HOME4TECHS
Hands On Maintenance Education 4 TECHnicianS

Steps & Lessons on Converting to a Competency-Based Hybrid Model Part 1

Presented by:

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Topics this training will cover:

- Overview of the CREATE project
- Traditional Educations versus Competency-Based
- Overview of the HOME4TECHS project
- Aligning the curriculum to employer needs
- What is an assessment model?
- Creating Hand-on Assessments & lab exercises
- Backward Design of a Course

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Workshop Materials Available for Download:

https://ate.is/Scaling_CBE

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Instructional Elements to Improve Technical Courses

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New NSF ATE Funded Project: CREATE

Creating Relevant, Effective & Accessible Technical Education

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CREATE: Goal #1

Goal 1: **Curriculum Development; enhance three courses of the TSCC PLC program to improve students' competency AND access by conversion to a CBE hybrid mobile access model.**

Objective 1.1: ***Align the curriculum and skills required for the three automation courses:***

Objective 1.2: ***Convert the three redesigned technical courses from the TSCC PLC Certificate to a hybrid/flipped classroom model*:**

CREATE: Goal #2

Goal 2: Provide TSCC faculty Professional Development with the skills required to convert their courses to a CBE hybrid mobile access model.

Objective 2.1: ***Develop the faculty skillset to convert existing technical courses to a CBE hybrid mobile access model and effectively teach these courses.***

Activity 2.1.2: ***Prepare faculty to utilize OER material for instruction and develop online learning objects (videos & simulations):***

Activity 2.1.3: ***Prepare faculty to deliver instruction within a hybrid/flipped classroom model:***

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A few things on the CREATE Project:

- Project is funded for 3 years
- Create, Implement & Evaluate (There is accountability)
- Mike H. is the project Principle Investigator
- Program Officer is assigned to the Project
- Rucks Group is the Project Evaluators
- Big advantage is the conversion has been started
- Build on what others have done – Do not start from scratch

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A few more things on the CREATE Project:

- Get your Micro-site setup at ATE Central
- Use this site as a communication hub to stakeholders
- Get a logo and project look designed
- Get showcase booth materials designed
- Will need to have a booth at the Showcase – PI Conf. in late October 2022

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Problem:

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Solution:

- Redesign the curriculum to meet employers needs
- Build a **competency-based, hybrid instructional model**
- Require individual skill assessements
- Move the courses' **lecture portion to an online format**
- Utilize technology tools to accelerate learning
- Offer the students a **flexible open-lab schedule**

Project consists of 3 distinct areas:

Curriculum

- Realignment of curriculum
- Competency-based learning
- Hybrid course model
- Modular online eLearning
- Hands-on assessments
- Open lab learning model

Technology to accelerate learning

- Virtual machines for each student
- Hands-on hardware simulations
- Student access to software 24/7
- Virtual interactive simulations
- MOOCs

Faculty professional development

- Quality matters
- Instructional systems design
- Online course development
- Instructing online courses
- Technical content cross-training
- Learning object development

Programmable Controller Course
Allen Bradley MicroLogix and CompactLogix

Motors & Controls
Allen Bradley PowerFlex 70s and 525s

Servo & Robotics
Fanuc LR Mate 200iD

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2017 PI Conference Washington DC

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Traditional Technical Course at NSCC, 8 years ago

Syllabus

Textbook

Lecture

Handful of labs

3 P/P Tests

Grade (ABCDF)

