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Science Teaching Excites Medical Interest: A Teacher Professional Development Program in Mississippi

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Abstract: The Science Teaching Excites Medical Interest (STEMI) program is an evolving collaboration of academic health science center-based biomedical clinical and research experts, graduate students in clinical anatomy, and Mississippi K-12 schools that seeks to develop a technologically-enhanced teacher-centered community of health learners. The present description of the STEMI community highlights development, implementation, and initial dissemination of high school learning products utilizing contemporary technological approaches and the flipped classroom pedagogical model. The goal is to better engage students within a context of exploring relationships between health literacy, the state's epidemic of obesity, and ensuing anatomic and functional pathophysiology. An evaluation team utilizes a robust mixed-methods approach to examine the program goals and the potential for program expansion and replication. The community is growing, in part through a robust collaboration with the Mississippi INBRE (IDeA Network of Biomedical Research Excellence) at the University of Southern Mississippi.

INTRODUCTION

As science educators respond to the Next Generation Science Standards, there is a need to provide professional development to enhance STEM learning experiences. Developing programs that address the standards in the context of unique regional needs can be particularly valuable. The high number of health disparities within the state of Mississippi creates a compelling need to offer science education that can enhance students' knowledge to positively impact their health. The Science Teaching Excites Medical Interest (STEMI) program was developed to address this need.

The STEMI program is a collaboration of university-based biomedical clinical and research experts at the University of Mississippi Medical Center (UMMC), Clinical Anatomy graduate students, and Mississippi K-12 schools that seeks to develop a technologically-enhanced teacher-centered community of health learners. The program also focuses on key local and national public health topics, particularly obesity and associated cardiovascular disease that are prevalent in Mississippi. The STEMI community is developing, implementing, and disseminating high school learning products utilizing new technological approaches for engaging students in the overall STEMI focus of exploring relationships between health literacy, the state's epidemic of obesity, and ensuing anatomic and functional pathophysiology.

The STEMI program recruits science teachers from Mississippi high schools. The program is strengthened by the involvement of a core group of experienced teachers, (STEMI Cadre Prime), who have been engaged in a long-term partnership with UMMC. Each year a new cadre of teachers is recruited to participate in a longitudinal training experience. The program provides a structured, two-year mentored exposure to technologies and curriculum elements that support successful implementation of flipped lesson/classroom (FL/C) science instruction. The flipped learning approach, which has gained considerable attention in both K-12 and health sciences education, increases student openness to engaging in both cooperative learning and in-

novative teaching (Bishop and Verleger, 2013; Mortensen and Nicholson, 2015). Teachers participate in two summer institutes in which lectures, problem-based learning, hands-on activities, skills training, and collaborative professional development are offered. Medical center faculty, clinicians, and clinical anatomy graduate students guide and support these activities. The collaborative group also meets several times in person as well as engaging in online communication during the academic year. These program components are described, followed by a description of the STEMI evaluation effort.

PROGRAM COMPONENTS

Summer Workshop. The primary intent of the STEMI program was to have teachers produce a complete flipped lesson unit in their particular science area for use in their respective classrooms. These lessons were intended to be developed through shared, collaborative formative feedback amongst the participating teachers and STEMI faculty. In order to facilitate the creation of these flipped lessons, an annual workshop was created by the STEMI investigators.

Teachers enrolled in the STEMI program participated in a four-week summer workshop held on the campus of the University of Mississippi Medical Center (UMMC) in Jackson, MS. These teachers committed to participating in two consecutive summer workshops, the first primarily as learners and the second as mentors to a new group of teachers. The summer workshop ran Monday through Friday from 9am to 5pm. Participating teachers received an hourly stipend for attendance.

The main objective and overarching concept for the STEMI program was to give the teachers the resources needed to produce flipped classroom lesson plans and related modules that they would take back to their classrooms and implement with their students. Additionally, the workshop was created to provide local high school teachers with mentored internships focused on creation of these lessons plans and to utilize concepts of health literacy that are relevant to the state of Mississippi, particularly obesity-related health disorders. Finally, the workshop intended to create and involve the teachers in a community of learners that included other high school teachers and UMMC faculty and graduate students in the Clinical Anatomy PhD program.

