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Online STEM Education Content Modules: An Ongoing Success Story

Lee Allen and Stephanie Ivey
University of Memphis, TN USA

Abstract

A team comprised of rural West Tennessee master teachers has developed, and continues to develop and disseminate Science, Technology, Engineering and Mathematics (STEM) education high school-level content modules and on-line resources accessible to all teachers in TN via a Web Portal. Required courses for graduation are integrated with STEM content, so as to enhance students' knowledge of STEM content and post-secondary education paths, and aligned with national, state, and Common Core standards. These virtual STEM education components have been designed to meet the needs of rural teachers and students who often lack access to resources of higher level science, technology, engineering and mathematics (STEM) instruction. The online high school content modules are also accessible by teachers and students in urban and suburban districts.

Keywords: *Science, Technology, Engineering and Mathematics education, online teaching and learning, content modules, rural secondary education*

1. Introduction

Rural school districts face the continuing challenge of having access to a limited number of teachers qualified to teach upper-level secondary science, technology, engineering and mathematics, or "STEM" courses (Goodpaster, Adedokun & Weaver, 2012). The West Tennessee STEM Collaboratory was developed as a component of a statewide initiative in the state of Tennessee to increase the pipeline of students entering STEM majors, improve K-12 transitions to IHE, and address the needs of regional industries (Honey, Pearson & Schweingruber, 2014). The West Tennessee STEM Collaboratory mission is to unite K–12, institutes of higher education, and STEM industry partners in an innovative approach to transforming regional STEM education and workforce opportunities. The partnership envisions a community-wide initiative to increase students' STEM preparedness, interest, and transition to

the STEM workforce. Industry and higher education partners, working with K–12 teachers and administrators, are helping to bridge gaps in developing appropriate curriculum content, delivery, and community connections to create unique learning environments.

1.1 Background

One component of the West Tennessee (TN) STEM Collaboratory has been to organize a team of exemplary secondary master teachers who are currently working on a set of online STEM and STEM-integrated course content modules for high school/secondary (HS) education. The steps for meeting this goal were met by accomplishing the following:

- Recruiting ten teachers from the West TN mostly rural districts who were identified by their district's administrators as being master teachers in STEM as well as other HS curriculum.
- Identifying and dedicating a location in which to meet with the teacher team to develop HS core content online modules.
- Develop modules for 100% online delivery cooperatively as five two-member teacher teams in the specialization areas of required HS core content: English/Language Arts; Mathematics; Science; and Social Studies, plus a two-teacher team dedicated to developing content in HS Engineering.
- The content modules are based on Challenge-Based and Problem-Based Learning instructional concepts (Johnson & Adams, 2011; Boud & Felleti, 1998; Savery & Duffy, 1995; Margetson, 1991), comprehensively utilizing problem- and project-based learning while incorporating STEM content and the Common Core Standards as these are being adopted nationally and in the state of Tennessee.

The primary goals and expectations for the interdisciplinary online HS content module development teacher-team are to:

