SOLAR ENERGY EDUCATION & TRAINING

BEST PRACTICES

Developing a Quality Course

IREC Interstate Renewable Energy Council, Inc.

U.S. DEPARTMENT OF ENERGY | Solar Instructor Training Network
National Administrator

SunShot U.S. Department of Energy

www.sitnusa.org

Letter from the Program Manager for IREC

National Administrator of the Solar Instructor Training Network

As a boy, I was fascinated with tools while working with my father, and later, as an electrician in the construction industry. The phrase, the right tool for the right job, became readily apparent to me. I appreciated the value of using the right tool to complete a task efficiently, producing a high-quality result. As a former community college professor of 32 years, I look at the Best Practices documents with the same appreciation of the right tool for the right job.

IREC assembled some of the best experts in the country on solar training, education, and workforce development to create this compendium of Best Practices. I am forever indebted to them for their efforts. The documents were thoughtfully designed to give solar instructors the right tools for the job of training a highly-skilled, globally-competitive solar energy workforce for the 21st Century. This suite of Best Practices documents builds on IREC's earlier versions of Best Practices from 2008 and 2010.

As a college professor building my solar program, I had scarce resources and tools to choose from to support my efforts. Separately and collectively, these Best Practices documents enable instructors to easily enhance current solar curriculum, while providing a detailed roadmap for instructors who are considering adding solar to related trades curriculum. These documents have the potential to significantly enhance the quality of solar education and training. How I wish I had something like these Best Practices when I was developing my solar program.

And now, thanks to the SITN, you do. As National Administrator of the SITN, IREC believes these documents will hasten the development of exemplary solar training programs. I am enormously proud to be associated with such an erudite team of solar educational professionals.

IREC will be working closely with the Regional Training Providers (RTPs) of the SITN to further enhance these Best Practices documents. By tapping the strengths of each RTP, the SITN will garner even more resources and best practices to share with solar instructors, creating an even brighter future for solar education and training here in the U.S.

From all of us at the SITN and IREC Team, we are pleased to offer these tools for you in your work.

Joe Sarubbi
PROJECT MANAGER

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About IREC

The Interstate Renewable Energy Council, Inc. supports market-oriented services targeted at education, coordination, procurement, the adoption and implementation of uniform guidelines and standards, workforce development, and consumer protection. IREC's mission is to accelerate the sustainable utilization of renewable energy and energy efficient sources and technologies. IREC is a nonprofit organization formed in 1982.

About the SITN

Launched in 2009, the U.S. Department of Energy established the Solar Instructor Training Network, composed of nine Regional Training Providers (RTPs) to help fulfill a critical need for high-quality, local, and accessible training in solar system design, installation, sales, and inspection through train-the-trainer programs. The nine RTPs are well-established solar training institutions that offer expert trainers and first-class training facilities across the U.S. The institutions and organizations are listed by region:

Region 1: Kennebec Valley Community College and Hudson Valley Community College
Region 2: Pennsylvania State University
Region 3: The Solar Center at North Carolina State University.
Region 4: Florida Solar Energy Center at University of Central Florida
Region 5: Midwest Renewable Energy Association
Region 6: Houston Community College-Northeast and Ontility
Region 7: Salt Lake Community College, Solar Energy International and Utah Solar Energy Association
Region 8: California Community Colleges Board of Governors, California Energy Commission, California Centers for Sustainable Energy, the Labor Management Cooperation Committee

About DOE SunShot Initiative

The U.S. Department of Energy SunShot Initiative is a collaborative national initiative to make solar energy cost competitive with other forms of energy by the end of the decade. Reducing the installed cost of solar energy systems by about 75% will drive widespread, large-scale adoption of this renewable energy technology and restore U.S. leadership in the global clean energy race.

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Developing a Quality Course

Introduction

As the number of solar installations has soared in this country, so has the need for high-quality courses to teach installers how to design, install, and sell solar systems effectively. The quality of courses that have been developed over the years ranges from highly effective (with stated learning objectives, student participation, and assessments) to poorly designed and executed (using what we often call the "sit and get" strategy).

Most courses have suffered from lack of a good description of the job for which they prepare students. That is, there have not been reliable job task analyses (JTA). In addition, some courses have omitted one or more of the following: clearly stated objectives, effective tests and assessments, interactive classes, hands-on labs, and good equipment.

This paper explores the process of developing a quality course, unit, or lesson and the instructional models and practices that can be used for solar education and training. It includes a discussion of the broad concept of a systematic program plan and how to use instructional systems design (ISD) to develop such a plan. It shows how one type of ISD model — **a**nalysis, **d**esign, **d**evelopment, **i**mplementation, and **e**valuation (ADDIE), — can be used to design and develop a course or workshop.