Summer Schedule and Activities. In order to achieve the objectives of the summer workshop, a variety of activities were scheduled throughout the summer. The activities were designed to introduce the teachers to the flipped classroom methodology, provide updates and refreshers in basic science content areas, introduce content on health issues facing Mississippi, and to provide resources and training opportunities for the teachers through interactions with each other and with faculty from UMMC.

Sessions were primarily led by STEMI faculty members and staff as well as teachers who completed the workshop in the previous summer. While some sessions were didactic and involved dissemination of information, other sessions specifically modeled the flipped classroom approach and required teachers to complete short homework assignments to be prepared for the session. Other sessions involved hands-on activities and laboratory experiences. The first week's schedule is seen in Table 1 and the breakdown of sessions and session times can be seen in Table 2.

The summer workshop had approximately 156 scheduled hours covering seven different content categories. Eight hours were dedicated specifically to the STEMI project and included the basic workshop introduction, human subjects research training, and time for program evaluation (surveys and interviews with the program's evaluation team).

About thirty hours were dedicated to the flipped-classroom methodology. Sessions in this category focused on the design and implementation of flipped lessons. Several sessions were taught by members of UMMC's media productions department and gave teachers information on creating and editing videos and other technologies that were beneficial to producing flipped classroom segments. Additionally, five sessions were specifically programmed to have teachers from previous summers demonstrate their flipped classroom modules in order to provide working templates for the current group of teachers. During week four, afternoons were dedicated specifically for the teachers to work on their flipped classroom design. This gave them time to work with other UMMC faculty and teachers from previous summers and allowed them to receive feedback on their module.

Professional development sessions covered almost a quarter of the allotted time. This category included sessions on writing small grants to support their flipped classroom modules, developing learning objectives, assessment of learning, and other education based development sessions. Teachers were exposed to unconscious bias training, responsible conduct of research topics, and tools to help assess and evaluate learning in the classroom.

Several sessions were also dedicated to health issues and basic science content. Sixteen hours were dedicated to training on various health issues facing the state of Mississippi. These topics were delivered by UMMC faculty which expertise in several fields of health disparity issues. Topics such as obesity, health literacy, and community health advocacy were covered. Basic science refreshers were scheduled over thirteen hours and covered several anatomy topics. Histology content provided the teachers with hands on training in creating and using microscope slides in the classroom. Two morning sessions were dedicated to the gross anatomy laboratory where teachers got to explore the effects of health disparities on a number of prosected human donors.

Table 1. *Week 1 Schedule*

	MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
9	SEPA/STEMI: Why are We Here? Cadres, Teachers, UMMC Faculty, Clinical Anatomy Students (ST)	Overview of Mississippi Health Issues: Scope of the Problem (HI)	Introduction to Health Literacy (HI)	Community Health Advocate Training (HI)	IM Center Training School of Nursing (HI)
10	UMMC Collaboratory: Introduction to Flipped Learning-6 Core Competencies (FL)	Obesity in Mississippi (HI)	Science of Learning (PD)	Community Health Advocate Training (HI)	SIM Center Training (HI)
11	Flipped Learning Example based on HW given to them? (FL)	Making Videos: UMMC Resources, Personal Phones and Cameras (FL)	Technology Training: Power Point, ARC, Video, and Editing (FL)	Community Health Advocate Training (HI)	Understanding Food Labels or Fad Diets? (HI)
Noon	Show and Tell (Col)	Show and Tell (Col)	Show and Tell (Col)	Show and Tell (Col)	Show and Tell (Col)
12:30	***LUNCH***	***LUNCH***	***LUNCH***	***LUNCH***	***LUNCH***
1:30	5E Template (FL)	Introduction to STEMI Evaluation Effort (ST)	Childhood Obesity (HI)	Incorporate Research: Science in the Classroom (PD)	Assessment (PD)
2:30	Introduction: A Flipped Lesson in the Classroom (FL)	Writing Case Studies for the Classroom (PD)	Obesity in Pregnancy (HI)	WebEx Training (PD)	Flipped Classroom Design (FL)
3:15	Mentorship (Col)	Mentorship (Col)	Mentorship (Col)	Mentorship (Col)	Mentorship (Col)
3:30	Exercise: Walk Around UMMC (Col)	Exercise: Walk Around UMMC (Col)	Exercise: Walk Around UMMC (Col)	Exercise: Walk Around UMMC (Col)	Exercise: Walk Around UMMC (Col)
4	Introduction to Grant Writing (PD)	Grant Writing (PD)	Grant Writing (PD)	Grant Writing (PD)	Grant Writing (PD)
4:50	Homework	Homework	Homework	Homework	Homework