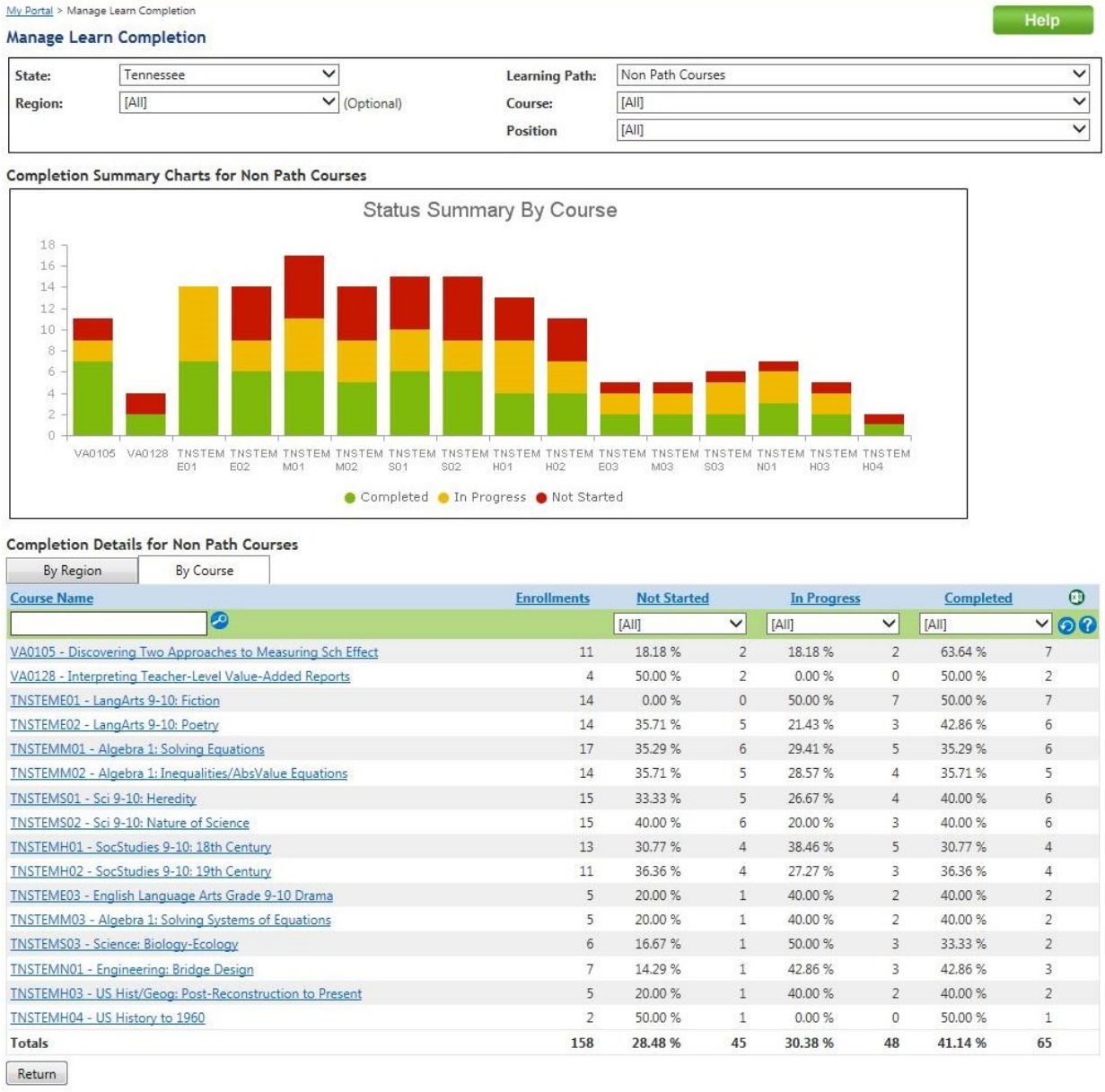
- Develop and make available a minimum of twenty online interdisciplinary/STEM integrated high school content modules during the timeframe of the funded project (2013-14).
- Integrate STEM and interdisciplinary content and incorporate Common Core standards and assessments where available in the TN curriculum.
- Promote regional implementation of the online STEM content modules and interdisciplinary curriculum.

2. Methodology

As of November 2014, twenty-three HS content modules available online via the Battelle For Kids/TN First to the Top (BFK/TNFttT) professional development web portal through a partnership with BFK; this venue was selected due to its already extensive use by K-12 teachers in the region (since 2011). The first set of courses was completed in summer 2013 with

availability for TN teachers during the 2013-14 academic year beginning in August 2013. The content modules are free and readily available to all TN teachers and usage can be tracked by region. The West TN STEM Collaboratory is currently working to build a portal through its website so that modules can be freely accessed by teachers across the country.

To gauge the success - or not - of the implementation and diffusion of the online HS content modules, the researchers determined that comparing the usage of the modules by region, as well as by course, would provide a visual representation in measuring of the degree of success – or lack thereof – by usage of the content modules available online via the BFK/TN portal. The initial "snapshot" (screenshot) of the modules' access and usage was collected on January 21, 2014, approximately six months after the 2013-14 academic year began for public schools in Tennessee (Fig. 1). Note that while all of the online modules shown in the view are designated as "Non Path Courses", the modules under discussion are labeled "TNSTEM".



