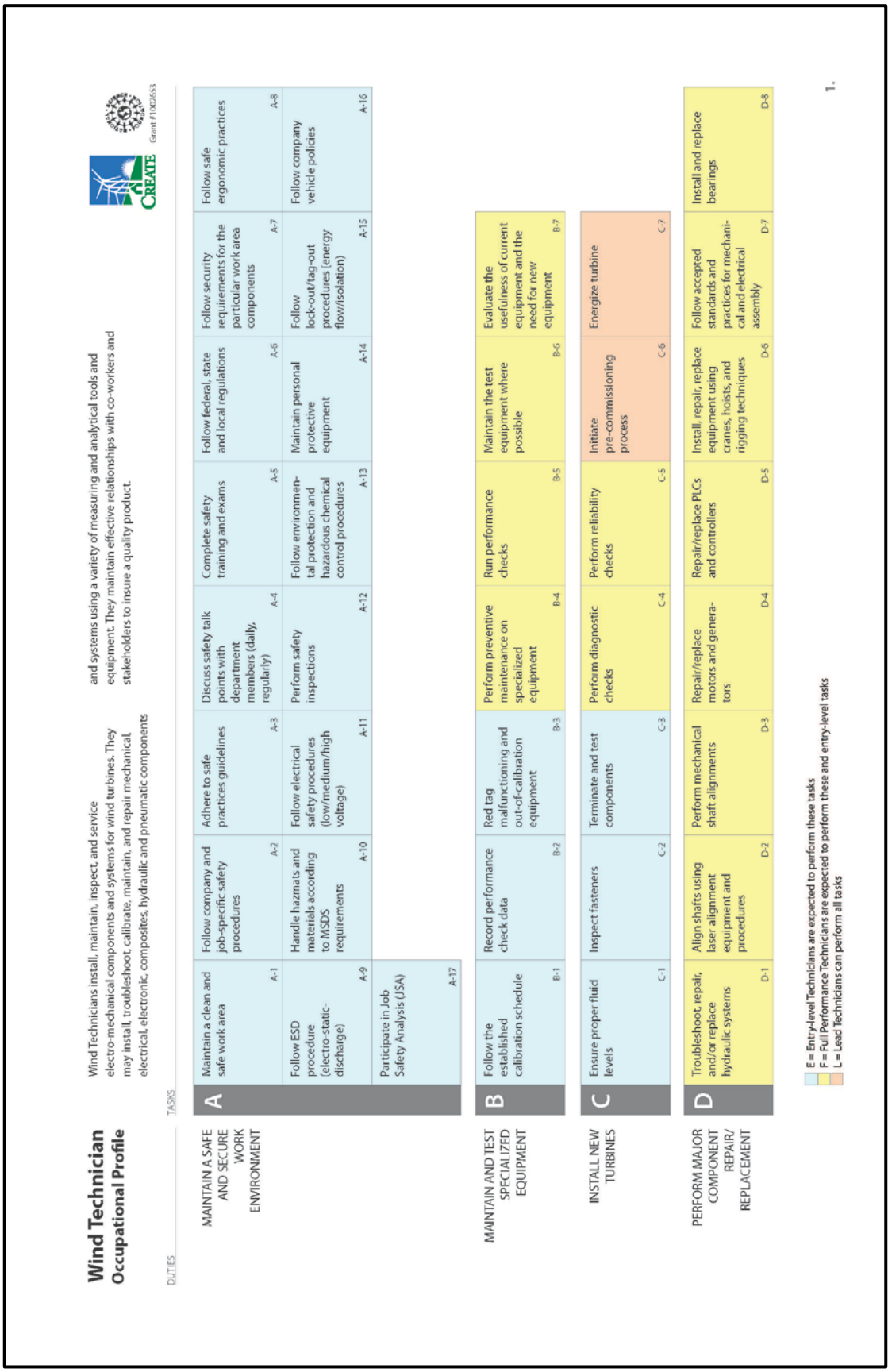
curriculum plan, degree framework, and future trends is available on ATEEC's website.)

The DACUM process is a structured type of occupational or task analysis that is used by businesses, industry, government, and educational institutions to identify knowledge gaps. The basic characteristics of the DACUM philosophy are:

- Curriculum needs to include real-world preparation for an occupation.
- An occupation can most effectively be described in terms of successfully performed job tasks or competencies.
- The expert worker is the best source for recognizing and describing job tasks.

The DACUM process has three main elements: needs assessment, a data-gathering workshop that produces a DACUM chart, and curriculum development. A needs assessment is simply a focused effort to determine whether instruction is needed and, if so, in what area; this effort often begins with a curriculum review or labor market survey. A DACUM workshop is held to bring together a focus group of expert workers in a specific field or occupation for a two-day brainstorming session. A trained DACUM facilitator guides the workshop participants to produce a chart that lists the tasks performed by an entry-level worker in the occupation and the knowledge and skills required. A curriculum designer and/or instructor then uses the DACUM chart to develop an industry-validated program of instruction for training an entry-level worker for the job.

DACUMs are mainly used for identification of instructional needs, instructional program planning, curriculum development, training materials development, creating and revising job descriptions and standards, employee recruitment, ISO 9000/14000 performance, and career guidance. In the past, DACUMs were mostly used by community colleges for vocational-technical instruction. Since the 1980s, business and industry have also used DACUMs extensively for corporate and industrial training programs. In the past few years, the DACUM concept is increasingly used by secondary and post-secondary educators in arts and science programs, as well as vocational-technical programs and business/industry.



Sample DACUM Chart

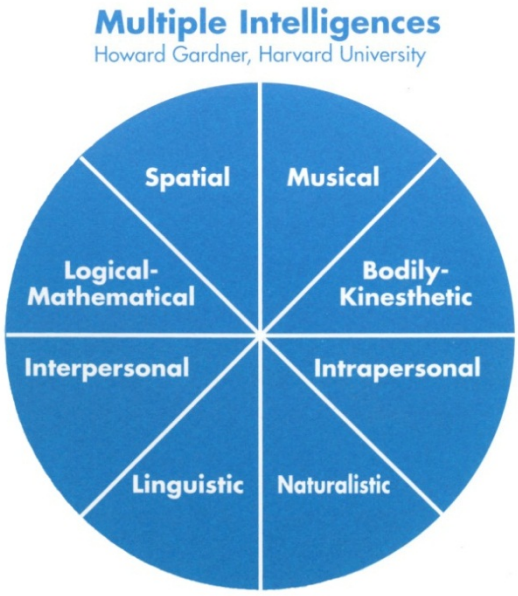
(Courtesy of the Center for Regional Engineering Technology Education (CREATE))

During the workshop process, expert workers on the DACUM panel work with the facilitator using guided brainstorming techniques to discuss and reach a consensus on a job title, job description, and identification of the areas of competency and tasks. Each suggestion is written on a card and attached to the wall for easy viewing by all panel members. This method ensures that the ideas can be easily created, rearranged, and discarded (or retrieved) during the panel discussion. Tasks are written using action verbs, to ensure that they are performance based and as clear as possible. When consensus on content is reached, the panel refines the wording and prioritizes the tasks. A graphical DACUM chart is developed, containing general areas of competency (in a single column to the left), followed by rows of the specific tasks within each general area.

Depending on the intended use and specific requirements of each DACUM, the panel may also identify the general knowledge and skills required of successful workers; the necessary facilities, tools, equipment, supplies, and materials; worker behaviors that are essential for success; and emerging technologies and issues likely to affect the occupational field. Whenever possible, the DACUM chart is validated with a wider industry representative audience.

Learning Support Analysis

In addition to determining what learning content is needed, the following areas need to be analyzed and factored into the overall needs analysis prior to and during curriculum development, as applicable:



- Target audience characteristics, such as:
  - Traditional or nontraditional students
  - Prerequisite skills
  - Learning styles (predominant types of learning intelligences[vii])
  - Working or full-time students
  - Current levels of content expertise
  - Experience
  - Socioeconomic, gender, culture, ethnicity, and race
  - Special needs
- Learning environment, such as:
  - Institutional support for program
  - Availability of instructors
  - Adjunct and/or full-time instructors
  - Adequate facilities
  - Proper equipment and materials
  - Appropriate safety and health procedures, if applicable

For more details on analyzing the learner and the learning environment, refer to the Supplementary Resources section.

