Curriculum Development Guide

EdNet LAI

EDUCATE MOTIVATE INNOVATE ™

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Contents

Introduction

Purpose

EdNet curriculum should be based upon sound teaching strategies that emphasize student learning. There is a difference between "what is taught" and "what is learned". Although this might seem obvious from reading the words, all too often, faculty members concentrate only on what they are "covering", not what the students are "absorbing". A body of knowledge exists to guide curriculum development to achieve effective student learning.

Scope and Usage

This guide is for use by EdNet teams collaborating to develop shared curriculum. The course materials and modules should incorporate the basic ideas covered in this guide to the extent possible. It is recognized that developing curriculum based upon sound pedagogical principles takes experience and multiple iterations. The goal is to start down the right path and then use continuous improvement.

Resources and Contacts

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Basic Design Steps

State the Goals

State the major goals of the training session and the student-centered outcomes you hope to accomplish through the module. Consider time constraints or other limitations.

Learning Objectives & Assessment

Be very specific for each major topic. Use student-centered performance objectives. Ask "What do the students need to do or know at the end of this session?" Determine what evidence is necessary to show understanding of the topics. Remember that students will forget far more than they retain. Be selective and choose the "need to know" before the "nice to know."

Design & Sequence

Now that you have specifically defined the content, plan the teaching and learning experiences. Try to think of a variety of approaches with opportunities for the group to participate and demonstrate their new skills or knowledge. Emphasize the real world and draw on the expertise of participants. Play with the order until you have a sequence that has a good mixture of techniques and makes sense. Plan specifically for the opening, the middle, and the end of the session.

Revise & Evaluate

The design steps are iterative, so evaluation and revision of your process and materials should be part of the module development. This includes testing the module. A suggested testing sequence begins by asking peers and former students to review it and suggest corrections. The next step is to "go live" with a class. Often several cycles through this sequence are needed to hone the module to achieve the learning objectives. Develop contingency plans in case time runs short. Constantly monitor and evaluate the student performance during the class. Evaluate the session to see if the performance objectives were met in a participative way. This can be accomplished during, immediately following and several months after the session.

Pedagogical Elements

Each module should be architected around a set of pedagogical elements such as learning objectives, measureable outcomes and active or engaged learning. These elements will help contribute to successful transference and learning. EdNet curriculum materials are created with attention given to these pedagogical elements described below. The design process that includes these elements in each module is an iterative process.

Learning Objectives

According to Robert Mager (1962, 1997), learning goals should be broken down into observable tasks or behavioral objectives. Mager suggests that writing clear learning objectives can guide course developers and aid students in the process.

Learning objectives are statements that clearly identify the skill or behavior that is expected, as well as any conditions or criteria/limits for an acceptable outcome. Mager emphasizes that learning objectives should be short statements that start with an active verb that clearly defines the skill or behavior and conditions that the student is expected to learn. Appendix I is a table linking the level of expected achievement with a list of active verbs. The first column gives increasing levels of learning that a module might address and the second column gives a list of words that should be used as the first word in a learning objective. Verbs that are vague, such as "understand" or "know about", should be avoided as they are not measurable.

Learning objectives should have the following characteristics:
- *Student-focused*
- Focus on the learning *resulting from* the module
- Focus on *skills and abilities* central to the discipline and based on professional standards
- General enough to capture important learning, but *clear and specific* enough to be *measurable*
- Focus on aspects of learning that will develop and *endure* but that can be assessed in some form now
- Reflect the organization's mission or the values it represents

As you design curriculum materials, try to avoid going overboard with too many learning objectives for each module. Three to five learning objectives for a module are plenty. This means that the objectives should avoid being too detailed, yet be specific enough that they can be measured. Normal educational criteria and conditions are assumed in these examples.