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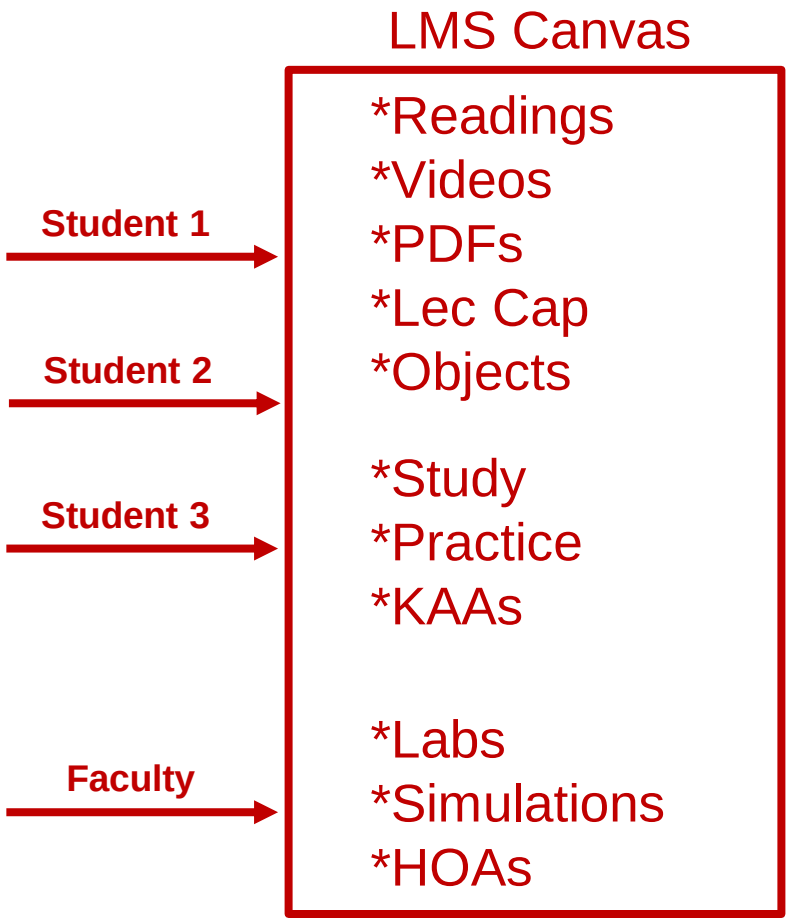
Competency-Based/Hybrid Instructional Model



On-campus class time

Lab Exercises **Hands-On Assessment**

Lab Packs sold in Bookstore (required)

Faculty facilitates learning

Faculty assesses student skill/knowledge

Self-proctored Online Assessments

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Traditional Education vs. Competency-Based

Topic Outcomes:

- Explain the differences between traditional education, and a competency-based model.
- Differentiate between direct assessment CBE, and hybrid CBE models
- List the positive attributes of a CBE model
- Identify the Champions that support the CREATE project.
- Compare assessments between traditional and CB
- Create an elevator speech to advocate for CREATE (Why are we doing this project)

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Competency-Based Education (CBE)

- Across the country there is a trend to transition away from seat-time and move towards a flexible structure that allows students to progress in their learning after they have demonstrated mastery, which is often time at their own pace. This trend is known as competency-based education (CBE). Good article by Janice Walton.

- https://www.gettingsmart.com/2017/12/12/competency-based-education-definitions-and-difference-makers/#:~:text=Competency%2Dbased%20education%20is%20defined,to%20more%20efficient%20student%20outcomes.%E2%80%9D

Traditional Education vs. Competency-Based

- Traditional education has a set time (16 weeks), and variable education (5 possible grades, and how much was actually learned).

- Competency-based education has set level of education/learning (mastery), and variable time (students progress based on their learning), where some students can finish early, but some may take a little longer.

What is Competency-based Education (CBE)?

- Competency-based Education consists of two important element:
  - **Mastery of Skills** - The CBE course is typically parsed into modules, with assessments in each module that must be passed at the mastery level.
  - **Flexible Pacing** - Student will progress through a course at their pace of learning (and of course mastery). Some students will finish early, and some will take a little longer.

Apprentices attending a CBE hybrid course

- Apprentices base progress on seat time (lecture and lab).
- Get ahead of this by discussing it with the Educational Representative form their joint committee
- Create a cross walk from the traditional course to the CBE hybrid course
- A learning sequence sheet will help in justifying the competency to contact hours

Traditional Education vs. Competency-Based

- In a traditional model, the faculty does primarily teaching, and some assessment.

- In a competency-based model, the faculty does primarily assessment, and less teaching than in the traditional model. The faculty becomes a learning facilitator.

What is a Competency?

- A competency is defined as observable and measurable statements that describe the specific skills, knowledge or abilities demonstrated by a learner (Salt Lake CC).

- Competencies are often focused at an overarching level, rather than a more granular level.