Designing and Developing Your Program

In practice, the work of the design and development stages are more closely aligned than any of the other stages. Generally, in the design stage, you'll select appropriate performance and learning objectives and assessment criteria. During the development stage, you'll select the appropriate curricular components (such as general topics, specific content, and how information is presented) to support and promote those performance objectives and prepare for implementation. The recommendation mentioned in this guide's introduction, which well bears repeating, is **DON'T reinvent the wheel**.

Your school or other schools may have existing similar programs or portions of programs that your own program needs. A minimal amount of research for existing materials can result in huge time savings. For example, if developing a new photovoltaic systems program, your school likely has electrical or electromechanical programs that can be used directly or adapted to your use. Another example is ATEEC's online resource section, containing environmental and energy program and course curricula and materials that are available for download at no charge. Do a little research and build on what already exists.

The **target audience** and **program occupation** must always be the most important elements. Components of program design and development include:

- Performing occupational analysis with heavy industry involvement
- Organizing an advisory committee of industry representatives and other stakeholders to provide guidance and assess progress in all phases of program development and implementation
- Forming alliances and partnerships with other schools and industries to strengthen recruitment, retention, and motivation
- Listing the program resources that will be needed, including faculty/staff, physical space, equipment, materials, etc. to enhance program cohesiveness and align facilities with specific programmatic needs
- Using the information gathered in the above items to select a delivery method (e.g., online, face-to-face,

hands-on activities) to begin developing the curriculum
- Performing continual formative (ongoing) evaluation checks to measure program effectiveness
- Providing support services to enable the largest number of potential students to participate (Refer to the Supplementary Resources section.)
- Providing support services in balance with cultural and historic traditions, and socioeconomic realities (Refer to the Supplementary Resources section.)

CURRICULUM DEVELOPMENT

The value of a targeted occupational analysis cannot be overemphasized for developing effective curriculum. It is the critical starting point for the curriculum development process. The fact that there are a variety of methods (e.g., DACUM, JTA, competency model, direct step-by-step job observation report) to achieve the goal should not be a concern. It is no accident that the outcomes from this variety of processes are nearly identical; they all detail job competencies, both technical (including job-specific tasks, knowledge, and skills) and general (e.g., communication, computer, teamwork, interpersonal skills). Bottom line—whichever process is used, it becomes the starting point for your curriculum development effort.

Design

During the design stage of curriculum development, use your occupational analysis information as a basis to determine the specific content needed for training. Create your performance goals, competencies, criteria, and assessment:

1. Analyze each task to determine what specific knowledge and skills are necessary for performing the task. An example of a task for an environmental technician might be, "Sample surface waters."

2. Write a performance objective as a measurable, specific criterion of acceptable performance. (See "R.F. Majer's "Parts of a Learning Objective"[viii] to the left.) Following the previous example, one of the performance objectives might be, "Label and document the sample container."

Parts of a Learning/Performance Objective

1. **Action verb** that describes the learning required by the student
2. **Subject content reference** that describes the content being treated
3. **Level of achievement** in measurable terms
4. **One or more conditions** under which the evaluation would take place

For example:
- Using OSHA's Bloodborne Pathogens standard in 29 CFR 1910.1030 (*condition*)
- write (*action verb*)
- an Exposure Control Plan (*subject content reference*)
- that complies with all the requirements in paragraph (c)(ii). (*level of achievement*)

3. Continue to identify and sequence the steps a worker follows to complete the task. Include cues, decisions, warnings, or errors that may occur during these steps. For example:

   - Make field observations and utilize appropriate math skills to take measurements to accompany water sample.
   - Log field observations, measurements, and procedures.
   - Determine sampling target.
   - Use a technique appropriate to the sampler.
   - Fill sample container.
   - Decontaminate sampler.
   - Label and document the sample container.
   - Prepare the sample for transport.

4. Determine the necessary equipment and materials needed to complete the task. For example:

   - Samplers: subsurface grab sampler, Kemmerer bottle, bailer, dipper, and pump
   - Meters: dissolved oxygen meter, thermometer, flow meter, conductivity, and depth
   - Sample containers for water: vials, jars, and caps
   - Written sampling plan
   - Transport/storage containers, cooler, and ice packs
   - Documentation materials: logs, labels, seals, chain of custody forms, and waterproof pen
   - Decontamination supplies: solvent, (organic-free water), de-ionized rinse water, scrub brushes, plastic wrap, and paper towels

5. Write measurable performance criterion for assessing learning outcomes. Ensure that the assessment aligns with the original performance objective. For example, "Demonstrate a sampling of surface water." Measurement of the successful completion of this objective would be observation of the learner accurately completing the steps in item 3 above.

After staff and industry advisors use this process to analyze and flesh out the tasks from the occupational analysis, the information continues to be developed as student

Authentic Assessment Strategies

The authentic assessment is not simply a standard question and answer test but is a realistic, meaningful, and purposeful demonstration of achieving the learning objective; for instance, the authentic assessment for the OSHA Bloodborne Pathogens example (on the previous page) is the student's written Exposure Control Plan.

Examples of authentic assessments that require a student to use higher order thinking:

- Recommend a solution to a problem
- Write an analysis
- Design something
- Illustrate a concept
- Develop an analogy for a concept
- Draw conclusions from data

performance objectives and are organized into units or courses. When working on a course, one of the results of your design efforts will be the syllabus.

Development

During the development stage, determine how the above content can best be presented. Select and/or create delivery strategies and learning activities that directly support the performance goals and competencies from the design stage.

During learner analysis, you've found what the different types of learning "intelligences" exist, and can now target as many of these as possible in your teaching strategy. Keep in mind that the ADDIE model can be used to organize the development of an entire program of study, a course, or simply a unit, lesson, or activity.

When working on a course, some of the results of your development efforts should be:

- Content organization
- Lesson plan content
- Delivery methods (e.g., lecture, reading/writing assignment, multimedia, demonstration, discussion, hands-on activity, practice, group work
- Assessment/feedback mechanisms
- Pilot testing prior to introduction into the classroom

ATEEC highly recommends contextual teaching and learning (CTL) methods , i.e., instruction presented in the context of a real-world situation that the student would encounter, whenever possible. (Refer to Supplementary Resources.)

CTL methods recognize that knowledge and "know-how" are constructed when learners meet complex challenges in a meaningful social setting. CTL is characterized as:

- Problem- and project-based. CTL can begin with a simulated or real problem. Students use critical thinking skills and a systematic approach to inquiry (possibly using scientific method) to address the problem or issue. Students may also draw upon multiple content areas to solve these problems and implement their projects. Worthwhile issues that are relevant to students' families, school experiences, workplaces, and communities hold a greater personal meaning for students and learning will be better retained.
- Multiple contexts. Theories of situated cognition suggest that knowledge cannot be separated from the physical and social context in which it develops. How and where a person acquires and creates knowledge is therefore very important. CTL experiences are enriched when students learn skills in multiple contexts (i.e., school, community, workplace, family).
- Student diversity. On the whole, our student population is becoming more diverse; with increased diversity comes differences in values, social mores, and perspectives. These differences can be the impetus for learning and can add complexity to the CTL experience. Team collaboration and group learning activities respect students' diverse histories, broaden perspectives, and build interpersonal skills.
- Self-regulated learning. Ultimately, students must become lifelong learners. Lifelong learners are able to seek out, analyze, and use information with little to no supervision. To do so, students must become more aware of how they process information, employ problem-solving strategies, and use background knowledge. CTL experiences should allow for trial and error, provide time and structure for reflection, and provide adequate support to

Contextual Teaching and Learning strategies focus on students as active learners and provide a wide range of learning opportunities, leading students to solve complex, real-world problems.

Ohio Resource Center for Mathematics, Science, and Reading

assist students to move from dependent to independent learning.

- Interdependent learning groups. Students will be influenced by and will contribute to the knowledge and beliefs of others. Learning groups, or learning communities, are established in workplaces and schools in an effort to share knowledge, focus on goals, and allow peer teaching and learning. When learning groups are established in schools, educators act as coaches, facilitators, and mentors.
- Authentic assessment. CTL is intended to build knowledge and skills in meaningful ways by engaging students in real-life, or authentic, contexts. Assessment of learning should align with the methods and purposes of instruction. Authentic assessments show (among other things) that learning has occurred, are blended into the teaching/learning process, and provide students with opportunities and direction for improvement. Authentic assessment is used to monitor student progress and inform teaching practices.