> **Short Learning Objectives**
>
> - Describe key attributes of a lean supply chain
> - Draw a process map
> - Use lean tools to improve a simple office process
> - Compare & contrast management vs. leadership

Measureable Outcomes

Each learning objective should be measurable. A requirement should not be written which cannot be verified or measured. The measurable outcome should be a short statement starting with an active verb similar to the learning objective, and giving as precise a description as possible for what will be measured. It must be accompanied by a method of measurement.

Traditional courses use techniques such as problem sets, papers, quizzes or tests, interviews, oral presentations or other means to measure learning achievements. Most of these are not appropriate for a short off-campus course. However there are a number of ways to measure and ensure student learning by using active learning techniques. Many active learning techniques can help faculty make sure they are on track and that participants are learning key concepts. Through these techniques, both teachers and participants will be able to see learning and growth.

Examples of active learning techniques that can help measure outcomes are:
- A One-Minute Quiz: Ask participants to answer a question at the end of a module. Participants take a minute to reflect and write their answer on an index card. See example responses in Appendix II.
- End of the day evaluations could include a question which measures one specific learning objective.

> **Example Illustrating Measurable Outcomes**
> **The One-Minute-Quiz**
>
> *Answer one of the following questions*
> 1. *Why should lean be implemented across the entire enterprise?*
> 2. *Why is lean a "journey" and not a "state?"*
> 3. *How does lean thinking relate to your current job?*

Example responses for the *One Minute Quiz* are given in Appendix II. It may not be possible or even feasible for every learning objective to be measured during the course. But in principle, there should be a way that the learning *could be* measured, even if it can't be applied within the time constraints available.

Active & Engaged Learning

Education is more than just presenting information; the participants must also learn. It is important to engage learners and make them active participants in gaining new knowledge. Learning takes place when we introduce new material and build upon what is already known. *Active learning* is an approach that engages learners as they interact with the concepts or topic. Active learning can be described as teaching strategies "that involve students in doing things and thinking about the things they are doing" (Bonwell and Eison, 1991).This can be done through reading, writing, identifying key terms, simulations, exercises, reflection,

discussion, interviews, and presenting ideas. Active techniques are also excellent ways that faculty can assess student learning since they can see the results of discussions and exercises.

What kinds of things can you do to engage learners?
- Ask for their opinions or ideas
- Make the learning topic or activity directly relevant to their job/goals
- Create a comfortable environment for open discussion
- Encourage participation
- Plan a variety of techniques
- Call upon student experiences
- Offer choice to students

Active learning can be seen in the classroom when the focus is on the student, not the teacher.   So, instead of worrying about "What material to cover" or "What should I say?" faculty and developers should ask "What will the students be doing today to learn this topic."

> **Active Learning**
> Play a game, participate in a simulation
> Role play
> Take a quiz
> Discuss with others

Lecture can be enhanced through simple ideas to involve participants:
- Guided note taking - fill in missing <u>key</u> words in your notes
- Ask a question
- Write this down!
- Pair & share – Pausing after 10 or 15 minutes of lecture and asking the class to turn to the person next to them and discuss examples to share with class.

> **Example to Enhance Lecture**
> **Think-Pair-Share**
> *"Give an example of positional negotiation"*
>
> Ask students to think about this for a minute, discuss this with their neighbor for 2 minutes. Then, the instructor calls upon two or three student pairs to share their answers with the class

Showing a video can be an interesting way to demonstrate concepts. Watching a video can be a passive activity. Try to give students a guide of things to watch-for or a list of questions they should try to answer while watching. A short demonstration could be turned into an active exercise by making it a hands-on activity for students.

Benefits of Active Learning

The main reason for designing instruction that engages learners is for improved retention and recall. By designing curriculum materials that include active learning techniques, there will also be improvements in student interaction with instructors and each other, as well as their attitude toward the subject (McKeachie, 1998).

Edgar Dale (1996) categorizes various audio visual experiences by their impact on learning. Dale shows the least effective impact is through verbal and visual symbols. Impact is greater with recordings, pictures and video. He saw the greatest impact from study trips, demonstration experiences as well as contrived and direct experiences. So, the greater the student involvement, the higher the impact on learning.