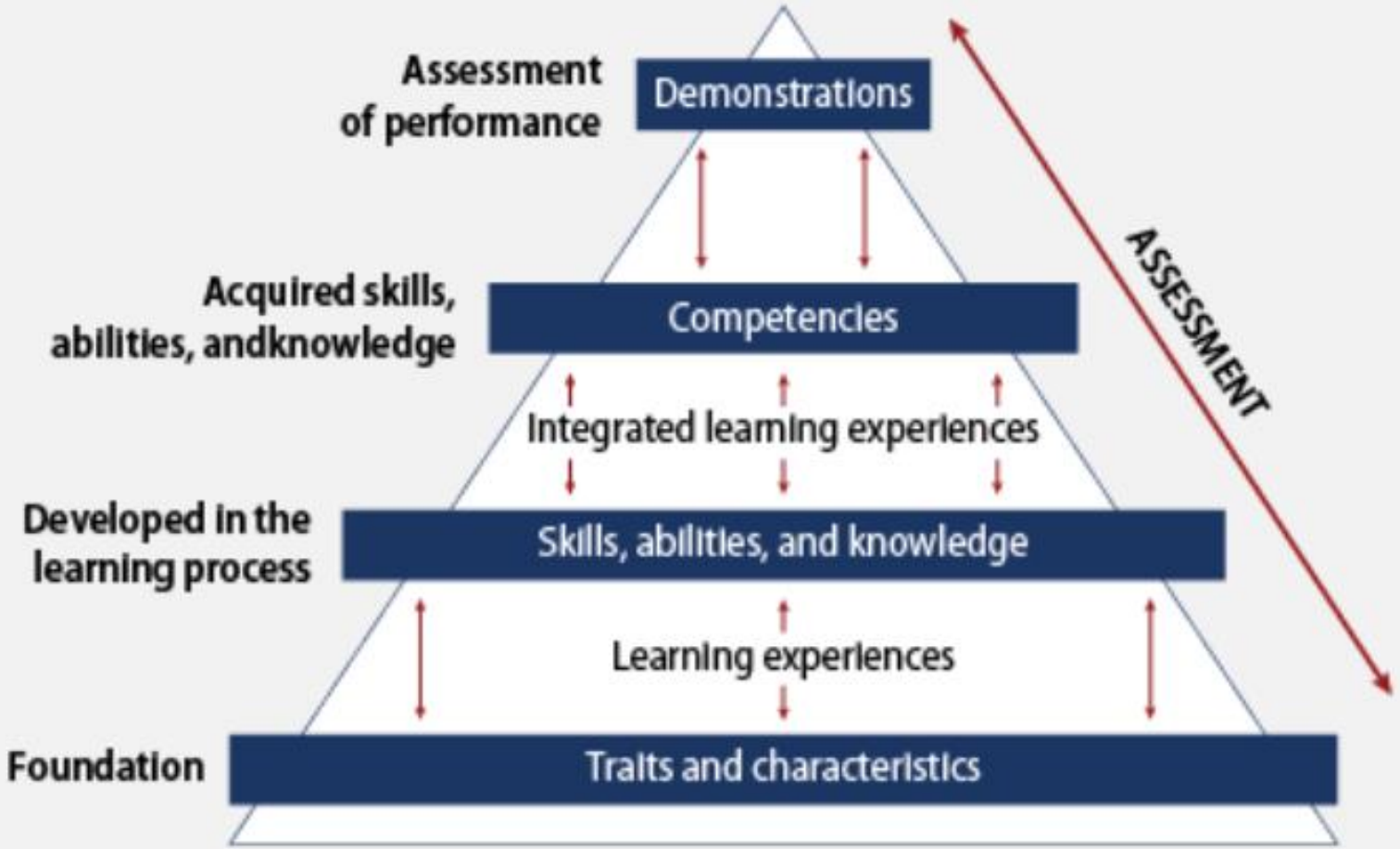
- Competencies are many times derived from a job description

Sources/Resources for Developing Competencies:

- Employers, advisory committees, roundtables, trade unions
- Department of Labor has competency models and support documents for many occupations
- Professional associations

FIGURE 1

A conceptual learning model



Source: U.S. Department of Education, 2001.