Course Name	Enrollments	Not Started		In Progress		Completed	
		[All]		[All]		[All]	
VA0105 - Discovering Two Approaches to Measuring Sch Effect	11	18.18 %	2	18.18 %	2	63.64 %	7
VA0128 - Interpreting Teacher-Level Value-Added Reports	4	50.00 %	2	0.00 %	0	50.00 %	2
TNSTEME01 - LangArts 9-10: Fiction	14	0.00 %	0	50.00 %	7	50.00 %	7
TNSTEME02 - LangArts 9-10: Poetry	14	35.71 %	5	21.43 %	3	42.86 %	6
TNSTEMM01 - Algebra 1: Solving Equations	17	35.29 %	6	29.41 %	5	35.29 %	6
TNSTEMM02 - Algebra 1: Inequalities/AbsValue Equations	14	35.71 %	5	28.57 %	4	35.71 %	5
TNSTEMS01 - Sci 9-10: Heredity	15	33.33 %	5	26.67 %	4	40.00 %	6
TNSTEMS02 - Sci 9-10: Nature of Science	15	40.00 %	6	20.00 %	3	40.00 %	6
TNSTEMH01 - SocStudies 9-10: 18th Century	13	30.77 %	4	38.46 %	5	30.77 %	4
TNSTEMH02 - SocStudies 9-10: 19th Century	11	36.36 %	4	27.27 %	3	36.36 %	4
TNSTEME03 - English Language Arts Grade 9-10 Drama	5	20.00 %	1	40.00 %	2	40.00 %	2
TNSTEMM03 - Algebra 1: Solving Systems of Equations	5	20.00 %	1	40.00 %	2	40.00 %	2
TNSTEMS03 - Science: Biology-Ecology	6	16.67 %	1	50.00 %	3	33.33 %	2
TNSTEMN01 - Engineering: Bridge Design	7	14.29 %	1	42.86 %	3	42.86 %	3
TNSTEMH03 - US Hist/Geog: Post-Reconstruction to Present	5	20.00 %	1	40.00 %	2	40.00 %	2
TNSTEMH04 - US History to 1960	2	50.00 %	1	0.00 %	0	50.00 %	1
Totals	**158**	**28.48 %**	**45**	**30.38 %**	**48**	**41.14 %**	**65**

Fig. 1. Screenshot of usage by course on January 21, 2014

As shown in Figure 1, the total number of users for all of the "Non-Path" courses after six months was 158; the total number of users of the TN STEM courses was 143 (158 - 15). The total number of users who had completed the TNSTEM courses by the Jan. 21, 2014 date was 56 (65 – 9).

The latest "snapshot" (screenshot) of the modules' access and usage was taken on November 10, 2014, approximately ten months after the first view, and sixteen months after the initial availability of the modules for public and private schools in Tennessee (Fig. 2). Again, note that

while all of the online modules shown in the view are designated as “Non Path Courses”, the modules under discussion are labeled “TNSTEM”.

Course Name	Enrollments	Not Started		In Progress		Completed	
		[All]		[All]		[All]	
TNSTEME01 - LangArts 9-10: Fiction	34	14.71 %	5	26.47 %	9	58.82 %	20
TNSTEME02 - LangArts 9-10: Poetry	30	43.33 %	13	16.67 %	5	40.00 %	12
TNSTEME03 - English Language Arts Grade 9-10 Drama	23	39.13 %	9	21.74 %	5	39.13 %	9
TNSTEME04 - American Literature Part 1	8	37.50 %	3	25.00 %	2	37.50 %	3
TNSTEME05 - American Literature Part 2	4	0.00 %	0	100.00 %	4	0.00 %	0
TNSTEMH01 - Social Studies 9-10: 18th Century	23	30.43 %	7	26.09 %	6	43.48 %	10
TNSTEMH02 - SocStudies 9-10: 19th Century	24	41.67 %	10	16.67 %	4	41.67 %	10
TNSTEMH03 - US Hist/Geog: Post-Reconstruction to Present	18	33.33 %	6	22.22 %	4	44.44 %	8
TNSTEMH04 - US History to 1960	15	26.67 %	4	13.33 %	2	60.00 %	9
TNSTEMH05 - US Hist/Geog: FDR through Obama	5	60.00 %	3	0.00 %	0	40.00 %	2
TNSTEMM01 - Algebra 1: Solving Equations	44	22.73 %	10	29.55 %	13	47.73 %	21
TNSTEMM02 - Algebra 1: Inequalities/AbsValue Equations	30	43.33 %	13	26.67 %	8	30.00 %	9
TNSTEMM03 - Algebra 1: Solving Systems of Equations	25	48.00 %	12	16.00 %	4	36.00 %	9
TNSTEMM04 - Statistics Module A	5	20.00 %	1	20.00 %	1	60.00 %	3
TNSTEMM05 - Statistics Module B	4	50.00 %	2	50.00 %	2	0.00 %	0
TNSTEMN01 - Engineering: Bridge Design	27	22.22 %	6	33.33 %	9	44.44 %	12
TNSTEMN02 - Engineering: Solar Energy	7	42.86 %	3	14.29 %	1	42.86 %	3
TNSTEMN03 - Engineering: Rockets	4	50.00 %	2	50.00 %	2	0.00 %	0
TNSTEMS01 - Sci 9-10: Heredity	36	30.56 %	11	19.44 %	7	50.00 %	18
TNSTEMS02 - Sci 9-10: Nature of Science	40	32.50 %	13	20.00 %	8	47.50 %	19
TNSTEMS03 - Science: Biology-Ecology	24	33.33 %	8	20.83 %	5	45.83 %	11
TNSTEMS04 - Science: Biological Evolution	7	28.57 %	2	42.86 %	3	28.57 %	2
TNSTEMS05 - Science: Biology - Cells	4	50.00 %	2	50.00 %	2	0.00 %	0
VA0105 - Discovering Two Approaches to Measuring Sch Effect	11	18.18 %	2	18.18 %	2	63.64 %	7
VA0128 - Interpreting Teacher-Level Value-Added Reports	4	50.00 %	2	0.00 %	0	50.00 %	2
Totals	**456**	**32.68 %**	**149**	**23.68 %**	**108**	**43.64 %**	**199**