Two best practices methods for contextual teaching and learning are problem- and project-based learning.

Problem-Based Learning

A great example of problem-based learning is a role-playing simulation. Picture a classroom of students actively engaged in solving a real-life community problem, for which a town meeting has been scheduled. Teachers have students gather data as they prepare to address the issue of an abandoned, environmentally contaminated property acquired by the community. The problem statement reads, *"How can we determine the most economically advantageous and environmentally safest use of this parcel of land, so that the people and the municipal government are happy with the result?"*

Time is provided in applied math, science, communications, economics, psychology, fine arts, and technology classes to get ready for a simulated town meeting activity. Each student assumes a role of one community stakeholder. Each stakeholder participates in the "town meeting" about the future of the site. The goal is to achieve consensus among stakeholders regarding the

proper use of contaminated land. Then the entire class attends the actual town meeting, with the most logical and persuasive group presenting.

When students find academic and technical concepts to be relevant to their lives, they are more likely to learn, retain, and apply the concepts properly.

Project-Based Learning

Project-based learning involves actual production of a product, such as students gathering data for a report on the effects of bovine grazing on the environment and to determine potential solutions for any problem that exists.

This experience helps students appreciate the environment while actively engaged in conservation methods, and will share those methods with other interested parties.

For more information on best practices in teaching and curriculum development, refer to the Supplemental Material section.

FACILITIES, SUPPLIES, AND EQUIPMENT

In setting up new or reworking existing facilities, be sure to simultaneously consider the supplies and equipment that will be necessary, e.g., smart boards, projectors, and storage. Also, be sure to replicate actual on-the-job conditions whenever feasible. A number of factors must be considered, including:

- Funding
- Prioritization
- Procedures
- Inventory
- Maintenance and security

Above all, whether working in a chemistry laboratory for a course on biofuels or simply taking students on a walk-through activity of a local business for an energy auditing lesson, establish an appropriate emergency management plan. Train all students, faculty, and staff. If applicable,

adopt an existing safety manual or write your own. Depending on the class, you may need to offer prerequisite classes in health and safety.

Funding

Traditional classrooms, multimedia, laboratories, and outdoor facilities are essential to running many environmental or energy programs. With so many environmental laws, regulations, and cases online, access to a computer lab and the Internet is a must. Even a basic science facility can be very expensive to design, build, and maintain.

If you are lucky enough to be able to create your own facilities, work directly with architects and talk to technology teachers about design, layout, equipment, storage, vents, fans, etc. Contact state health and fire departments for current regulations and building codes.

Credit: Partnership for Environmental Technology Education

If you must make do with an existing facility, the proper equipment and supplies can be acquired by asking science and technology instructors and community businesses for suggestions on funding and procurement for your programs.

Funding is acquired through endowments, student tuition and fees, industry support, and often grants offered by agencies, organizations, and the U.S. government. Applying for grants takes considerable time and networking skills. The applicant needs to know the providers well enough to discern exactly what they are looking for and how to word the application to suit their requirements as well as the applicant's needs.

Other options for management of funding issues include:

- Sharing facilities with other departments, high schools, or colleges;

- Offering short-term training programs to create income;
- Partnering with industries that hire graduates of your programs; and
- Soliciting for used equipment and supplies.

Beware of old equipment in need of repair or for which parts are unavailable. Old appliances such as refrigerators can cost more than they are worth to maintain. Make sure all chemicals are still within their active shelf life, and properly packaged, labeled, and stored.

Acquisition

Acquire facilities, equipment, and supplies that cover core training necessities first. Only purchase what you really need. Be creative; make your own equipment when possible. Collaborate with engineering, electrical, mechanical, and construction departments or businesses. Checklists for equipment[ix] categories are provided on ATEEC's website.

Procedures

Standard operating procedures (SOPs) should be developed for handling facility functions and activities, such as locking cabinets and doors for security and in emergencies. Department facilities should be in compliance with Occupational Safety and Health Administration (OSHA) standards to ensure the health and safety of employees and students. SOPs should also be developed when taking students off-site for activities. Following regulations reduces school liability and sets an example for students who are learning to apply these rules in their future workplaces.

Allow students to assist in auditing departmental facilities for real-life experience. Students can design facility checklists for compliance.

Typical compliance procedures include:

- Hazard communication (signage, labeling, and data sheets);
- Proper storage of chemicals;
- Lockout/tagout of electrical and mechanical hazards;

- Walkway design and layout;
- Egress plans;
- Respiratory protection; and
- Laboratory hygiene.

Reduce injury by keeping facilities clean and well maintained. Comply with all local building, electrical, and fire codes. Take a walk-through with an industrial hygienist and the local fire chief.

Inventory

To ensure that equipment and facilities are available and in good condition when needed, align procedures for periodic inspection, and routine and preventative maintenance. Follow all requirements set by the Occupational Safety and Health Administration (OSHA)[x], Department of Transportation (DOT)[xi], and Environmental Protection Agency (EPA)[xii]. Follow professional standards such as those outlined by the National Fire Protection Association (NFPA)[xiii] and manufacturers' documentation.

When inventorying supplies, create a checklist or spreadsheet. For each item, describe the supply, unit price, source of supply, expiration date (if applicable), and number of units. Date and initial the checklist each time inventory is conducted. Store supplies in proper facilities. Keep chemicals locked in cabinets marked poisonous, flammable, and so on. Keep flammable materials in fire-resistant containers. Inventory can be conducted on a weekly, monthly, or quarterly basis depending on how often items are used and replaced.

Maintenance

Department facilities, equipment, and supplies should be in compliance with OSHA standards to ensure the health and safety of employees and students. Check OSHA general industry standards in the Code of Federal Regulations (29 CFR 1910)[xiv]. The facility should comply with all applicable local building, electrical, and fire codes. Ask administration if the insurance company has a loss prevention specialist or industrial hygienist who could walk through the facility and make recommendations on how to keep the facilities clean and well maintained. Local fire chiefs will also walk through the facility and make recommendations on how to

reduce hazards, such as those that could cause falls or fires.

For much more information on facilities, equipment, and supplies, refer to the Supplemental Resources section.

PARTNERSHIPS

The need for strong alliances and partnerships cannot be overstated. Business and industry relationships provide internship possibilities for students and training revenue for community projects. Community networking is essential to communication and the development of fruitful partnerships. In addition to the more common articulation agreements, working with other educational institutions can provide other opportunities and facilities that a single school may not be able to manage.

Possible partners include:

- K-12 schools
- Two-year colleges
- Four-year colleges and universities
- Businesses
- Industries
- State governments
- Federal government programs
- Federal government agencies

Success then depends on the school's ability to partner with the best resources available.

The ACS Model

An excellent model[xv] for the initiation and continuation of successful alliances is offered by the American Chemical Society (ACS), partially reprinted here by permission.

A partnership can be defined as a system by which there is a shared responsibility between education, industry, labor,

government, and community to develop the human resources required for high-performance workplaces. Alliance activities must yield benefits to all participating members.

A successful alliance:

- Continuously updates, improves, and customizes industry-based competencies;
- Develops curricula, course content, and programs;
- Uses instructional materials that support a customized set of industry-based competencies;
- Provides workplace experiences for students;
- Provides professional development activities for faculty;
- Links intermediate, secondary, and postsecondary institutions;
- Shares financial, capital, and human resources;
- Monitors employment, occupational trends, and other regional trends;
- Provides public relations, outreach, and career guidance; and
- Communicates about events, activities, and findings.

The Roles of Partners

Education	Government	Community	Business and Industry	Labor
Build courses, curricula, and programs.	Endorse processes to identify and validate industry-based competencies.	Coordinate public outreach activities such as career days.	Identify competency requirements for the workplace.	Participate in the process of identifying and validating industry-based competencies.
Articulate with other educational institutions.	Establish portfolio, certification, and credentialing frameworks.	Participate in state academic and skill standards initiatives.	Identify business and employment trends.	Promote continuing education for workers.
Encourage faculty and students to take advantage of workplace experiences, co-ops, and internships.	Establish and monitor safety, health, and environmental data.	Encourage participation in faculty development and opportunities.	Provide financial, capital, and human resources.	Ensure that current workers have access to education and development opportunities.
Provide financial, capital, and human resources.	Provide a seamless link between secondary and post-secondary education.		Provide workplace experiences for faculty and students.	Participate in state certification and portfolio initiatives.
Ensure well-rounded educational experience to support technical skills and knowledge.			Encourage employees to participate in alliance activities.	
Provide flexible schedules for current workers.			Provide public awareness programs.	
			Participate in career guidance activities	
			Provide scholarships.	