Systematic Program Plan and Instructional Systems Design

A ***systematic program plan*** is a generic term that refers to a documented process to create or revise educational programs, workshops, or courses using the interrelated components of analysis, design, development, implementation, assessment, and evaluation. It is typically required to develop most types of instruction. (See Figure 1)

Instructional systems design (ISD) is one example of systematic program planning. ISD is defined as the systematic analysis, design, development, implementation, and evaluation of instructional materials, lessons, courses, or curricula to improve student learning and teaching efficiency. Based on information processing learning theory, ISD focuses on the design of effective instructional materials, lessons, units, and courses, with the goal of insuring that students learn.

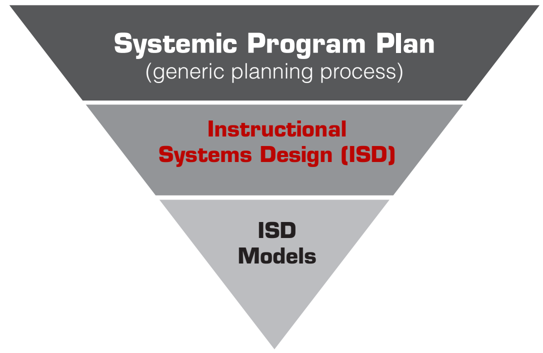

FIGURE 1:
Instructional System Design (ISD) and Systematic Program Planning

The wide variety of ISD models available share four basic processes (see Figure 2) that address the following questions:

- **Conducting a needs assessment**. What, if anything, do students need to learn to perform effectively and proficiently on the job?
- **Specifying objectives and test items**. What measurable or observable competencies must students master to be proficient?
- **Developing learning activities, strategies, and media**. How will content be taught to the students?
- **Conducting program evaluation**. How successful has the program been in promoting student learning?

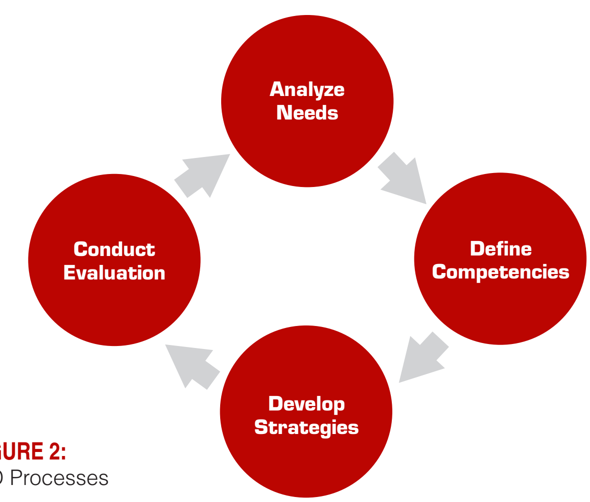

FIGURE 2:
ISD Processes

In addition, systematic program planning models incorporate the following principles:

- The development process is ***dynamic and iterative***, not linear. (Models are often shown with the components in a straight line. However, the models have interconnected components.)
- All the components must be ***aligned*** for the process to be complete.
- The basis for the model is what students need to learn in terms of ***performance***, with the desired outcomes and competences clearly stated.
- Decisions about how to present information, topics, and content to students are made ***after*** performance goals are defined.
- Learning activities and strategies should directly ***support*** the performance goals and competencies.

The ADDIE Model

An ISD model based on analysis, design, development, implementation, and evaluation (ADDIE) has been used successfully to design and develop instruction in the renewable energy field. ADDIE can be visually depicted in many different ways. Figure 3 shows one example of how the five processes are interrelated.

Let's look at some of the key aspects of designing instruction using these ISD processes.

The Analysis Phase

The needs and the goals of the proposed instruction are identified in the Analysis phase. Several questions must be answered to determine whether instruction is needed to address a ***performance problem*** (a person's inability to do a specific job or task).

- Is training really necessary?
- Who are the students?
- What equipment, resources, and facilities are available?

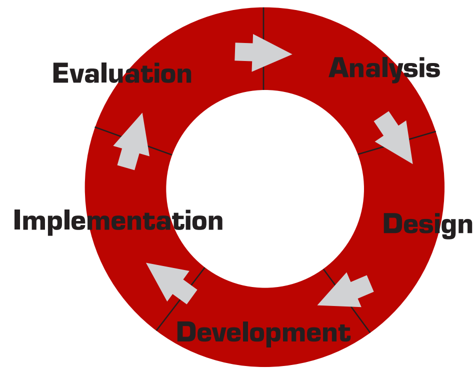

FIGURE 3:
Example of a Model for Instructional Analysis, Design, Development, Implementation and Evaluation (ADDIE)

1. Is training really necessary?

ISD begins by examining the root cause of a performance problem.