Fig. 2. Screenshot of usage by course on November 10, 2014

As shown in Figure 2, the total number of users for all of the "Non-Path" courses after six months was 456; the total number of users of the TN STEM courses was 441 (456 - 15). The total number of users who had completed the TNSTEM courses by the Jan. 21, 2014 date was 190 (199 – 9).

3. Results

The screenshots illustrating TNSTEM online content module usage from, respectively, January 21st and November 10th, show an overall increase of user enrollment and completion rate of the TNSTEM modules. User enrollment increased from 143 in January to 441 in November, an increase of 298 users, or over 200%. A comparison of user completion of the TNSTEM modules between January and November shows an increase from 56 to 190, an increase of 134 users, or almost 240%.

4. Discussion

The results of the comparison of the TNSTEM online content modules between January and November 2014 readily reveal that the implementation has been a marked success, overall, in achieving - and surpassing - the primary goals and expectations for the online HS content modules as determined by the West TN STEM Collaboratory; to wit:

> *Develop and make available a minimum of twenty online interdisciplinary/STEM integrated high school content modules during the timeframe of the funded project (2013-14)*.

This goal has already been achieved and exceeded, as there are currently 23 online content modules available, with a total of 28-29 anticipated by the end of the funding period on December 31, 2014.

> *Integrate STEM and interdisciplinary content and incorporate Common Core standards and assessments where available in the TN curriculum.*

While the integration of interdisciplinary STEM content into each online module cannot be measured by a numerical comparison of the modules' overall usage, the significant increase in completion of the TNSTEM modules could indicate that the users are determining that the content is of value to them as teacher/educators.

It is also noteworthy that each and every content module contains the full name and email address of the two teachers who developed and authored that particular model, and, to date, none of the ten teachers involved have been contacted in regards to the module. In addition, the name and email address of the teacher team coordinator is also provided, as is the BFK/TNFttT hosting web portal administration's contact information. None have ever received communications in regards to the TNSTEM modules.

Promote regional implementation of the online STEM content modules and interdisciplinary curriculum.

Promotion and dissemination of the information on the availability of- and instructions on how to access the content modules online via the BFK/TNFttT web portal has been the product of cooperative efforts by the Battelle For Kids organization as hosts of the TNSTEM modules, and by the West TN STEM Collaboratory, as the sponsoring agency of the initiative.

The product of these efforts consists of, primarily, printed informational flyers developed collaboratively by BFK and West TN STEM Collaboratory communications' teams. The flyer has been distributed at various STEM-related presentation and conference venues throughout West Tennessee, mostly, and the state as a whole; it is also available online as a downloadable PDF. The West TN STEM Collaboratory also hosts its own website with links to various STEM-related resources accessible online, and promotes the online HS content modules via that vehicle as one of the available teacher/educator resources.

5. Conclusions

By bringing the various West Tennessee rural and urban districts' recommended excellent teachers together in February 2013, the five 2-person teacher teams designed course content - as well as associated professional development - to improve teachers' STEM content knowledge and pedagogical approaches. As a result of the ca. 20 month implementation in developing and uploading the online HS content modules, teachers and other educators have benefitted from the products made available via the BFK/TNFttT web portal, as evidenced by the very significant increase in access, use, and completion of the modules over the monitored ten-month period.

While the relative qualitative "value" of the online modules cannot be identified via analysis of the quantitative data collected of user enrollment and completion of the modules, the overall numerical increase in these two areas over a relatively brief time period cannot be viewed other than as significant: the availability of the online HS content module met - and surpassed - the criteria for the goals and expectations of the original mandate for the West TN STEM Collaboratory in the areas of development, dissemination, diffusion, and actual *use* of online STEM- and Common Core-related high school/secondary core content made available online via a readily accessible vehicle.

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