A traditional model has typically 2-3 written or online assessments.

A CBE model has many more assessments so the faculty can determine mastery of the knowledge/skill of each student in each module.

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DACUM Competencies

- **D**evelop **A CU**rriculu**M**
- 5-7 Industry SMEs meet for 2-3 days to identify all the duties and tasks required for a technology or a job
- At least part of your competencies should be obtained from a DACUM, which you can then say are validated.
- VET all competencies through the Industry SME group

DACUM results for a Class 2 Water Operator in Ohio.
DACUM is an Ohio State format

DACUM Research Chart for Class 2 Water Operator

Duties	Tasks				
A Manage Source Water	A-1 Identify source water area	A-2 Collect raw water samples	A-3 Review raw water lab results	A-4 Develop source water protection program	A-5 Implement source water protection program
B Manage Treatment Processes	B-1 Complete facility inspection	B-2 Monitor SCADA system	B-3 Obtain chlorine sample results	B-4 Obtain fluoride sample results	B-5 Obtain turbidity sample results
	B-13 Adjust water treatment rate	B-14 Adjust chemical feed rates	B-15 Fill chemical day tanks	B-16 Backwash filters	B-17 Regenerate water softeners
	B-24 Calibrate bench top meters	B-25 Change flow charts	B-26 Refill bulk chemical storage	B-27 Unload chemical deliveries	B-28 Complete daily worksheet
C Comply with EPA Sample Requirements	C-1 Collect SOC samples	C-2 Collect VOC samples	C-3 Collect TTHM/HAA5 samples	C-4 Collect radiological samples	C-5 Collect lead & copper samples
	C-13 Collect organics samples (e.g., benzene, carbon tetrochloride, toluene)	C-14 Collect cryotosporidium/ giardia samples		C-15 Collect special bacteria samples	C-16 Collect dissolved oxygen samples
D Manage Distribution Processes	D-1 Monitor chlorine/ chloride residual levels	D-2 Develop backflow prevention program	D-3 Implement backflow prevention program	D-4 Inspect booster stations	D-5 Inspect water towers
	D-13 Maintain hydrants	D-14 Exercise valves	D-15 Read meters	D-16 Maintain meter pit integrity	D-17 Rotate booster/lift station pumps
E Perform Preventive Maintenance	E-1 Develop preventive maintenance program	E-2 Change oil/fluids in equipment (e.g., motors, compressors)	E-3 Grease equipment (e.g., pumps, valves)	E-4 Test-run equipment (e.g., pumps, valves, generators)	
	E-12 Calibrate	E-13 Calibrate	E-14 Calibrate	E-15 Oversee	E-16 Rebuild

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DACUM format for Control Technicians

DACUM format by NOCTI group in MI

A.			BASIC ELECTRICAL CONTROLS
			Control panel wiring standards
			Wiring & Troubleshooting electrical control systems
	1		Install communication cable and low voltage cable
	2		Install/repair/replace starters
	3		Demonstrate knowledge of electrical safety (NFPA 70E)
	4		Install/maintain relays
	5		Perform panel/box inspections
	7		Troubleshoot/replace/install circuit boards
	8		Operate electrical/electronic test equipment
	9		Perform electrical calculations
	55		Interpret electrical schematics (combine with 56)
	56		Maintain schematic documentation (combine with 55)
B			COMPUTERS/NETWORKING
			Configuring laptop hardware devices
			Using Windows Explorer for disk (drive) utilities
			Installing and removing software
			Network basics and hardware
			Ethernet Basics
			Overview servers and workstation operations
			Troubleshooting a network problem
	50		Use operating systems
	51		Use computer software (tasks covered in technical topic areas)
	54		Use laptop for troubleshooting and installation
	62		Maintain servers and clients using RADMIN
C			DISCRETE CONTROL (PLC & HMIs)
			See Allen Bradley PLC-5/RSLogix5 Dacum
			See Allen Bradley ControlLogix/RSLogix5000 Dacum
	37		Create/modify ladder logic for PLC-5