If	Then
Workers do not have the ***knowledge, skills and attitudes*** required for adequate job performance	A training or education course or program ***may*** be necessary
The performance problem is caused by something ***other than worker deficiencies***, such as: • Inadequate materials (e.g. faulty inverters or PV modules) • Poor policies and procedures (e.g. inattention to safety on the job)	A training program ***may not*** be needed

The key concept here is to identify the ***knowledge, skills, and attitudes*** (KSAs) that are necessary for successful job performance and determine whether or not those performing the job have the key KSAs. If they do not, training ***may or may not*** be necessary. Typically, when workers do not have the necessary KSAs, training is needed; however, it is possible that a worker is missing one small step in a process or is deficient in a single skill. Rather than produce a whole training course or program, we might be able to provide a job aid or send an e-mail that will correct the problem.

"A" Stands for Attitudes

Notice that "A" stands *for <u>attitudes</u>, not abilities or aptitudes* in this report. The "A" in KSA has been used to refer to aptitudes, abilities, attributes, and attitudes in a multitude of contexts — from learning and instruction to curriculum, and certification. In reference to learning, aptitudes often refer to innate traits or abilities that cannot be changed by education or training. Knowledge, skills, and attitudes can be taught and learned. We, therefore, define the "A" in KSAs as attitudes.

2. Who are the students?

Once it is established that training is needed, a course developer must determine what experience and knowledge the prospective students bring to the training. Important information to gather includes:

- The level of student expertise in the subject matter
- The amount of experience they have in this area
- The attitudes students have toward training
- Any special needs and constraints

Knowing students' experience and competency helps us design the most appropriate instruction for them. For a more complete discussion of learner analysis and strategies for gathering information, see *Good Teaching Matters: Section 1: Know Your Students:* <u>http://irecusa.org/wp-content/uploads/2010/12/IREC-Teaching-Matters-12-15-10-Web.pdf</u>.

If you only have time to find out one thing about your students, try to determine their prerequisite knowledge and skills — even if it is on the first day of the course.

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3. What equipment, resources, and facilities are available?

This question refers to the facilities, equipment (such as projectors, flip charts, smart boards, as well as power tools, inverters, PV arrays), and resources (texts, PowerPoint presentations, computers, web sites, databases, test banks, practical exercises) that are available for training. Before planning learning activities and assessment plans, course developers will want to know: what ***educational*** and ***technical*** equipment and resources are available to be used in training and in testing? (Technical equipment refers to electrical and mechanical equipment that may influence job performance.)

Other questions include:

- Is there adequate lab space for the particular type of instruction?
- Are there enough qualified trainers for course delivery?
- What conditions will the students face when they go back to the job and how can the instruction address and, if possible, mirror those conditions?

Qualified Trainers

Assess both their ***subject matter expertise*** and their ***instructional skills***.

Trainers should have content knowledge and good presentation skills.

The Solar Energy Education and Training Best Practices document on *<u>Lab Development</u>* can help you determine whether you have adequate space and equipment for your training.

One goal of developing a training course is to determine the extent to which the learning environment can recreate the job setting.

In summary, the purpose of the analysis phase of systematic program planning is to get as complete a picture as possible of any job performance problems and determine whether the problems are due to students' lack of KSAs or to something else. Once it is determined that a training course can remedy a performance problem, then an assessment of the students (KSAs and prerequisites) and the setting is performed. This insures that the instruction starts at the right point and that the necessary equipment and facilities are available.

The Design Phase

The purpose of the Design phase is to specify learning objectives and criterion-referenced testing procedures. As much as any phase in the instructional design process, this is the crux of systematic planning. Without well-stated learning objectives and well-designed assessment instruments, it is nearly impossible to have an effective education or training course. Here are the key questions to ask during the design phase:

- Is there a task analysis to guide the design process, or do I need to create one?
- What competencies and objectives must students master?
- What assessment, test items, and checklists can I use to determine whether students are competent?

1. Is there a task analysis to guide the design process, or do I need to create one?

A JTA breaks a main task down into subordinate tasks and shows the relationships among the tasks. It provides a list of competencies (knowledge, skills, and tasks) that are required for a particular job.

The competencies specified in the task analysis are used as the basis for defining instructional objectives and prerequisites. Figure 4 presents a partial example of a competency chart showing prerequisite relationships. Most JTAs do not show the prequisite relationships among the skills and tasks.