Key: ST – STEMI specific activities, FL – Flipped Lesson sessions, Col – Collaboration time, PD – Professional Development sessions, HI – Health Issue sessions, MENTORSHIP - pair up with teachers from other Cadres; SHOW AND TELL - group sharing of useful apps and web sites; HOMEWORK – Preparation for the following day, Note – Science content sessions were done in weeks 2 and 3

Table 2. *Number and Hours for Each Session Category*

Category	Number of Sessions	Approximate Hours
STEMI Specific	8	8
Flipped Classroom Methods	31	31
Professional Development	44	44
Health Issues	12	16
Science Content	9	13
Collaboration Time	40	20
Field Trip	3	24
Total	147	156

Several sessions each day were dedicated to collaborative work. These sessions helped accomplish two things. First, they gave teachers the time to reflect and synthesize the exposures and information they were gathering. Second, and most importantly, these sessions provided the teachers dedicated, purposively scheduled time to work together on issues they face in their classrooms. One collaborative session was called "Show and Tell" and gave the teachers an opportunity to present and discuss resources that they found useful in teaching such as educational apps or websites. Other collaborative time gave the teachers the opportunity to explore the campus of UMMC in small groups, exploring different aspects of the academic medical center.

Three days were scheduled in the workshop for teachers to take field trips to other areas in the state. Two of the field trips were to university campuses, the University of Mississippi in Oxford, MS and the other to the Mississippi INBRE (IDeA Network of Biomedical Research Excellence) program at the University of Southern Mississippi in Hat-

tiesburg, MS. The teachers traveled to these campuses and interacted with various academic departments, touring of facilities, and meeting others involved in science education in the state. The third field trip was to a local high school where one of the teachers conducted the "*Wolbachia* Rodeo," a hands-on molecular biology-oriented learning experience for high school science students. This event allowed the teachers to interact with students as they collected scientific data on the prevalence of infection of insects by *Wolbachia* bacteria in Mississippi.

Academic Year Activities. In order to offer continued support and to further develop the community of learners, the STEMI teachers meet four times during the academic year. At these Saturday sessions, faculty, graduate students, and all of the science teacher participants gather at the medical school campus for day-long sessions that vary in content. Teachers present modules for feedback, medical faculty provide additional training, and activities to build and strengthen the community of learners are conducted. Online communication continues throughout the academic year.

Mentorship. A hierarchical mentorship model permeates the concept of STEMI professional development. Cadre Prime master teachers have received extensive, individualized mentoring from UMMC faculty, often over a period of decades and yielding numerous teacher-initiated external grants and publications/presentations co-authored by teachers and UMMC faculty. Cadre Prime teachers help recruit subsequent Cadre members and provide ongoing mentoring, both at their respective schools/school districts and during summer workshops. Each successive group of Cadre teachers in turn, recruits and mentors the next generation of Cadre teachers. A goal is to create an enlarging nucleus of trained teachers at each of the eight loci for teacher involvement.

STEMI TEACHER PARTICIPANTS

STEMI recruitment occurs in high schools/school districts in central Mississippi (including sites within the Catholic Diocese of Mississippi, Madison County School District, Jackson Public School District, Lincoln County School District, Hinds County School District, and the private St. Andrew's Episcopal High School). Within each, a school site was identified because of existing relationships between UMMC faculty and a master teacher. A total of eight teachers/sites were initially recruited and each site was to repetitively recruit eight new cadre members/years. Actual recruitment rates have varied due to challenges that include teacher turnover, school administrative support, and a limiting pool of STEM-discipline teachers in some smaller schools. The initial group of eight schools included those in large urban public school districts, private ecumenical schools, and small rural public school districts (Figure 1). In some cases, a school might have only a single teacher teaching in a STEM science (biology, chemistry, physics), which has proven to be a limiting factor in recruitment. The range of educational technology support at these diverse sites is highly variable. While availability of web-accessible devices (computers and cell phones) is virtually ubiquitous, the subscription rates for wide band-width web access limits the access of students to web-based instructional materials in both inner city urban schools and smaller rural schools.