Credit: American Chemical Society

Advisory Committee

One of the most critical alliances for an environmental or energy program is the advisory committee (AC). The AC is composed of knowledgeable persons from business, industry, government, community organizations, area high school and higher education staff, faculty, and students. Their charge is to advise and consult with administrators and faculty on educational programs for the community or technical college. Establishing an active AC is a necessary part of a team effort to provide quality education for students in technical fields.

The institution needs close cooperation with the community if it is to provide relevant occupational education. The evaluation and advice of experienced employers and employees ensure that the knowledge and skills being taught are applicable to the needs of the businesses and industries that will most likely hire them after completion of their degree program.

An AC provides guidance on the following functions:

- Assist in assessing the need for education and training in an occupational area.
- Assist in determining an appropriate program of study to meet the needs of students and the community.
- Assist in analyzing and/or validating the tasks as well as the knowledge and skills required in that occupation.
- Provide insight into the educational program relative to expected student outcomes/job skills.
- Recommend instructional equipment and assist in obtaining it (e.g., soliciting donations).
- Make recommendations in planning and/or modifying facilities.
- Assist in recruiting and placing students.
- Identify people in the field who can advise and make presentations to students and instructors.
- Create public awareness of the program by promoting good public relations between the school and the community.

Articulation Agreements

Early planning facilitates communication and curriculum coordination among educational institutions providing an essential service to students, employers, and the community.

Two-year colleges provide a natural bridge for articulation programs between secondary schools and four-year colleges. Articulation agreements are often initiated by two-year colleges and reviewed annually by an advisory committee. Community colleges are particularly good at developing smooth articulation paths.

Other Partnerships

Alliances with other community and technical colleges expand the institutions' ability to provide high quality educational opportunities at reasonable costs. Partners might arrange for each college to choose a program to specialize in, and offer articulation agreements with partner colleges. Each college need only equip one or two labs instead of building separate labs for each subject. Supplies can be purchased in bulk and are easier to categorize. Partnered schools share faculty and staff as well as services not otherwise available through institutions operating alone.

For more information on partnerships, refer to the Supplementary Resources section.

Implementing Your Program

During the implementation stage, the instruction is finally presented to the students. This is where you will actually teach the materials developed in previous stages. Remember, whenever possible, pilot test your course during the development stage and revise accordingly before implementing the program in the classroom.

There are many resources readily available on teaching methods and pedagogy. The previous section of this guide highly recommends contextual teaching and learning methods, i.e., instruction presented in the context of a real-world situation that the student would encounter. (Refer to Supplementary Resources.) We don't presume to be able to effectively present all these methods in this brief guide. But the following information encapsulates several well-researched, standard instructional design best practices for teaching.

According to Robert Gagné[xvi], learning occurs in a series of learning events. Each learning event must be accomplished before the next in order for learning to take place. Similarly, instructional events should mirror the learning events:

Gagné's Nine Events of Instruction

1. Gain attention: To ensure reception of coming instruction, the teacher gives the learners a stimulus. Before the learners can start to process any new information, the instructor must gain the attention of the learners. This might entail using abrupt changes in the instruction.
2. Inform learners of objectives: The teacher tells the learner what they will be able to do as a result of the instruction. The teacher communicates the desired outcome to the group.
3. Stimulate recall of prior, prerequisite learning: The teacher asks for recall of existing relevant knowledge.
4. Present the stimulus: The teacher gives emphasis to distinctive features.
5. Provide learning guidance: The teacher helps the students in understanding (semantic encoding) by providing organization and relevance.
6. Elicit performance: The teacher asks the learners to respond, demonstrating learning.
7. Provide feedback: The teacher gives informative feedback on the learners' performance.
8. Assess performance: The teacher requires more learner performance, and gives feedback, to reinforce learning.
9. Enhance retention and transfer: The teacher provides varied practice to generalize the capability.

Adapted from: Gagne, R.M. et al. (2004). Principles of Instructional Design. New York: Cengage Learning.

Benjamin Bloom's "Taxonomy of Cognitive Levels"[xvii] provides direction on types of learning, arranged from lower to higher order thinking. These action verbs are also excellent examples of verbs to use when writing a performance objective or learning outcome.

Taxonomy of Cognitive Levels

Knowledge
Remember previously learned material.

Arrange, define; duplicate, enumerate; identify; label; list; match, memorize, name; order, recognize; recall; repeat; reproduce; restate; select

Comprehension
Grasp the meaning of material.

Classify; cite; convert; describe; discuss; estimate; explain; express; generalize; give example; identify; locate; report; sort; paraphrase; summarize; translate

Application
Use learned material in new situations.

Act; administer; apply; chart; compute; construct; control; demonstrate; determine; develop; discover; implement; illustrate; instruct; interpret; operate; predict; prepare; preserve; produce; record; report; sketch; solve; use

Analysis
Break down material to determine structure.

Break down; calculate; categorize, compare; contrast; criticize; correlate; diagram; differentiate; discriminate; distinguish; examine; experiment; illustrate; infer; inventory; outline; prioritize; question; separate; test

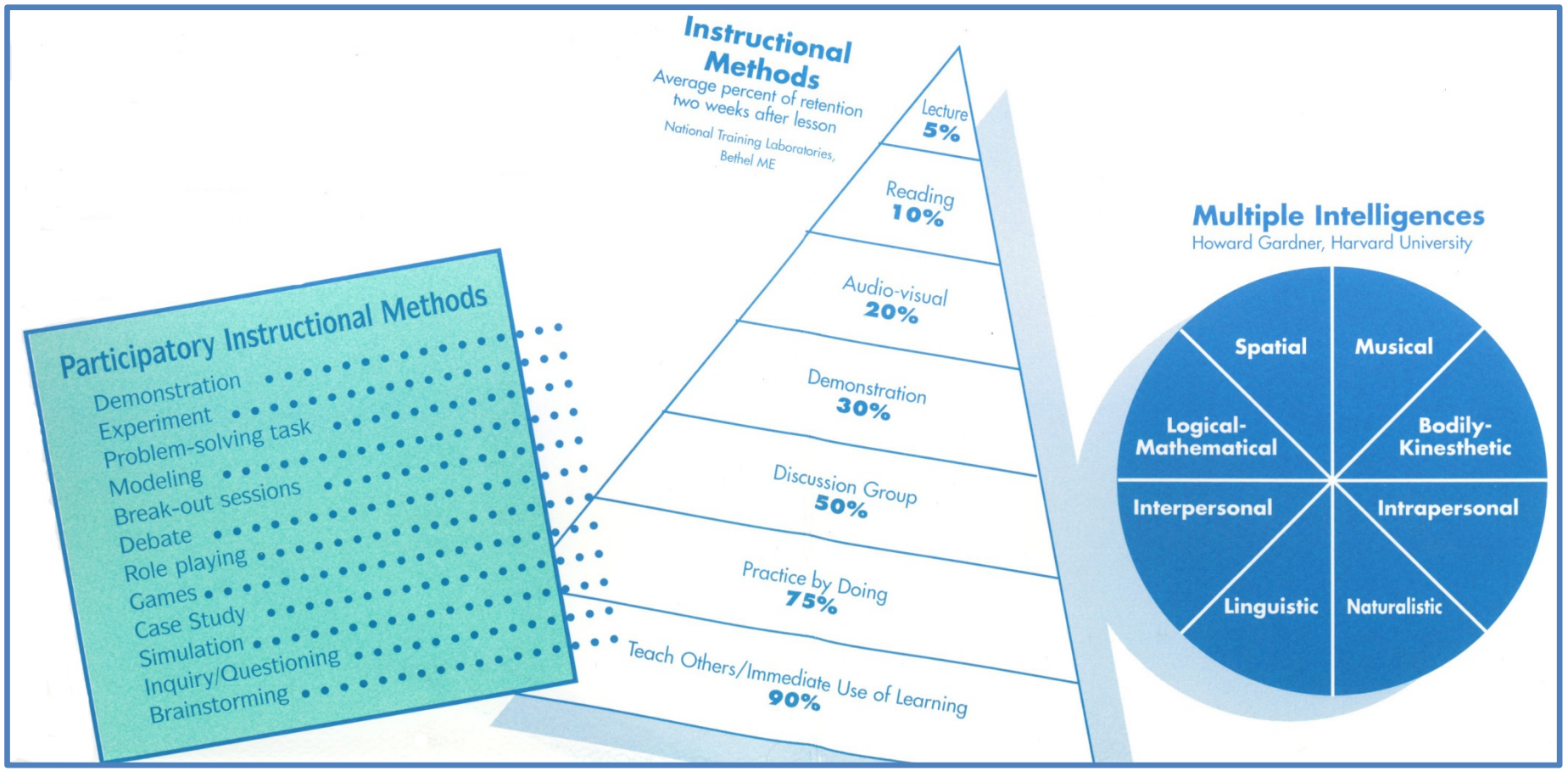
Synthesis
Put parts together to form a whole.