Task Analysis Example

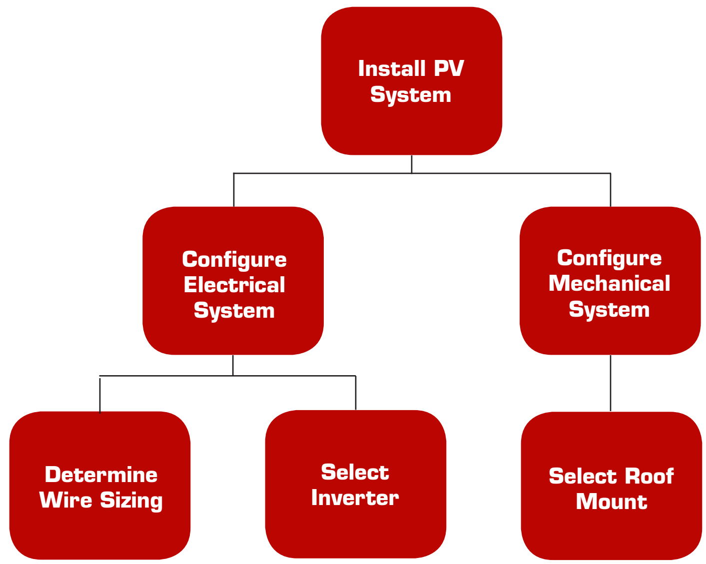


FIGURE 4:
Chart of Competencies in Job Task Analysis

What if a JTA is not available? There are many good resources that can help you design a task analysis. This is not an easy process, however, and usually requires the help of subject matter experts (SMEs). The Solar Energy Education and Training Best Practices document on *Curriculum and Program Development* discusses job task analysis and gives examples of the NABCEP tasks analyses that are available.

2. What competencies and objectives must the students master?

The task analysis lists the competencies that students must master and the prerequisites they should have when they start a course. Course developers translate those competencies into ***learning objectives*** — specific and measurable statements that describe what students must accomplish at the end of a course. Learning objectives have four components:

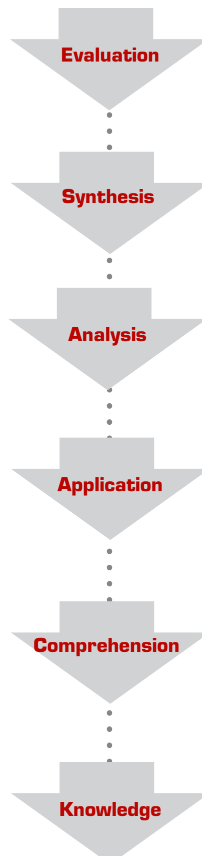
- **Audience** – Who is the target audience?
- **Behavior or action** – What behavior or action must the student perform?
- **Conditions** – What conditions (including equipment, time constraints, and resources) will the student have during the assessment?
- **Degree or standard** – What standard or criterion level is required?

Sample Learning Objective

Given specifications for a PV system, a site survey, and a series of 20 questions about a PV installation (*condition*s), each student (*audience*) will make correct installation decisions (*action or behavior*) by answering 19 of the 20 questions correctly (*degree or standard*).

Although there is not a one-to-one match between any single task on the PV Installer task analysis and the sample learning objective above, the objective states that the student must make correct installation decisions (similar to those that might be required on the job under similar conditions). Several different tasks from the JTA are being assessed in this one objective. Notice that students are not required to go out to a job to perform the tasks. This is a ***cognitive*** objective. Students are being tested on their mastery of conceptual information and knowledge, not on their physical skills.

Cognitive objectives measure the knowledge and intellectual skills that students have. Bloom's Taxonomy is often used to differentiate between different types of cognitive objectives. Figure 5 shows six cognitive levels, presented from highest to lowest. The Taxonomy can also be presented in the reverse order, from the simplest behaviors to the most complex. When *designing* instruction, we select the most complex behavior we want students to use on the job and write learning objectives to reflect those tasks or skills. When *teaching*, we start with the simplest skills and insure that students master those before going on to the higher ones.



- The ability of the learner to judge the worth of another's work — such as critique a new PV system design
- The ability of the learner to put together something new to him/her — such as design a PV system for a specific site
- The ability of the learner to break things down into component parts, to troubleshoot — such as find the problems with a PV system design
- The ability of the learner to use something new to them in a novel way — such as select the correct wire size for a PV system
- The ability of the learner to interpret data or to put something into his/her own words — such as explain the meaning of "Ohm's Law"
- The ability of the learner to recall and/or recite information, such as give the definition of a lead acid battery

FIGURE 5:
Cognitive Domain Levels in Bloom's Taxonomy

The importance of these cognitive levels cannot be overstated. Because we want students to perform well on the job, we want them to operate at the higher levels of the cognitive domain. Rather than simply recalling facts or definitions or demonstrating comprehension of an idea, we want students to apply the information they learn, troubleshoot problems, solve problems, and make decisions. ***Every course in every program should have at least one <u>primary</u> objective that is written at the application level or higher.***

For more information about how to write and use good learning objectives, go to *Good Teaching Matters: Section 2, Learning Objectives*. For more information about Bloom's Taxonomy, see http://www.nwlink.com/~donclark/hrd/bloom.html

3. What assessment, test items, and checklists can I use to determine whether students are competent?

Learning objectives and assessment instruments are different sides of the same coin. Learning objectives state the conditions, behavior/actions, and standards that students must meet to become competent in a particular task or skill. When the items on a test can be used to evaluate whether or not students have mastered the task or skill stated in the objective, the assessment instruments are referred to as ***criterion-referenced***. See the table below for an example.

Criterion-Referenced Testing
In correct systematic program planning, the learning objective and the assessment instrument must match.