Learning Styles

As you design teaching material, it is important to keep in mind that your students are not all the same. People have different learning styles and learn best through different methods. Keeping this in mind, try to include a variety of teaching techniques throughout the class. Focusing too much on one method of delivery could make it very difficult for some of the students to remain attentive.

Many different learning styles exist and have been defined by a variety of researchers. To keep things simple, we list the three basic learning styles as auditory, visual, and tactile or kinesthetic. The internet can be used to find out a personal learning style through a simple online quiz or survey. Two examples or *Learning Style Inventories* can be found online at: http://www.usd.edu/trio/tut/ts/stylest.html or at http://www.psuonline.pdx.edu/learnstyle/page1.php. An overview of learning styles and examples of successful techniques are included below.

Auditory Learners learn by hearing information. They may not even appear to be paying attention to what's happening in the front of the room, but they sit where they can hear. These learners remember by verbalizing information to themselves. Techniques that work well for this type of learner are discussions, explanations and lecture.

Visual Learners learn best through seeing and making a visual picture of concepts. These learners may even close their eyes to visualize as a way to remember. Techniques that work well for visual learners are pictures, video, diagrams, charts and observation.

Kinesthetic Learners are those who learn best by doing hands-on activities. They tend to be active and rely on their experiences. Teaching techniques that engage these learners include games, design, research, practice or problem solving,

Summary
There is no single "best way" to design instruction or for students to learn. Curriculum developers must consider the content material, the audience, the instructors and the environment in order to create successful educational materials. This guide is meant to be a helpful resource as you come up with unique and creative ways to design and teach courses.

"Tell me, and I will forget;
        *Show me and I may remember; **Involve me** and I will understand"*

Chinese Proverb

Tips for Creating Slides

Remember that slides are a tool that should support the teaching and learning objectives. Only use key terms or graphics that serve as a reminder or visual representation of key points. An excellent series of publications about use of Powerpoint and creating effective presentations has been produced by Edward R. Tufte and are available from http://www.edwardtufte.com/tufte/index. Two of his works on listed in the References.

Use bold, clear fonts
- Use at least 18 point font
- Four by Four Rule - 4words per line, 4 lines
- Avoid vertical lettering
- Use but don't over-use color
- Leave ample white space

Choose your words
- Think in bullets
- Use active words
- Use KEY phrases

Imagination
- Not all people relate to words, think about visual images
- Cartoons, graphs, charts, photographs, illustrations

Keep it Simple
- The visual should be clear, accurate and relevant
- Avoid unnecessary animation, use it when it adds accent or helps in sequencing presented material

References

Bloom, B.S., Englehart, M.D., Furst, E.J., Hill, W.H., and Krathwohl, D.R. (1956). *Taxonomy of Educational Objectives: The classification of educational objectives. Handbook I: cognitive domain.* David McKay, New York.

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Silberman, M. (1996). *Active learning: 101 strategies to teach any subject.* Needham Heights, MA: Allyn & Bacon

Tufte, Edward R., *The Cognitive Style of Powerpoint: Pitching Out Corrupts Within*, 2nd Ed., Cheshire, CT, Graphics Press LLC

Tufte, Edward R., *Visual Explanation: Images and Quantities, Narrative and Explanation*, Cheshire, CT, Graphics Press LLC