Arrange; assemble; collaborate; collect; combine; compile; compose; construct; create; design; devise; formulate; generate; incorporate; integrate; modify; organize; plan; prepare; rearrange; reconstruct; revise; validate

Evaluation
Judge the value of material for a given purpose.

Appraise; argue; assess; conclude; confront; criticize; critique; decide; defend; estimate; evaluate; interpret; judge; justify; predict; rate; score; support

Bloom, Benjamin et al., *A Taxonomy of Educational Objectives Book 1: The Cognitive Domain.* Harlow, United Kingman: Addison Wesley Publishing Company, 1987.


Participatory Instructional Methods
Demonstration
Experiment
Problem-solving task
Modeling
Break-out sessions
Debate
Role playing
Games
Case Study
Simulation
Inquiry/Questioning
Brainstorming
Instructional Methods
Average percent of retention two weeks after lesson
National Training Laboratories, Bethel ME
Lecture 5%
Reading 10%
Audio-visual 20%
Demonstration 30%
Discussion Group 50%
Practice by Doing 75%
Teach Others/Immediate Use of Learning 90%
Multiple Intelligences
Howard Gardner, Harvard University
Spatial
Musical
Logical-Mathematical
Bodily-Kinesthetic
Interpersonal
Intrapersonal
Linguistic
Naturalistic

For further details on classroom implementation and teaching methods, ATEEC recommends a basic instructional design course or textbook. See the Supplemental Resources section.

Evaluating and Maintaining Your Program

What is the difference between assessment and evaluation?

Generally, assessment is the measurement and gathering of data . Evaluation is the analysis and interpretation of the assessment data.

Program evaluation is a systematic process for the assessment of all the elements that have gone into the development of a program: collection (also known as program assessment), analysis, and interpretation of data concerning a program and its curriculum. The purpose of the evaluation process is to improve quality and relevance and to ensure the effective and efficient use of resources. Additionally, program evaluation is a cooperative process that uses the knowledge and expertise of instructors, administrators, students, graduates, advisory committee members, and employers. Program quality is built by seeking and acting on feedback from all stakeholders.

Program evaluation is ultimately a means of ensuring that the needs of both students and employers are met. The process assesses the viability of the occupational field, as well as the degree to which the program outcomes meet the needs of the labor market. Program evaluation initiates the process of self-examination among administrators, faculty, and staff, and assists in the formulation and clarification of program goals and objectives.

What is the difference between formative and summative evaluation?

Formative evaluation is an ongoing effort throughout the program to measure its success. Summative evaluation is performed after a course/program/project is complete or after a section (semester or year) of it is complete.

In addition to your own formative and summative evaluation, use your institutional research department for assessment. Statistical data is collected annually for all programs. Data is compiled by the institution and provided to the internal review team for use in evaluating the program. Examples of statistical data include enrollment, contact hours, full-time equivalency (FTEEs), costs, graduation rates, and success rates.

Student perceptions are gathered through surveys, providing valuable feedback on whether learning objectives were clear and whether content was delivered effectively. Outcomes from student assessment allow evaluation of whether increased knowledge, skills, and attitudes were achieved.

Institutionally, program evaluation enables the organization to make informed decisions regarding program development, maintenance, modification and elimination, and allocation of resources. It provides information regarding the job market for program graduates, the success of program graduates, direction for curriculum improvement, and the equipment and materials needed for successful program delivery. Externally, program evaluation will ensure that the institution is providing quality education, enabling individuals to become academically, occupationally, and socially competent. It communicates to

employers and the community a commitment to excellence and continuous quality improvement.

For more in-depth information on the procedures for program evaluation and maintenance, refer to the Supplemental Resources section.

PART II

Supplemental Resources

This document is intended to be a quick guide to environmental and energy program development. This Supplemental Resources section will provide more in-depth information and links, with many step-by-step procedures and charts, to achieve that goal.

The following topics will be provided and/or expanded upon here:

- Analysis
- Design/Development
- Implementation
- Evaluation
- Professional Development
- Recruitment and Retention
- Student Support Services

ANALYSIS

ADDIE Instructional Systems Design Model

- For more information about the ADDIE model, including a timeline, written history, critical analysis, and links for further research, see Donald Clark's article "ADDIE Timeline" at http://www.nwlink.com/~donclark/history_isd/addie.html.

- A PowerPoint presentation illustrating the ADDIE model can be downloaded from ATEEC's website at http://ateec.org/addie-model/.

- Basic information on instructional systems design and the ADDIE model are available in the Interstate Renewable Energy Council's *Solar Energy Education and Training Best Practices* document on "Developing a Quality Course" at http://www.irecusa.org/publications/best-practices-3-developing-a-quality-course/.

Existing Curricula

Before developing a new program, or updating an existing one, check other programs in the field you are considering. A listing of environmental, energy, and water degree, certificate, and workforce development training programs in the United States can be found on ATEEC's website at http://ateec.org/resources/programs-databases/about-the-databases/.

Instructional Design

- Many textbooks on instructional design are available. Some of the standard books used in the classroom include:

    - Robert Gagne's *Principles of Instructional Design* at http://www.amazon.com/Principles-Instructional-Design-Robert-Gagne/dp/0534582842/ref=sr_1_1?s=books&ie=UTF8&qid=1386621900&sr=1-1&keywords=Principles+of+Instructional+Design
    - P.L. Smith and Ragan's *Instructional Design* at http://www.amazon.com/Instructional-Design-Wiley-Jossey-Bass-Education/dp/0471393533/ref=sr_1_1?s=books&ie=UTF8&qid=1393964598&sr=1-1&keywords=instructional+design+books+smith+and+ragan
    - G.R. Morrison, S.M. Ross, J.E. Kemp and H.K. Kalman's *Designing Effective Instruction* at http://www.amazon.com/Designing-Effective-Instruction-Gary-Morrison/dp/0470522828/ref=sr_1_2?s=books&ie=UTF8&qid=1393964740&sr=1-2&keywords=instructional+design+books+kemp.

Labor Market Assessment (LMA)

A template *Labor Market Assessment (LMA) Survey* for environmental and energy careers is available on ATEEC's website at http://ateec.org/labor-market-assessment-survey/. The survey instrument can be customized to suit individual needs.

An example of a LMA done for United Tribes Technical College (summary below) is available on ATEEC's website at http://ateec.org/wp-content/uploads/2012/12/Tribal/Reports/uttc_final_report.pdf.

LMA Case Study

On July 15th of 2008, ATEEC visited United Tribes Technical College (UTTC) located in Bismarck, North Dakota to facilitate a job/labor market assessment workshop in the field of environmental science on the reservation and throughout the region.

UTTC indicated that a job market/labor market assessment for the reservation and the region would allow UTTC to better design relevant curriculum in their environmental science courses. As a result of knowing what jobs were available, students would be better prepared to enter the workforce on or off the reservation. UTTC invited representatives to the workshop who work throughout the state, region, and the reservations to participate in the discussion. UTTC mentioned they would like participants to focus on available jobs that require only a two-year degree and to think about the following fields:

1. GIS
2. H2O Quality
3. Fire Safety
4. Hazmat
5. Soil Conservation

The job/labor market assessment area covered North Dakota, the reservations, and surrounding areas.