When writing test items all types of items can be used including multiple-choice questions or short-answer questions. Multiple choice items are more difficult to write but easier to grade. The reverse is true for short-answer questions. True-false items should not be used because the learner has a 50-50 chance of guessing the correct answer. There are many good resources about good test writing, including:

- http://depts.washington.edu/cidrweb/resources/exams.html
- http://www.testdesigner.com/about/how_to_write_good_test_questions/
- http://www.thelearningmanager.com/pubdownloads/writing_effective_questions.pdf
- http://www.utc.edu/Administration/WalkerTeachingResourceCenter/FacultyDevelopment/Assessment/test-questions.html

Another way to assess student knowledge and skills is to use criterion-referenced ***product and performance checklists***. These are used when students must perform a task (such as strip wire) or produce a product (such as a blueprint or site survey). Even when students are asked to physically perform a task (demonstrate how to install a

Learning Objective	Criterion-Reference Evaluation/Test
Given the specifications for a PV system, a site survey, and a series of 20 questions about a PV installation (***conditions***), each student (***audience***) will make correct installation decisions (***action or behavior***) by answering 19 of the 20 questions correctly (***degree***).	The **conditions** state that we are going to give the students specs (can be visual or text) for a PV system, a site survey (a graphic), and 20 questions. They must answer 19 out of the 20 correctly. The questions will ask them to make correct installation decisions based on the specs and site survey. Sample items include: 1. The charge controller must be capable of controlling a continuous input current of: (a) 50.0 A (b) 56.4 A (c) 62.6 A (d) 85.2 A 2. The minimum size of the equipment grounding conductor must be: (a) #20 copper (b) #12 copper (c) #6 copper (d) #3 copper 3-20: Similar questions about sizing the inverter, determining wire runs for the site, voltage drop, etc.

PV array), they are often being tested on their cognitive skills *as well as* their psychomotor or physical skills (their ability to use tools). We want to know whether the students can make correct installation decisions as well as if they can use the tools and equipment correctly.

Use real life situations to test learners!
This is called situation-based or problem-based testing.

A recent trend in testing is to use test items and checklists that ask students to perform on the assessment as closely as possible to the real-life situation they will face on the job. These are called ***problem-based*** or ***situation-based*** tests and use scenarios and situations that mirror actual job performance.

In the table below are two job aids that may help you design assessment instruments. The first is a set of general guidelines for ***test development***. The second provides general guidelines for developing any type of ***test item*** — from multiple-choice to matching and short-answer items.

To learn more about assessment and testing, go to Good Teaching Matters: Section 3 Design Test and Evaluation Measures that Promote *Transfer*.

The Development Phase

During the Development phase, lessons, learning activities and strategies, and media are selected, constructed, and produced for the training. Some key questions that should be answered are:

General Guidelines for Test Development

1. Is the test based on a validated ***task or job analysis*** or on learning objectives that are specific and measurable?
2. Is some portion of the examination ***application-based*** rather than recall-based? That is, are test takers required to apply their knowledge and skill to real-life problems and settings?
3. Are the test questions and the instructions for taking the test written at an appropriate ***language level*** for the test takers?
4. Have all the ***resources*** that test takers can use — such as manuals, books, and calculators — been specified?
5. Are there reasonable ***time limits*** for taking the test?
6. Do the test questions follow ***standard guidelines for specific types of test items***? For example, do multiple-choice test questions have only one correct answer? Are there no clues in the items, so that one item does not provide the answer for another question?
7. Has a subject matter expert, other than the test developer, ***reviewed*** the test items for accuracy and relevance to the job market? Have necessary changes been made to improve the test? Have these been recorded?
8. Are there clear criteria for defining a ***passing vs. a non-passing score***?

General Guidelines for Developing Test Items

The following guidelines apply to all types of test items:

- Make the wording clear and concise
- Use language appropriate to the audience
- Be sure that knowledgeable students only have to read items once, twice at the most, to answer the questions
- Avoid grammatical clues
- Avoid words like always, none, never, sometimes, often, many, generally
- State the item in positive rather than negative terms
- Avoid using negative words, e.g. not, none
- Be sure there is only one correct answer
- Cite an authority if the item asks a question that is controversial or requires an opinion
- Avoid items that assess knowledge of very minor points or details
- Avoid using a recognizable pattern to the answers (such as a-b-c-d-a-b-c-d-a-b-c-d)
- Provide clear directions

- How do I create a lesson plan? How should the content be organized?
- What instructor and student activities should be included?
- How do I provide practice for students?
- What media should I use when teaching?
- How can I present confirming and corrective feedback?

This paper provides a brief overview of the development phase of systematic program planning. This phase and the implementation phase are discussed in detail in the Solar Energy Education and Training Best Practices document on *Becoming an Effective Teacher*.