DACUM format for Control Technicians

DACUM format by NOCTI group in MI

AMTEC Duties and Tasks from Original Turbo-DACUM Session

A		MECHANICAL EQUIPMENT
	1	Troubleshoot/repair/replace brakes & clutches (electromechanical and mechanical)
	2	Troubleshoot/repair/replace gears
	3	Troubleshoot/replace belts, sheaves/pulley
	4	Troubleshoot/maintain chains and sprockets
	5	Troubleshoot/repair/replace cams
	6	Troubleshoot/repair/replace seals and o-rings
	7	Troubleshoot/repair/replace bearings and bushings
	8	Troubleshoot/repair/replace shafts
	9	Perform alignment and balancing
	10	Troubleshoot/repair/replace motors (AC and DC)
	11	Maintain couplings
	12	Maintain fans
	13	Install/maintain valves (cut-off, pressure relief...)
B		PNEUMATIC/HYDRAULIC EQUIPMENT
	14	Troubleshoot/repair/replace pneumatic/hydraulic valves
	15	Troubleshoot/repair/replace cylinders and intensifiers
	16	Troubleshoot/repair/replace hoses and tubing
	17	Adjust pressures and flows mechanically and electronically
	18	Maintain fluid levels for hydraulic systems
	19	Replace filters on hydraulic/pneumatic systems
	20	Troubleshoot/repair/replace gauges
	21	Troubleshoot/repair/replace pneumatic/hydraulic pumps
	22	Troubleshoot/replace accumulators
	23	Troubleshoot/repair/replace air motors
	24	Maintain vacuum system on pneumatic equipment
	25	Maintain filtration systems
	26	Adjust switches and controls on hydraulic/pneumatic system
	27	Install/design hydraulic/pneumatic components to upgrade/enhance systems

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DACUM format for Control Technicians DACUM format by NOCTI group in MI

General Mills, Inc.
Controls Technician
Duties, Tasks and Steps

A.			BASIC ELECTRICAL/ELECTRONIC	Tools and Equipment
	3		**Demonstrate knowledge of electrical safety**	
		a	Ladder safety	Common hand tools
		b	Hazards related to moving equipment	Specialized tools
		c	Electrical safety	
		d	CPR	
		e	Shock hazards	
		f	Pinch points	
		g	Personal Protective Equipment	
			--safety glasses	
			--hard hat	
			--jewelry	
			--shoes	
			--gloves	
			--hearing protection	
			--respirators	
			--body harness	
			--clothing (long sleeves, non-flammable, 100% cotton, etc.)	
		h	Slip and fall hazards	
		i	Slings and lifting equipment	
		j	Confined space entry	
		k	Hot work permits	
		l	Scaffold safety	
		m	Fire extinguishers (types and operation)	
		n	HAZCOM	
		o	Asbestos hazards	
		p	PCB hazards	
		q	Blood born pathogen	
		r	Emergency response procedures	
		s	Machine guarding	
		t	Potential hazards (energy, chemical and engulfment)	
		u	Lock out/tag out procedures	
		v	Burn safety	

Universal Terms

- Universally, the terms Competency, Learning Objective, and Learning Outcome are often used interchangeably.
- A competency is a broader statement than an objective
- Outcomes make up a competency
- VET all competencies and outcomes through the Industry SME group

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Overview of the HOME4TECHS Project

- Won in 2015. Ran from 8/1/15 to 7/31/18.
- Amount was approximately $200K
- Focus was to build a model to convert lecture/lab technical courses to a competency-based/hybrid model
- 3 courses were converted:
  - IND223: Motors & Motor Controls
  - PLC200: Programmable Controller I
  - PLC230: Servo & Robotics

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Overview of the HOME4TECHS Project, cont.