Workforce Development and Occupational Analysis

Workforce development "Defining the Field" reports and charts for environmental technology, energy technology and services, and water management. These documents are available on ATEEC's website and provide an overarching view of the fields, including categories, job titles, and general job functions.

DESIGN/DEVELOPMENT

Occupational Analyses

Explanations and descriptions of occupational analyses (DACUMs and JTAs) are available in the Interstate Renewable Energy Council's *Solar Energy Education and Training Best Practices* document on "Curriculum and Program Development" at http://www.irecusa.org/publications/best-practices-2-curriculum-program-development/.

A sample of a complete DACUM occupational analysis from Cerro Coso College can be found on ATEEC's website at http://ateec.org/wind-technician-dacum/.

A slideshow presentation on the DACUM process can be found on ATEEC's website at http://ateec.org/dacum-process/.

Teaching and Learning Strategies

Teaching and learning strategies that promote effective instruction are available in the Interstate Renewable Energy Council's *Solar Energy Education and Training Best Practices* document on "Becoming an Effective Teacher" at http://www.irecusa.org/wp-content/uploads/2009/10/SITN-BP-1.pdf.

Details on designing learning and performance objectives, see R.F. Majer's "Parts of a Learning Objective" at http://www.amazon.com/Preparing-Instructional-Objectives-Development-Instruction/dp/1879618036.

Benjamin Bloom's "Taxonomy of Cognitive Levels" from *Taxonomy of Educational Objectives Book :1 Cognitive Objectives* at http://www.amazon.com/Taxonomy-Educational-Objectives-Book-Cognitive/dp/0582280109/ref=sr_1_1?s=books&ie=UTF8&qid=1386622135&sr=1-1&keywords=Benjamin+Bloom+Cognitive+Levels provides direction on types of learning, arranged from lower to higher order thinking.

Facilities, Equipment, and Supplies

Facilities' equipment checklists can be found on ATEEC's website at http://ateec.org/equipment-checklists/.

An example of an emergency management plan for Berkeley College can be found at http://berkeleycollege.edu/berkeley_bc/2588.htm.

An example of a safety manual from the National Institute for Occupational Safety and Health can be found at http://www.cdc.gov/niosh/docs/2007-107/.

Facilities Maintenance

Department facilities should be in compliance with OSHA standards to ensure the health and safety of employees and students. Check OSHA general industry standards in the Code of Federal Regulations (29 CFR 1910). The facility should comply with all applicable local building, electrical, and fire codes. Ask administration if the insurance company has a loss prevention specialist or industrial hygienist who could walk through the facility and make recommendations on how to keep the facilities clean and well maintained. Local fire chiefs will also walk through the facility and make recommendations on how to reduce hazards, such as those that could cause falls or fires.

Facilities Maintenance: Equipment

Once again, the OSHA regulations in 29 CFR 1910 contain standards for respirators, ladders, power tools, and other equipment. Equipment standards are also published by several national organizations such as the American National Standards Institute (ANSI), American Conference of Governmental Industrial Hygienists (ACGIH), and Underwriters Laboratory (UL) for electrical equipment standards. However, OSHA standards are aligned with other organization's standards and should be the primary source of information for processes, procedures, and policies.

Equipment manufacturers supply documentation about their products that spell out procedures for calibration, inspection, maintenance, cleaning, hazardous materials decontamination, and battery charging. They explain procedures for parts replacement for monitor sensors and lamps. A maintenance timetable can be added to remind staff of recommended factory inspection and cleaning dates, warranty deadlines, and parts replacement guidelines.

Handling and wearing of personal protective equipment (PPE) can pass germs between users. After each use of especially vulnerable equipment such as face masks, follow manufacturer instructions for disinfection.

If equipment is needed for only a short time, consider renting or leasing it instead of purchasing. Establish partnerships with local industries; they may be willing to loan equipment as an investment in quality preparation and training of future employees. Discuss partnerships fully to determine who maintains this equipment and how to handle any problems that may arise (e.g., replacement of broken and worn parts, accidental damage, and so on). Consider who owns the equipment and what is covered by the user's insurance.

Equipment must be functioning properly to protect the safety and health of students and staff. Ensure that machine guards are in place, personal protective equipment is worn, and medical surveillance is conducted for those who wear respiratory protective equipment. Medical surveillance includes a baseline physical examination by a physician and monitoring of any difficulty with respiratory equipment, especially in hot weather.

Facilities Maintenance: Supplies

A simple recordkeeping system helps to maintain adequate stores of supplies. Don't wait for inventory time; some materials have a limited shelf life. Determine how often you will need to purchase these materials so that you use them before they pass their expiration date and new supplies arrive before the old stock runs out.

Chemical materials should arrive with a Material Safety Data Sheet (MSDS). If not, contact the manufacturer, since OSHA requires MSDS to be accessible to all staff and students.

Develop written procedures for handling chemicals that include but are not limited to:

- Proper storage (flammables in storage cabinets),
- Prevention of hazardous exposures,
- Disposal of waste materials, and
- Response to emergencies.

Train staff and students to follow established procedures. Label materials and post National Fire Protection Association (NFPA) hazard warning signs on doors of each area where hazardous materials are used or stored.

Facilities: Security

Plans for security maintenance should also be developed. All equipment should be assigned to responsible individuals who are properly instructed in maintenance and operational procedures. Control access by unauthorized persons to hazardous or potentially dangerous situations, install fire detection and suppression equipment, and plan response procedures for emergency situations.

Sample Laboratory Guidelines for Staff: All Teachers, Technicians, and Support Staff

- Teachers and technicians have a general duty to take reasonable care for the health and safety of themselves, other members, staff, and students. They need to be familiar with the health and safety policy, its updates, the texts to which it refers, and appendices. They must cooperate with the employer's instructions, observe the requirements of the policy, and fulfill special responsibilities when applicable. They must cooperate with colleagues in their specific health and safety duties. They have a duty to report to local management any failure of equipment that has a health and safety function.

- Staff must set a good example to students and follow laboratory rules (e.g., wearing eye protection).

- Staff must be familiar with emergency drill procedures and with the locations of escape route, fire-fighting equipment, eye wash station, the main gas cock, the main electricity switch, and the nearest spill kit.

- Laboratories must remain safe. Special arrangements must be made for equipment left running overnight, and hazardous equipment left out. In general, all gas taps should be completely turned off and all apparatus operated from a main terminal or power source switched off. (At the end of the day, if practical, gas should also be turned off at the laboratory main gas cock and electricity at the laboratory main switch.)

- Eating, drinking, and the application of cosmetics should not take place in laboratories, storage areas, or preparation rooms unless an area in which it is safe to do so has been created. Students should not be allowed to drink from water bottles.

- When staff is alone in the science department, nothing should be done which could lead to an accident requiring remedial measures. A teacher or technician must assess risks very carefully before conducting any practical operation in such circumstances.

- In general, students must not be left unsupervised in a laboratory. Staff needing to leave a class briefly must assess the risks of doing so, perhaps arranging for temporary supervision by a neighboring staff member. Special arrangements may be needed for senior students doing project work, depending on the hazards involved (e.g., an experienced member of staff in an adjacent room).

- Science laboratories, preparation rooms, and storage areas must be locked by staff when not in use. Special arrangements must be made if access is required to a fire escape route. Students must never be allowed into preparation rooms unless 100% supervision can be guaranteed. Laboratories must be cleared before being used by teachers who are not scientists. If clearing the laboratory is not possible these teachers must receive special training Teacher-supervised club activities in laboratories should only be possible by special arrangement.