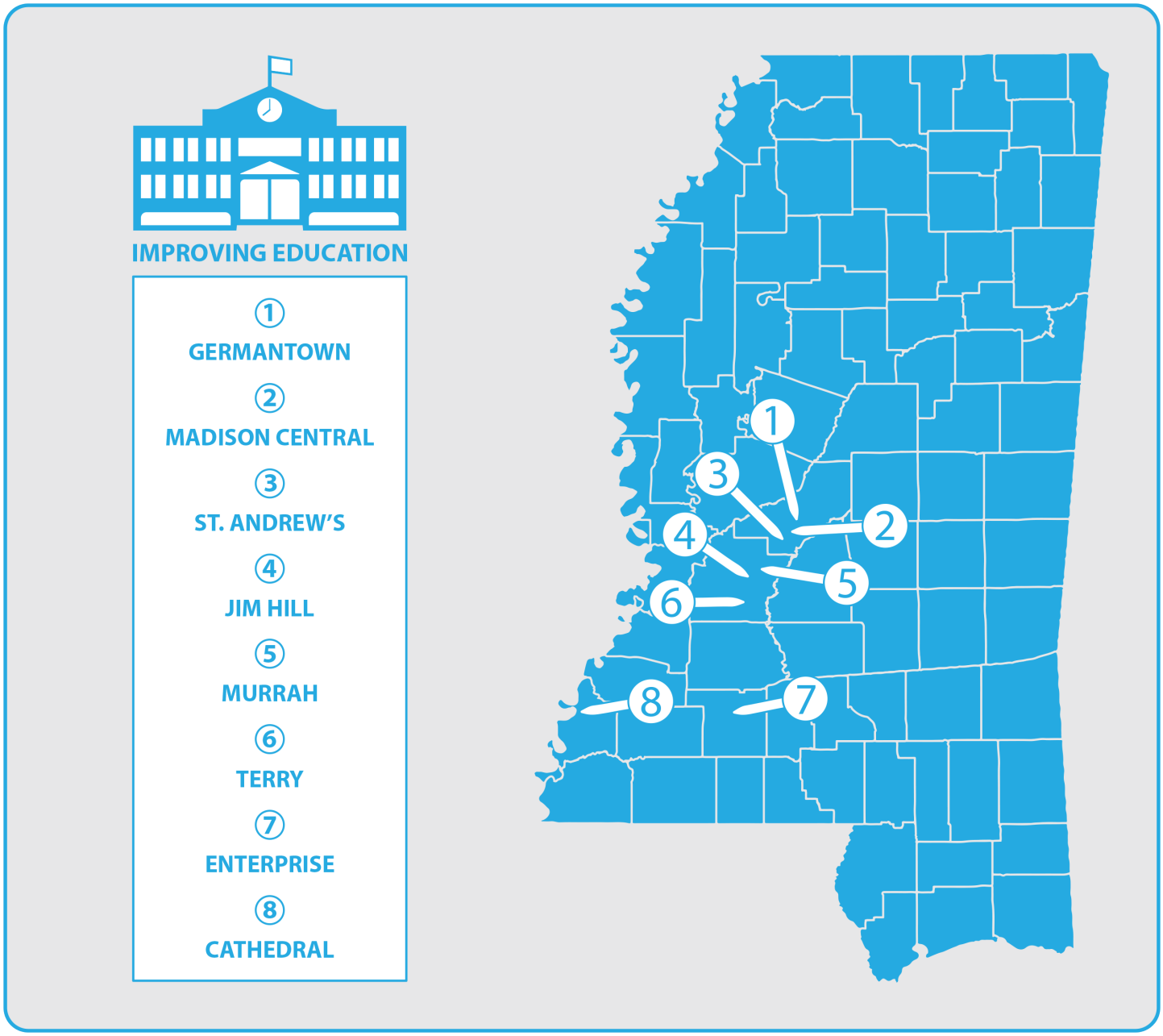
STEMI PROGRAM EVALUATION

Overview. Evaluation of STEMI utilizes an adaptation of the RE-AIM framework, developed to enhance the quality, speed, and impact of public health educational interventions (Glasgow et al., 1999; Jilcott et al., 2007; Klesges et al., 2005). This framework examines implementation efforts from research to application and policy, including the ability to evaluate the potential for an intervention for translation for a broader impact. An internal and external evaluation team utilizes a robust mixed-methods approach to collect data to examine the program's specific aims and the potential for program expansion and replication. Approval from the University of Mississippi Medical Center Institutional Review Board was granted prior to the initiation of the evaluation.