- 3 faculty were PI & Co-PIs
- Assessment model changed everything
- Lecture moved online, scheduled & open lab model
- Project results (2 yrs previous to 2 yrs of the new model):
  - 44% increase in enrollment (of the 3 courses)
  - 10% increase in retention
  - 7% increase in grade level attainment

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Overview of the HOME4TECHS Project

- Why did NSCC pursue funds for this project?
  - New LEAN initiative at NSCC
  - The college had to get the voice of the customer
  - 60 employers met in groups of 6 for roundtables
  - Employers expressed their needs for training
  - Employers gave a gradecard to NSCC

- The college had to make some changes

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- Utilize technology tools to accelerate learning
- Offer the students a **flexible open-lab schedule**

Project consists of 3 distinct areas:

Curriculum
- Realignment of curriculum
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- Hands-on assessments
- Open lab learning model

Technology to accelerate learning
- Virtual machines for each student
- Hands-on hardware simulations
- Student access to software 24/7
- Virtual interactive simulations
- MOOCs

Faculty professional development
- Quality matters
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Allen Bradley MicroLogix and CompactLogix

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Servo & Robotics
Fanuc LR Mate 200iD

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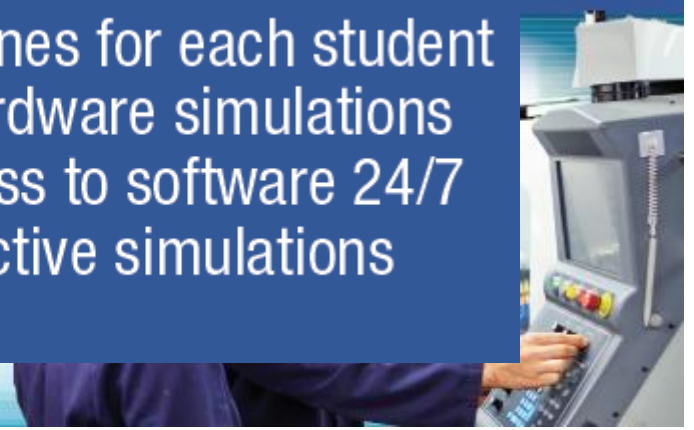

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Original Technical Course Model at NSCC

Course Outcomes	Student Materials	Delivery Method	Student Pacing	Hands-on Experience	Assessment	Delivery Timeframe
Based on Textbook	Based on Textbook	F to F Lecture Instructor	Based on Instructor	Lab Exercises to support lecture	Grade based on 3 tests	16 week semester

A traditional technical course offered at many 2-year colleges

Competency-Based, Hybrid, Flexible-Lab Course Model (NSCC)

Course Outcomes	Student Materials	Delivery Method	Student Pacing	Hands-on Experience	Assessment	Delivery Timeframe
Aligned with Industry Skills Requirements	Active Learning: Videos, Voice over PPT, Simulations. PDF, OER, Textbooks	Hybrid, Lecture Online Labs on Campus	Flexible: Student masters module then moves to next module	Labs used to develop skills and prepare for HOA	Hands-on Assessment (HOA) 100% skills mastery (8 HOAs & 8 LMS Assessments/course)	8 week mini -semester (Part of Term)

Traditional Course Model, scaled to include Outcomes & Assessment

Course Outcomes	Student Materials	Delivery Method	Student Pacing	Hands-on Experience	Assessment	Delivery Timeframe
Aligned with Industry Skills Requirements	Based on Textbook	F to F Lecture Instructor	Based on Instructor	Lab Exercises to support lecture	Hands-on Assessment (HOA) 100% skills mastery	16 week semester

A traditional technical course scaled to include the Course Outcomes & Assessment from the Competency-based Model