Appendix I – Bloom's Taxonomy

Description From: Bloom, B.S., Englehart, M.D., Furst, E.J., Hill, W.H., and Krathwohl, D.R. (1956). *Taxonomy of Educational Objectives: The Classification of Educational Objectives. Handbook I: Cognitive Domain*, David McKay, New York.	Sample terms to use when writing objectives
Knowledge • is defined as the remembering of previously learned material • represents the lowest level of learning • involves recalling or reciting: facts, observations, or definitions	define identify record name list retrieve repeat
Comprehension • is defined as the ability to grasp the meaning of material • represents the lowest level of understanding • involves explaining, interpreting, or translating	discuss report summarize restate tell recognize express locate extrapolate translate review explain describe interpret
Application • refers to the ability to use learned material in new and concrete situations • requires higher level of understanding than comprehension • involves applying: rules, methods, laws, principles	demonstrate practice apply schedule illustrate use sketch operate
Analysis • refers to the ability to break down material into its component parts so that its organizational structure may be understood • represents a higher level than previous categories because of requirement of understanding of both the content and structural form of the material • involves analyzing relationships, distinguishing between facts and inferences, evaluating data relevance	authenticate solve decipher compare itemize contrast distinguish criticize analyze diagram differentiate inspect appraise debate calculate test experiment
Synthesis • refers to the ability to put parts together to form a new whole • represents creative behaviors, with emphasis on the formulation of new patterns or structures • involves proposing plans, writing speeches, creating classification schema	compose create design assemble integrate set up construct formulate organize arrange plan prepare manage
Evaluation • is concerned with the ability to judge the value of material for a given purpose • represents highest level because of inclusion of elements of all other categories plus conscious value judgments based on criteria • involves judging logical consistency, adequacy of data support for conclusions	appraise judge grade evaluate qualify rate measure compare score estimate choose assess

Appendix II – Example Responses from a <u>One-Minute-Quiz</u>

Spend a minute writing your thoughts to one of these questions on a 3 x 5 card

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Why should lean be implemented across the entire enterprise?

- Lean should be implemented across the entire enterprise because it will continue to increase competition resulting in better and more efficient products for all customers.
- Lean seems to obviously apply to situations that are repeatable such as manufacturing. But how to apply it to an area where you do a process once or only a few times?
- Lean in manufacturing process seems like glorified industrial engineering. Applying it to the other functions, while very challenging, seems like it offers huge potential.
- Inefficiencies can and do exist everywhere. Most businesses are only as efficient as their least efficient portion.
- More and more in aerospace, an increasing fraction of assembly/production is out sourced.
- It is important for the entire enterprise to embrace lean from it to be implemented successfully. It is not enough to emphasize manufacturing only. Everyone can use the concepts and it makes for a more efficient, productive, profitable company.
- If your suppliers do not employ lean, then it will be hard for you to. Example: If your supplier is not just-in-time then you have extra storage.
- Excellent to see effectiveness of lean process throughout all of industry. Important to understand how if lean process is not implemented across the enterprise the effectiveness is lost.

Why is lean a "journey" and not a "state"?

- A system in the duration of improving productivity will have to incorporate the lean practice. One thing to keep in mind is the end result, and the initial conditions. From there comes the route which determines were [sic] to go to or how to come on top at the end.
- Lean is a "journey" and not a "state" because an industry is always changing and we should always strive to look for ways to improve productivity.
- There is always fat that can be trimmed from an operation. Improvements can always be made.
- Lean is a journey not a state because lean is a <u>process.</u> You continue to learn.
- I think the biggest part is convincing people that lean manufacturing is a journey and not a state. People tend to not be as open to constant changes all the time.
- Things (products, processes, designs, etc.) are always changing. Knowledge about lean enterprise is always increasing.
- Lean is a "journey" because it is a continual evolving process. New techniques and principles are always being introduced.

How does lean thinking relate to your current job?

- I am in design and I can eliminate waste before it happens during the design process on manufacturing floor, procurement, offices, support, etc.
- Coming from a business background I think there are many ways to implement LEAN concepts to increase productivity. My new group does a lot of manual work or uses older technology. I am going to change or transition our group to be more electronic and improve processes using LEAN. Thanks.
- I like the idea of continual improvement; a "journey", not a "state", etc.. I just wanted to comment that I don't know, yet, how LEAN is going to apply to my current job, but am excited to find out. This is the most important to me.
- By applying lean to flight test, you can reduce flight count/cost and improve f<u>low</u> of test process.
- How do I get my engineering team moved to a LEAN group? (mostly software and testing).