1. How do I create a lesson plan? How should the content be organized?

Key steps in creating lessons and lesson plans include:

- Introducing students to the topic
- Explaining what students need to learn and telling them what the objectives are
- Presenting the instructional materials
- Giving students an example of correct performance
- Letting students practice what they've learned
- Providing corrective or constructive feedback
- Assessing student performance
- Providing summaries and reviews

To increase learning and motivation, change learning activities every 15-20 minutes.

2. What instructor and student activities should be included?

Instructors can either directly present the information to students or use an inquiry/discovery method. Using the inquiry method takes more time as students are "led" to the correct performance using various indirect methods.

Direct Instruction	Inquiry/Discovery Method of Instruction
• Lecture • Show and tell • Spray and pray • Sit and get	• Question and answer • Case studies • Scenarios

Lectures have been used for centuries and are a staple of instruction. However, as students' attention spans get shorter and shorter, lectures need to be shorter and interspersed with a variety of learning techniques that let students practice new skills and use the new knowledge they are acquiring.

Studies have shown that students rarely learn from lectures alone regardless of the quality of the lecture or the lecturer. To read a study about physicists who learned that lectures alone are not an effective technique, go to: http://www.npr.org/2012/01/01/144550920/physicists-seek-to-lose-the-lecture-as-teaching-tool?ft=3&f=111787346&sc=nl&cc=es-2012010

For optimal results when using the lecture method, make lectures short and then add an interactive activity that engages the learner.

One of the easiest ways to engage learners is to use questions and answers. Kenneth E. Vogler offers an excellent resource in *Asking Good Questions – ASCD*, with questions matched to Bloom's taxonomy.

(See http://www.ascd.org/publications/educational-leadership/summer08/vol65/num09/Asking-Good-Questions.aspx.) Some examples of PV questions matched to Bloom's Taxonomy can be found in the table on page 15.

3. How do I provide practice for students?

Regardless of the strategy used, instructors must give students the opportunity to practice the skills they are learning. Practice can occur in the classroom when students engage in decision making about the size of an inverter or the length and amount of wire needed for a particular application. Practice can also occur in a lab when students physically connect PV system components or strip wire. Instructors must also provide feedback that either confirms for the students that they are on the right track or that corrects incorrect behavior.

Students should have an opportunity to succeed and/or fail in the classroom rather than on the job. We want to help students correct their mistakes in a controlled environment.

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4. What media should I use when teaching?

Media available for teaching include PowerPoint presentations, videos, slides, pictures, flip charts, and job-related objects. Adapting media rather than creating it from scratch is usually both time and cost efficient. Some ways to adapt media are to:

- Add or delete parts
- Add practice and/or feedback opportunities
- Rewrite to match student characteristics
- Add content-relevant examples

When designing PowerPoint slides, the number of words on each slide should be around eight or ten. If students need a complete set of notes, prepare two sets of slides, one for the students to take with them and one to use during presentation. ***Avoid at all costs having text-dense slides that are projected and then read during the instruction.***

To learn more about creating good PowerPoint presentations, see the Best Practices document on *Becoming an Effective Teacher* and/or *Good Teaching Matters: Section 5: Create Simple PowerPoint Presentations*.

Effective PowerPoint Presentations

- Have 10 or fewer words per slide
- Use progressive disclosure
- Include graphics, pictures, schematics, and illustrations
- Use bulleted lists

5. How can I present confirming and corrective feedback?

Nearly all educators believe that providing quality practice and immediate feedback is critical to student learning. Confirming feedback acknowledges that students are correct or that their performance is acceptable. Corrective feedback helps students redirect and adjust their incorrect thinking or wrong answers. It is often followed by a related question or a complementary task to insure that students have achieved mastery.

To learn more about providing practice and feedback, go to the Best Practices document on *Becoming an Effective Teacher* and/or *Good Teaching Matters: Section 4: Include Practice and Feedback in the Training*

The Implementation Phase

During the Implementation phase, instruction is presented to the students. Some of the questions listed below are determined during the development phase of the process but are carried out during the implementation phase:

- How do I motivate students?
- How do I introduce the lesson?
- What kinds of questions are best to use?
- How do I use PowerPoint slides or other presentation media?
- How do I summarize and review each lesson or presentation?
- How do I use my time wisely during the lesson?

This section provides a brief overview of the implementation phase of systematic program planning. This phase is discussed in detail in the Best Practices document, *Becoming an Effective Teacher*.

1. How do I motivate students?

John Keller, from Florida State University has developed a motivational instruction model (ARCS) based on four components:

- Gaining **A**ttention
- Establishing **R**elevance
- Facilitating **C**onfidence
- Ensuring **S**atisfaction

Key Ideas for Facilitating Motivation

- Show students the **benefits** of what they are learning, and make it **relevant** to them
- Make the tasks they are learning **difficult enough** to stretch them but not unattainable
- Instill **confidence** by helping students succeed
- **Reward** students when they do succeed — focusing on their abilities, not on luck

An overview of Keller's ARCS model can be found at: http://www.learning-theories.com/kellers-arcs-model-of-motivational-design.html.