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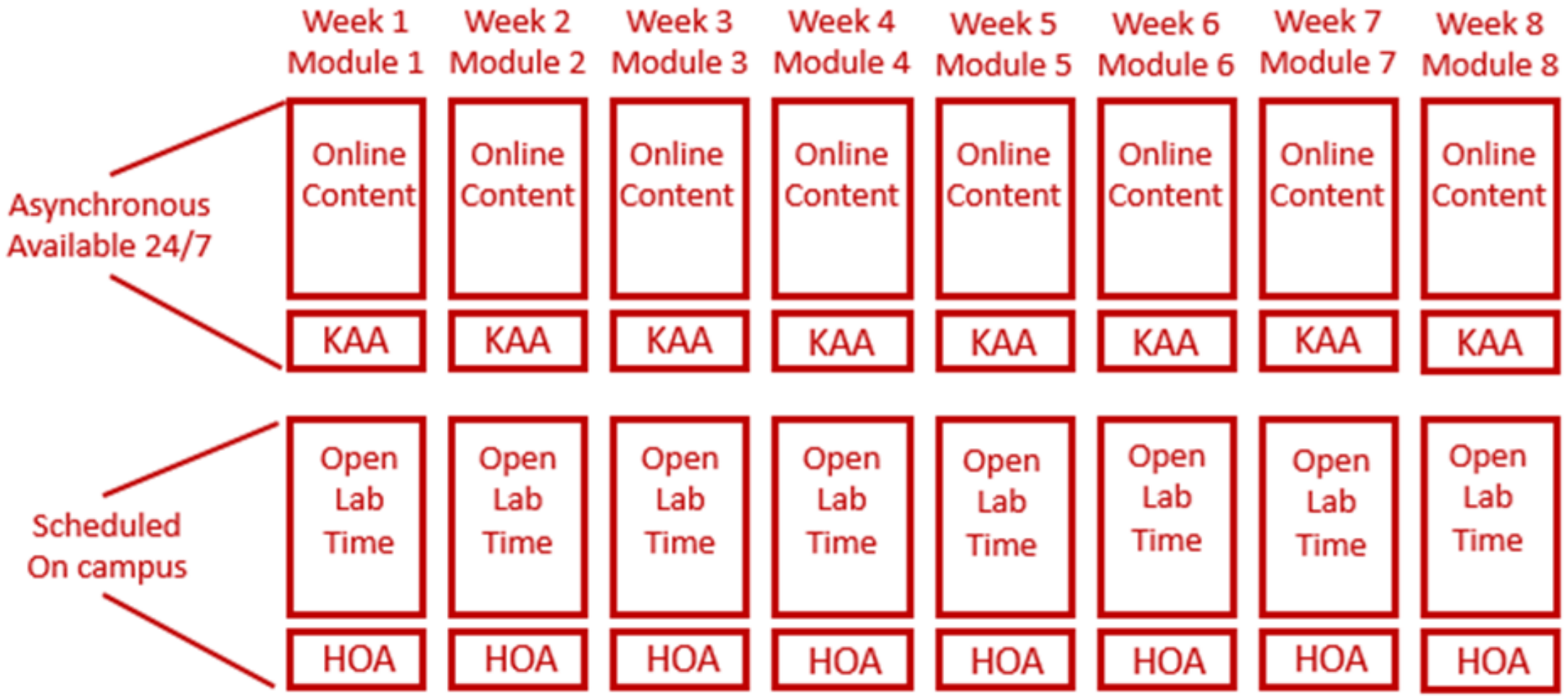
Course Schedule in an 8-week mini-semester



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Student Grades in the NSCC model:

- The grades the students are awarded in the NSCC Ind. Tech hybrid courses are: A, B or F.
- The hands-on assessment (HOA) must have 100% mastery, so students have to get 100. This is not averaged into the grade. It is required.
- The knowledge & application assessment (KAA for short) is the cognitive, online assessment. Student have to get at least an 80% on this assessment to pass the module. They have two tries at taking KAA in each module.
- 16 assessments in each course (8 online, 8 hands-on)

What's in it for Me? The Stakeholders Perspective:

- **Students**: Students like the 24/7 access to the course materials, and knowing what is expected of them for the assessments.
- **Faculty**: Faculty like the consistency in the curriculum, and that all materials are developed, so they do not have to spend time preparing for a class. They also like the flexibility of time on campus.
- **Employers**: Employers like the more accessible classes for their employees, and better prepared graduates. They really like the assessment model of student accountability.
- **College**: Increase in enrollment, increase in retention (SSI), and knowing that the other 3 stakeholders are happy.

A Few Lessons Learned:

- This is a team effort. Support each other and have a common cause with the end goal in mind. Don't be critical of each other.
- Student learning behavior will follow the assessment model. The employers wanted more hands-on learning. By requiring HOAs, students wanted more lab time.
- Online was new for us, so we had to change the faculty culture. We also had to change the student culture.
- We learned not to use the CBE term, but how the elements of CBE are embedded in the model

A Few Lessons Learned cont.:

- This model has moved the student learning off the shoulders of the faculty, to the student. Students are responsible for their learning, and when they take their assessments.
- Employers really like this model since all of the curriculum is developed. A positive thing for the companies was if they sponsored students into a course that had two sections with two different instructors, the students get the same learning experience. Reducing the variance.