Sample Laboratory Guidelines for Staff: Teachers

- At the beginning of each school year, teachers must ensure their students understand the rules for working in a laboratory. Issue copies in writing to be kept handy in places like an exercise book or work folder.
- Teachers must enforce the student laboratory rules, reminding students of them often enough for them to become familiar. With new students, time should be spent explaining the rules with appropriate demonstrations.
- Lesson preparation should include risk assessments and a list of the health and safety precautions required to work with the materials. Requisitions must be handled in time to obtain materials for testing before use in the classroom. Technicians must be given adequate time to prepare the work space and materials for use in a safe manner.
- Time should be allowed for consulting more experienced colleagues where there is any doubt and to try out experiments, particularly those involving significant hazards. Teachers must only deviate from the scheme of work—for which the activities have been checked against model risk assessments—after making a further risk assessment, checking with a subject specialist, and possibly obtaining a special risk assessment from a safety organization (such as CLEAPSS®). Teachers should explain precautions to students as part of their health and safety education (using Student Safety Sheets where appropriate).
- Open-ended investigations must be organized to allow teachers to assess risks and identify precautions before any hazards are met or practical work begins.
- Work should be modified or candelled if health, safety, and discipline cannot be maintained during certain practical work for a large class size. This decision should be reported to the head of the department or other appropriate person.
- The teacher is responsible for the health and safety of students in his/her classes taught by a trainee teacher. If the normal class teacher is absent, another science teacher must be given this responsibility by the head of department.
- Teachers in charge of courses are responsible for ensuring that technicians are familiar with the appropriate precautions needed to control hazards that may be encountered during the preparation of and clearing away of equipment. Class teachers may need to remind technicians of such warnings.

Partnerships

An excellent model for the initiation and continuation of successful alliances is offered by the American Chemical Society (ACS) at http://www.acs.org/content/acs/en/education/resources/twoyear/partnerships/how-to-start-a-chemical-technology-education-partnership.html.

An example of an articulation agreement between academic institutions can be viewed at the Mississippi Public Universities website at http://www.mississippi.edu/cjc/downloads/articulation_agreement.pdf.

Alliance Case Study

SpaceTEC (National Resource Center for Aerospace Technical Education) is an NSF ATE Center allied with the National Aeronautics and Space Administration (NASA).

"Based on input from members of the aerospace industry, SpaceTEC plans to add additional certifications.The plan calls for a DACUM (Developing A CurriculUM) "conducted with representatives from industry who are subject matter experts. The DACUM identifies duties and tasks; knowledge and skills; tools and equipment; and traits and attitudes for inclusion in new certifications. Competencies are then developed and SMEs are identified who can help develop the test bank.After a beta test of the bank is completed and analyzed, the new certification examination is approved for use and released, opening a new credentialing opportunity for technicians. In today's work environment, certifications are an indispensable element for qualifying employees, and [online assessment] plays a key role in that effort." (SpaceTEC Newsletter, 2011, May)

IMPLEMENTATION

A student video presentation explaining Bloom's taxonomy is available at http://www.youtube.com/watch?v=__YdXxwBZ7Q.

An instructor's PowerPoint presentation explaining Bloom's taxonomy is available at www.niu.edu/facdev/programs/handouts/blooms_presentation.pptx.

Teaching and learning strategies that promote effective instruction are available in the Interstate Renewable Energy Council's *Solar Energy Education and Training Best Practices* document on "Becoming an Effective Teacher" at http://www.irecusa.org/wp-content/uploads/2009/10/SITN-BP-1.pdf.

EVALUATION

Sections on evaluation, both formative and summative, can be found in any instructional design textbook. Search the Web, or start with the following:

- Robert Gagne's *Principles of Instructional Design* at http://www.amazon.com/Principles-Instructional-Design-Robert-Gagne/dp/0534582842/ref=sr_1_1?s=books&ie=UTF8&qid=1386621900&sr=1-1&keywords=Principles+of+Instructional+Design

- P.L. Smith and Ragan's *Instructional Design* at http://www.amazon.com/Instructional-Design-Wiley-Jossey-Bass-Education/dp/0471393533/ref=sr_1_1?s=books&ie=UTF8&qid=1393964598&sr=1-1&keywords=instructional+design+books+smith+and+ragan

- G.R. Morrison, S.M. Ross, J.E. Kemp and H.K. Kalman's *Designing Effective Instruction* at http://www.amazon.com/Designing-Effective-Instruction-Gary-Morrison/dp/0470522828/ref=sr_1_2?s=books&ie=UTF8&qid=1393964740&sr=1-2&keywords=instructional+design+books+kemp.

The following are guides on evaluation from granting organizations that contain both general and agency-specific evaluation requirements.

- National Science Foundation's *2010 User Friendly Handbook for Project Evaluation* at http://www.westat.com/pdf/projects/2010ufhb.pdf.

- Institute of Museum of Library Science's *Perspectives on Outcome Based Evaluation for Libraries and Museums* at http://www.imls.gov/assets/1/workflow_staging/AssetManager/214.pdf.

PROFESSIONAL DEVELOPMENT

Nothing is more effective at increasing teachers' use of specific instructional practices and active learning strategies than quality professional development and teacher training. Unfortunately, training is often the first thing cut when budgets get tight. Travel bans have practically eliminated professional development opportunities for community and technical college instructors. To recruit and retain quality teachers, institutions must provide a wide range of professional development opportunities on a regular basis.

Some of the best resources for professional development services are the:

- U.S. Department of Education at http://www2.ed.gov/teachers/landing.jhtml?exp=5

- Staff Development for Educators at http://www.sde.com/

- Association for Supervision and Curriculum Development at http://www.ascd.org/professional-development.aspx

RECRUITMENT AND RETENTION

Recruiting

Virtually every college has recruiters who are tasked with the goal of increasing the brand recognition of the college as well as identifying and engaging potential students. Oftentimes it takes the involvement of a department chair or similar person to establish recruiting ties above and beyond what the college has in place.

It is vital for recruiting in the environmental and energy departments to know what kinds of jobs exist locally. Department chairs (or their equivalents) are often expected to have relationships with local businesses and associations.

JTAs, DACUMs, and other procedures used in the design of the curriculum will help provide this sort of information and foster the beginning of these relationships. Any printed materials or website content developed will be valuable for sharing with prospective students, guidance counselors, workforce development centers, and staffing services. This sharing of information can help foster the relationships with area high schools and identify interested students.

Retention

Two-year colleges face significant challenges in the struggle to keep students beyond the first one or two trial courses. Students attend courses for a number of reasons such as social expectations, personal ambitions, peer or parental pressure, career changes, certification issues, etc. Students tend to span a wider range of age and economic groups than traditional four-year college students. Therefore, two-year institutions serve an extremely heterogeneous population. They are expected to provide a wide range of opportunities to a very diverse group of students.

Meeting this range of diverse needs requires a strategic retention plan. According to Noel-Levitz, Inc., which has studied recruitment and retention for 37 years, the development of a Successful Retention Plan requires six steps:

1. Set the stage by obtaining a three-year commitment from the board and administrators.
2. Establish retention priorities and formulate goals.
3. Integrate retention goals with existing programs and services.
4. Evaluate retention outcomes with data, exit interviews, and program reviews.
5. Prepare realistic retention timelines and action plans.
6. Recognize, reward, and celebrate student success.

Common components of a strategic retention plan include individualized academic advising, mentoring and tutoring, risk management counseling, internal and external community networking, and job placement services. (For more information, also see Student Support Services in the next section.)

An example of a retention plan can be viewed at the New Mexico State University-Alamogordo website at http://nmsua.edu/documents/Student-Retention-Plan09-14.pdf.

A PowerPoint presentation on retention is available from the University of Missouri-Kansas City at http://www.cas.umkc.edu/docs/Retention%20Presentation%202-11.pptx.

STUDENT SUPPORT SERVICES

Students often require assistance above and beyond the classroom in order to be successful. Student Support Services are an invaluable tool for students to anchor themselves in their chosen field of study. Colleges can use these support tools to remove the roadblocks that can otherwise hinder a student's academic development.

Students generally follow the same path to graduation: they decide what studies are appropriate for them and enlist in the applicable courses. They work through these courses to meet the requirements of their degrees, and they begin to establish themselves in their chosen fields.

Student support services offer assistance to students at every step of this path by offering academic advising, mentoring and tutoring, risk management counseling, and internal and external community networking.

Academic Advising

Academic advising helps match student interests and abilities with a rewarding career. Non-departmental academic advisors need to be familiar with and committed to environmental and energy technology programs. It is not enough to locate courses in the catalog and complete registration forms; advisors must be committed to the college and knowledgeable about its programs.