Appendix III

EdNet Slide Template

Module Title

Recommended Slide Order

- **Title Slide**
- **(Introductory Grabber - Optional)**
- **Learning Objectives**
- **Content Slides**
- **Summary/Wrap Up/Take Aways**
- **Reading List (see example)**
- **Acknowledgements (see example)**
- **Notes if needed (see example)**

Slide 3

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Logo in upper left.
Set in slide master

Layout and Fonts

Title in upper right.
Default is 32 pt font

- **Use Arial font**
- **Default sizes are set by the template**
- **28 Point**
  - **24 Point**
    - **22 Point**
      - **20 Point**
        - **18 Point**
        - **Don't use any font smaller that size 18, and use that only when absolutely necessary**

Source citation in lower
left. See next slide

Footer edited in
Slide Master

Source citation (see next slide) for slide is 10 Point Arial Font.

Module Title V#.# - Slide 3
© 2008 Massachusetts Institute of Technology

Slide 4

Lean Academy

Source Citations

- **Use the following guidelines for citation of source material on slides:**
  - **"Source:XXXX" means that the material was reproduced directly from XXX. This is appropriate if you use a figure "as is" from some source. If the module is released for open source, permission will need to be obtained.**
  - **"Adapted from:XXX" means that you have modified the figure or material.**
  - **"Reference: XXX" means that you have taken the material from the citation. Use is much like in a publication.**

Module Title V#.# - Slide 4
© 2008 Massachusetts Institute of Technology

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Footers

- **There are three footers that need editing. From the "View" menu bar item, select "Master" and then:**
  - **"Slide master" to edit the lower right footer**
  - **"Handout master" to edit the footer on the printed handouts**
  - **"Notes master" to edit the footer on the speaker notes.**

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Speaker Notes

- **Module slides should have useful speaker notes.**
  - **Often these are not done on a beta or prototype module.**
  - **But it is easiest to create them as you go.**
- **Notes should not exceed one page when viewed in the "Notes Page" mode under the "View" item in the menu bar**
- **For slides that are modified or eliminated for the student handouts, such instructions should be given in first line of the speaker notes in bold face font.**

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Example Reading List

Note: Since this slide is not projected, font can be as small as 12 point

Clausing, D., *Total Quality Development*, ASME Press, New York, 1994

Haggerty, A., "Lean Engineering Has Come of Age", 30th Minta Martin Lecture, MIT Department of Aeronautics and Astronautics, April 10, 2002.

Lempia, D, "Using Lean Principles and MBe In Design and Development of Avionics Equipment at Rockwell Collins", Proceedings of the 26th International Council of Aeronautical Sciences, Paper 2008-6.7.3, Anchorage, AK, Sept 14-19. 2008

McManus, H., "Product Development Value Stream Mapping (PDVSM Manual)", Release 1.0, Sept 2005. Lean Advancement Initiative.

McManus, H., Haggerty, A. and Murman, E., "Lean Engineering: A Framework for Doing the Right Thing Right," *The Aeronautical Journal*, Vol 111, No 1116, Feb 2007, pp 105-114

Nuffort, M.R., "Managing Subsystem Commonality," Master's Thesis, MIT, Cambridge, MA, 2001.

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Example Acknowledgements

- **List contributors alphabetically**

- **Kirk Bozdogan - MIT LAI**
- **Tom Callarman - ASU**
- **Al Haggerty - MIT, Boeing (ret.)**
- **Greg Harris - Univ. of Alabama in Huntsville (UAH)**
- **Dick Lewis - Rolls-Royce (ret.)**
- **Tim Mead - DAU**

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Notes

- **Add blank "Notes" slides to round the printed version for students up to a multiple of 4 slides.**
- **This assures that when printed 2 slides per page and double sided, when modules assembled, each module will start on the front side of a page.**