A Few Lessons Learned cont.:

- CBE type of technical courses must have a solid structure. How we did technical courses before did not need as much structure.
- Until our Ind. Tech. hybrid courses, online courses were a wild west rodeo. 10 different courses, and they may all look different. Huge negative for the students.
- Our faculty needed to become more literate in the digital world (not just computer literate), due to the moving online, and they needed a support structure.

A Few Lessons Learned cont.:

- Faculty and developers had to become more literate in the digital world, such as:
  - Cloud based applications and storage
  - Internet/browser basics
  - Networking basics (Ethernet, WiFi, 4/5G)
  - Portable devices (phones, phablets & tablets)
  - Powerpoint for a graphics container
  - Using a camera for photos and videos
  - Snagit for capturing portions of computer screen
  - Capture video, produce and upload to YouTube

Aligning the Curriculum to Employer Needs

Topic Outcomes:

- How does Terra currently engages employers
- Explain the three types of employer engagement
- Explain the purpose of an Industry SME group
- Determine how to obtain and validate competencies

Engaging Employers

- How does the Technology division at TSCC engage employers?
- Accrediting bodies like a comprehensive employer engagement strategy.
- Purpose of an Advisory Board
- Purpose of an Industry Roundtable
- Purpose of a Focused Industry Visit

Importance of an External SME group

- SME stands for Subject Matter Expert
- 4-6 of these SMEs should be identified to vet information through as part of the development process for CREATE
- It is important to have all knowledge and skills development, align to the workplace
- This will be done through validated competencies, and measurable outcomes

Building Measurable Outcomes

Topic Outcomes:

- Explain the difference between a competency and an outcome.
- Explain the term of “alignment” when working with competencies and outcomes
- Show how to find the correct action verb for an outcome
- Create 3 skills based outcomes
- Create 3 knowledge based outcomes

Building Measurable Outcomes

- Outcomes must be aligned to a competency, which should align to to the workplace
- A Quality Matters alignment table is used to align the outcomes to the competencies
- Outcomes must be measurable
- Students must know what is expected of them. The term “Understanding” is not measurable

What is an Assessment Model?

Topic Outcomes:

- Compare the assessment for traditional education, and for competency-based
- Explain why there are more assessments in a competency-based than in traditional education
- Compare the CAEL portfolio model to the competency-based assessment for PLA
- Explain the faculty role for assessment within the CB/H model

What is an Assessment Model?

- Traditional technical courses typically uses a written/online assessment for the course.
- In a Competency-based course, the faculty must verify the student learning (both knowledge & skills) through a demonstration (HOA).
- The assessment model verifies that a student get credit for a course, either by taking the course, or by a PLA. The assessment should be the same.

Competency-Based Assessment

- The term CBA stands for Competency-Based Assessments. This assessment must be in place to assess mastery in a CBE model.
- Since the course content is parsed into multiple modules (8 modules for the NSCC model), there will need to be an assessment for each module, to prove mastery, so the student can move to the next module.
- There will be more assessments for students to take (and for faculty to create) in a CBE model

Proficiency by Portfolio

- CAEL is an organization that started as an effort to build a model where student were awarded college credit for experiential learning.
- Portfolio is a common method for getting college credit by documenting the learning and the experience of the student. The challenge is that many times this method of review is not objective. An assessment model will give an accurate assessment of a student.

Assessment by Faculty

- Assessment is the responsibility of the faculty.
- Student skills and knowledge are both assessed by the faculty in the HOA process.
- Knowledge is also assessed through an online assessment for each module that faculty developed, which consists of M.C. and T.F. questions
- LMS efficiency saves faculty valuable time
- The assigned instructor objectively determines if a student passes a module, and the course.

A Few Lessons Learned cont.:

- Student engagement by the faculty is very important. There is a direct correlation between student engagement and retention.
- The CBA model with 8 Hands-On Assessments naturally creates the student engagement environment.
- Lecture is not engagement. Lab activities is a little closer to student engagement, but assessment is the key.
- Also giving individual feedback through the LMS activities creates a great engagement model.

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The End of the Presentation

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