Offer a "Fresh Start" type of program for students on probation. Limit the number of registration days and notify students who have dropped classes or left programs of study that they are welcome to return. Tell them the school will do everything it can to make this time successful. Allow department chairs to remove poor grades from the transcript after completion of specific steps to improve academic standing and proof of intent to graduate. If all else fails, seek out and pursue appropriate transfer opportunities.

Mentoring and Tutoring

Tutorial services in large universities are usually provided by graduate students. Some community and technical colleges do not have that advantage. Instructors must be willing to offer tutoring in addition to class instruction.

Many students may be capable of understanding a concept, but are unable to read the textbook in English (e.g., English as a second language students, students with dyslexia) or cannot write papers in English, calculate mathematical equations, or use a computer software application (e.g., English as a second language students, students with physical disabilities).

Confidence-building is more important than any other student service. Many students come to college expecting to fail. They need soft skills training (e.g., critical thinking, problem solving, reliability, time management, accountability, Internet, library, and oral and written communication skills). Some students come to college never having read an entire book. Some may earn all A's, but when they get a single F feel like a total failure. Teach students to avoid problems before they occur.

Instructors should ask each other for help when faced with a student who needs tutoring or mentoring. An individual learning plan can be drafted when instructors know the student and the teaching and learning methods that prove most effective. A meeting with the student and one or more of his/her instructors should be held to design a plan of action and obtain commitment from all parties.

Mentoring services are exceptionally fruitful when students are paired with support personnel who have similar cultural affiliations and backgrounds. Mentored students often excel beyond the expectations of family, peers, and even themselves.

Risk Management Counseling

Risk management systems are vital for removing the roadblocks that can discourage students from going forward in their academic careers. The best way to help students who may be at risk for failure is to prevent failure before it happens. Early outreach programs require student orientation programs that provide information on financial aid, registration procedures, support services, and graduation requirements. Orientation can be provided online but is more effective on site.

Orientation

If students are required to take placement tests, offer testing at local high schools along with mini-orientation sessions. It is advisable for first-time students to take an introductory course in strategies for academic success. This course should teach stress management, test-taking, time management, note-taking, and study skills as well as school procedures and policies.

Financial Assistance

Financial assistance is crucial to the success of all students but especially those with low incomes and first generation students. Counselors must have the latest information on student job programs, financial aid, scholarships, and grants. They should be able to advise students of workshops and seminars that can be taken in addition to full-time college classes.

Libraries can provide textbooks for those who cannot afford to buy them. Books can be placed on reserve and checked out for specific lengths of time to use in the library.

Students with Disabilities

Students with learning disorders and deficits enroll in ever increasing numbers. Educational institutions are required by law to provide reasonable accommodation for disabled persons (Americans with Disabilities Act). Disability services provided in curriculum learning centers or other common areas allow all students to benefit from learning strategies taught by support specialists.

Students who require assistance should feel free to ask staff to walk them through difficult processes, such as registration, completing admissions forms, and filling out applications for financial aid. Students in need of academic support should feel free to ask for a tutor or mentor. Remove disability barriers within the classroom setting. Provide assistive technologies and instructor accommodations as needed.

Reasonable accommodations include:

- Untimed and/or private testing;
- American Sign Language and oral interpretation;
- Alternative print format (e.g., large print or Braille textbooks and closed-captioned videos);
- Reading services and permission to audio tape lectures;
- Note-taking services and copies of lecture notes;
- Portable equipment (e.g., listening devices, digital books, personal scanners, speaking systems);
- Laboratory assistants and specialized lab equipment; and
- Tutors, preferential seating, and partnered labs.

Private Counseling

High school and college counselors need to work together to help students navigate the emotional and personal hurdles they face when furthering their education. The counseling office must be prepared to offer emotional support and refer students to professional services if necessary. College students are often ill-prepared for the stress they face in their personal lives and the academic demands of higher education.

Community Networking: Internal

As students begin to master the information they learn in their classes, it is important to help them get established in their professional communities. Colleges can provide beginning connections for students to ease the transition to professional life through internal and external means.

Internal to the college, the services we automatically think of in reference to student support are more important now than ever before. Investment in support services increases community visibility, alumni support, and student identification with a college. Integrated support systems help students to bond with and support each other in times of need. Internal support services encourage students to study together and develop teamwork skills.

Student support groups are often affiliated with a particular cultural event or organization. Social clubs and peer support groups provide the stability that is missing during those first few years when students start making their own way in the world. Staff and instructor involvement increases student contact time. Support groups increase self-awareness and confidence.

Internal community networks are very good at marketing school and community events. Students volunteer to create Web pages, host workshops, write newsletters, tutor, and more. Internal community networks provide avenues for stress management through recreation. Recognition for academic achievement and exceptional instruction solidifies collegial bonds when disseminated internally.

Consider starting a student organization in conjunction with one of the following professional associations.

- ACS – American Chemical Society
- AISES – American Indian Science and Engineering Society
- ASES – American Solar Energy Society
- ASPRS – American Society for Photogrammetry & Remote Sensing
- AWEA – American Wind Energy Association
- BSA - Botanical Society of America
- IEEE – Institute of Electrical & Electronics Engineers
- NAAEE – North American Association for Environmental Education
- NACA – National Association for Campus Activities
- NAEP – National Association of Environmental Professionals
- NAHB – National Association of Home Builders
- NCSE – National Council for Science and the Environment
- NESEA – Northeast Sustainable Energy Association
- NWF – National Wildlife Federation
- SAF – Society of American Foresters
- SEEDS – Sustainable Energy for Economic Development (Northwest)
- UNESCO – United Nations Educational, Scientific and Cultural Organization
- USGBC – U.S. Green Building Council

Community Networking: External

Internships

Internship programs can provide valuable real-life experiences for students, especially when faculty works with the employer to set worksite performance objectives for the intern. According to the National and Community Service Act of 1990, service learning "enhances what is taught in school by extending student learning beyond the classroom and into the community and helps to foster the development of a sense of caring for others." Send a faculty member or experienced mentor with each student when the internship begins to provide moral support and ensure the student is comfortable working in the environment.

Service Learning

Before implementing a service learning or internship agreement:

- Review child labor laws, Fair Labor Standards, and workmen's compensation regulations;
- Delineate work hours and type of work to be performed;
- Use risk assessment checklists to define placement opportunities;
- Address health and safety issues before placing a student on site;
- Coordinate with the work site supervisor, placement officer, department chair, counselor, advisor, instructor, and student;
- Identify responsibilities of college and community members;
- Specify participant roles and expectations;
- Define reporting and assessment procedures; and
- Perform entrance interviews. (Conduct exit interviews when the agreement term expires.)

Successful mentors model dedication to academics, demonstrate refined skills, share knowledge, and provide progress reports on a regular basis. They guide learning in school and external learning environments. They take a personal interest in the student and have a real stake in their success. They communicate with instructors and counselors to head-off problems and create mutually beneficial solutions. They encourage leadership, responsibility, ethics, and dedication.

The best programs include individual and group sessions on a weekly basis. Youth outreach programs are especially good at capturing the scientific inquisitiveness of young people before they decide on a career to pursue.

Career Placement Services

Career placement often represents the end goal for students; they have invested time, energy, and money to become qualified in their chosen field. A placement services office will connect students with the companies that need them.

Most colleges already have a placement service office established, but those offices will need direction specific to environmental and energy careers. The occupational analysis component of curriculum development identifies local companies in the environmental and energy fields. Career placement offices will do the legwork of maintaining contact with these companies, and act as the bridge between the academic world and the professional world.

[i] http://www.ateec.org
[ii] http://ateec.org/labor-market-assessment-survey/
[iii] http://ateec.org/projects/current-projects/defining-environmental-technology/
[iv] http://ateec.org/projects/current-projects/defining-energy-technology-services/
[v] http://ateec.org/defining-the-water-management-field/
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[xi] http://www.dot.gov/
[xii] http://www.epa.gov/
[xiii] http://www.nfpa.org/
[xiv] http://www.osha.gov/pls/oshaweb/owasrch.search_form?p_doc_type=STANDARDS&p_toc_level=0
[xv] http://www.acs.org/content/acs/en/education/resources/twoyear.html
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Triple Bottom Line of Sustainability

Sustainability consists of social and environmental practices that protect and enhance the human and natural resources needed by future generations to enjoy a quality of life equal to or greater than our own.

—U.S. Environmental Protection Agency, 2010

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