Learning Strategies for Motivating Students

- An effective introduction is a good motivational strategy.
- Start each lesson with a review so that students can reconnect with what they've previously learned.
- Use problems, case studies, overviews, and probing questions to engage students in the lesson.
- Use open-ended questions when you want students to think through a problem or issue.
- Use closed-ended questions when are you looking for one correct answer.
- Summarize each lesson by highlighting the major points that students are responsible for learning.

2. How do I introduce the lesson?

An introduction sets the stage for the learning that is to occur. It creates a mindset for the students to receive new information. It taps into relevant knowledge and background information and can motivate students. Common types of introductions include:

- Asking questions
- Presenting a puzzling situation
- Providing a rationale
- Giving an overview of the lesson or topic (an advance organizer)
- Telling a relevant story or anecdote
- Using an analogy to link the unfamiliar with the familiar

3. What kinds of questions are best to use?

What you want students to learn will help you decide what type of questions to ask. Many people use Bloom's Taxonomy as the basis for developing questions. Some examples are listed in the table on page 15.

Levels of Bloom's Taxonomy	Example Questions
Knowledge	What are five key components of a stand-alone PV system with both AC and DC loads?
Comprehension	What is the primary purpose of the National Electrical Code?
Application	In the example shown with the electrical output of the PV array and the site location included, what are the DC wire sizes for the source circuits from the array to the combiner box, and from the combiner box to the inverter? Show your calculations.
Analysis	Given that actual system performance is significantly below predicted performance, what actions you would take to determine the cause of this discrepancy?
Synthesis	How would you design a simple grid-tied system that would satisfy customer needs given the following functional and operational requirements?
Evaluation	Which of the following two designs for PV system do you think is the most viable for this site? Be prepared to defend your answer including the system output, code compliance, esthetics of the design, etc.

In addition to matching questions to Bloom's levels, other types of questions include:

- Convergent vs. divergent (one answer vs. multiple answers or ideas)
- Sequencing and patterns (questions that build on each other rather than questions that stand alone)
- Narrow to broad (specific questions that lead to general ideas or trends)
- General to specific or broad to narrow (global ideas or concepts followed by specific examples)

4. How do I use PowerPoint slides or other presentation media?

When using PowerPoint or other presentation media in the classroom, it is helpful to:

- Summarize or paraphrase what is on the screen (Do not read the slide.)
- Face the audience
- Make sure everyone can see the projected image
- Turn the projector off when you are not using it (Students will look at the bright light rather than at you.)
- Use a pointer

5. How do I summarize or review each lesson or presentation?

To help students remember what they have learned, a summary or review gives the main points that have been presented or discussed. Instructors should have a list of the key points, but they do not need to give the list to the students. They can prompt students to develop their own summaries by asking questions or asking them to solve a new problem. The important thing is that students have a clear idea of the main points included in the lesson and how those points relate to job performance.

6. How do I use my time wisely during the lesson?

If you are running late, pick out the most important aspects of the lesson and focus on those. Use designations from the job task analysis (critical, very important, and important) to decide how much time to spend on any task or objective.

Use more examples and fewer explanations. Students can assess their understanding to see if the examples fit their frames of reference.

Two Important Tips when Teaching

1. **Focus on what's important**. Don't rush through everything you've prepared. Students will not remember very much of it and will be overwhelmed.
2. **Use examples**. Examples often teach better than explanations.

The Evaluation Phase

During the Evaluation phase, data is collected to determine if the lessons, course, or program have been successful. Some the questions that are asked include:

- How do I know if my course has been successful?
- Which experts should review the materials before a course is presented to students?
- Which changes should be made to improve the course after it is presented?
- Do the results justify the time and effort spent developing the course?

1. How do I know if my course has been successful?

Donald Kirkpatrick has developed a four-step model for evaluating instructional programs (See Figure 6). The four levels are:

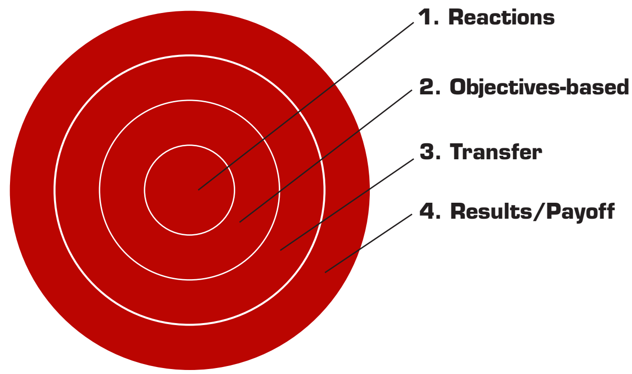


FIGURE 6:
Four Steps in Evaluating Instructional Programs

Several types of evaluation data are collected to determine if a course has been successful. Program evaluation is partly based on whether or not the students successfully met the objectives as originally specified.

- For ***reactions***, students are asked their perceptions of the course. For example: Were the objectives clearly stated? Were the instructional materials easy to read and follow? Were the classroom and labs adequate? Was the instructor knowledgeable and engaging? Surveys that let students describe their feelings about the instruction are often called "smile sheets."
- ***Objectives-based*** evaluations help to determine if the participants met the learning objectives that were established. For example: Was there an increase in knowledge, skills, and attitudes? Were the correct learning objectives and prerequisites identified?
- In ***transfer*** evaluation, evaluators want to know if students can transfer KSAs from the classroom to the job.

- ***Results/payoff*** evaluation examines what the educational institution gained from the final results of the course and whether this was worth the cost and effort to develop it.

For more information about Kirkpatrick's evaluation levels and methods for measuring these levels, see: www.masterminds-ink.com/Evaluation.pdf

2. Which experts should review the materials before a course is presented to students?

Evaluation is an on-going process in systematic program planning. A course is usually evaluated as it is being developed (***formative evaluation***) as well as after the course is presented to the target audience (***summative evaluation***).

BEWARE using students or team members who do not know the content as formative evaluators. They usually do not have the knowledge base or the instructional-planning skills to provide good feedback about how effective a course is.

During formative evaluation, SMEs knowledgeable about the content and education specialists competent in systematic program planning should evaluate the course. Content experts check to make sure the subject matter is correct. Instructional design experts check to make sure that all the program components are aligned.

A summative evaluation is conducted after the course has been presented. Data are collected to see how successful the course was. Students' reactions to the course and their assessment data are gathered. Once students get to the job, they are evaluated to see how well the KSAs have transferred to the work environment. Return on investment (ROI) studies are also part of summative evaluation. These are usually conducted by personnel who are knowledgeable in conducting them.

3. Which changes should be made to improve the course after it is presented?

The first and most important change to any course involves content. Content that is incorrect or out of date ***must*** be changed.

Success is the ONLY Option!!!
If a significant number of students do not pass one of more objectives, course developers must look first at the content to see if it is accurate and then at the instructional strategies that were used.

Student reactions to the course (Kirkpatrick's first level of program evaluation) may be helpful in determining which strategies were useful and which were not. However, SMEs must evaluate the content. The data collected allows a course developer to make decisions about which changes, if any, should be made to produce a more effective, higher-quality course.

4. Do the results justify the time and effort spent developing the course?

This question is addressed in Kirkpatrick's Level 4 evaluation, results. This is a high-level evaluation of the course and often revolves around the "payoff" that the administrator or institution receives from presenting a course. This payoff might include determining the ROI or finding out if the course produced additional market share. Course developers are often involved in designing the evaluation instruments and implementing them for a Level 4 evaluation. Typically, however, someone higher up in the organization runs this part of the evaluation.

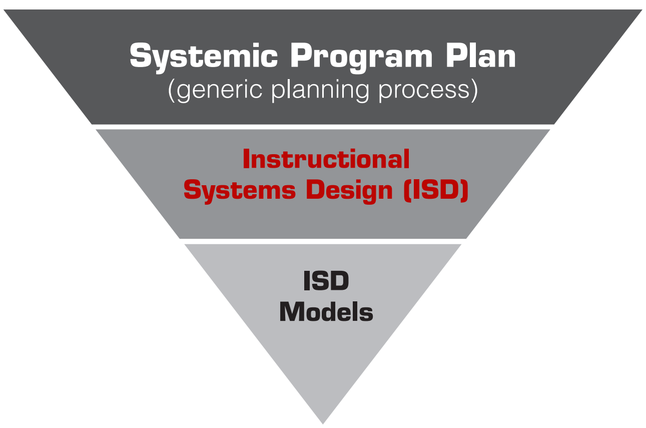
Get Expert Help for a Level 4 Evaluation!!
If your institution is interested in doing an ROI evaluation or some other aspect of a Level 4 evaluation, you will need expert help from someone who is familiar with the process.

Summary

Systematic program planning is a generic term that refers to the process of creating or revising educational programs, workshops, or courses. It uses the interrelated components of analysis, design, development, implementation, assessment, and evaluation.

Instructional systems design is an application of that process for designing and producing high-quality lessons, courses, programs and curricula.

The ***ADDIE model***, one example of instructional systems design, has been successfully used to develop renewable energy courses.



A key idea when using a systematic program planning process is to determine what students need to know on the job (the knowledge, skills, attitudes, and tasks) ***before*** planning how the instruction will be implemented. Such knowledge of what students need to learn and what prerequisites they have paves the way for deciding what and how the instruction will be presented.

Sources

This document is part of the Solar Energy Education and Training Best Practices document series. All Best Practices documents can be accessed online at http://sitnusa.org/trainer-resources/best-practices. Other resources available online are referenced throughout this document with web-addresses and hyperlinks. There are no text-only resources for this document.