Social Network Analysis. A key component to the success of the STEMI program is the development of a community of learners. In order to evaluate the development of this community, a social network analysis is being conducted. In addition to documenting the development of the community, this analysis facilitates an understanding of how relationships develop and are utilized over time in a professional development program as well as which participants and/or what roles are key (Wasserman and Faust, 1994). Understanding these factors permits the program to leverage these key actors to strengthen the community and to explore and potentially intervene to more appropriately engage program participants to fully utilize the expertise and resources in the program. The STEMI program utilizes a quarterly social network survey to track the development of the network. This information is triangulated and supplemented with documentation from a tracking system that monitors interactions in a social media site as well as an online course the program uses, in addition to tracking email and in person interactions.

Competencies. There is strong evidence that teacher quality has a significant impact on proximal student learning, as well as long-term student outcomes such as enrollment in college and higher salaries (Chetty et al., 2013). The STEMI model aims to improve teacher quality by developing key

Figure 1. STEMI teacher participating schools



teacher-level competencies necessary for implementation of the flipped classroom technologically-engaged modules on topics that address obesity. A competency model was developed and will be utilized to track the impact of the STEMI program on the teacher participants (Table 3).

Participant Perspectives. All STEMI workshop participants complete post-assessments to provide data to support program quality improvement efforts. The participants indicated somewhat or strong agreement with the ideas that the institute is challenging and enjoyable, that they gained new resources that will enhance their teaching, that what they were learning would have a positive impact on their students, that the institute increased their enthusiasm for teaching science, and that they felt more confident teaching about obesity. Overall, participants were satisfied with the institute. The guest lecturers/presenters, the hands on activities, STEMI staff, and the facilities received high satisfaction ratings.

FUTURE DIRECTIONS

Continued evaluation will assess the nature and utility of bringing teachers together during the school year. As teachers are introduced into online aspects of a learning community, it may be possible to transition to using online video conferencing rather than face-to-face meetings. The University of Mississippi Medical Center has a very active Telehealth program which may serve as a vehicle to expand

Table 3. *STEMI Teacher Competencies*

Code	ATTITUDES TOWARD FLIPPED LEARNING TEACHING in STEM *Demonstrates willingness to engage in efforts to effectively teach STEM in a flipped learning environment.*
AT-1	Confident in teaching capability
AT-2	Confident in teaching STEM content
AT-3	Willing to design and implement innovative STEM curricula
AT-4	Willing to actively participate in a community of learners about flipped learning in STEM
AT-5	Willing to receive feedback on flipped learning STEM teaching
AT-6	Willing to improve STEM concept knowledge
	KNOWLEDGE APPLICATION *Applies knowledge of flipped learning, health content, and best practices in teaching to develop lessons that are aligned to standards and represent a coherent sequence of learning.*
KA-1	Writes and aligns learning objectives and outcomes for flipped lessons and in-class lessons
KA-2	Creates lesson plans and content to meet learning objectives
KA-3	Incorporates hands on and/or inquiry-based STEM activities to complement and extend material outside class
KA-4	Utilizes new techniques in daily routines to replace old techniques, not merely use them as additional techniques
	KNOWLEDGE IMPLEMENTATION, EVALUATION, & DISSEMINATION *Implements, evaluates, and disseminates flipped learning STEM instruction.*
KIED-1	Implements a flipped learning instructional method
KIED-2	Monitors the effectiveness of instructional practices
KIED-3	Demonstrates to other teachers the effectiveness of flipped lesson instruction
KIED-4	Identifies and applies for support for flipped learning STEM teaching/programs/students
KIED-5	Engages in evaluation activities as a practitioner-scientist
	LEARNING ENVIRONMENT MANAGEMENT *Implements effective pedagogical practices to support active learning in a flipped learning environment.*
LEM-1	Implements classroom management practices that facilitate a positive and productive learning environment
LEM-2	Connects learning with students' previous knowledge and experience, highlighting the value of an assigned activity in personally relevant ways
LEM-3	Models technology to facilitate students' success with the technology in the flipped environment
	TECHNOLOGY SKILLS *Utilizes technology to effectively engage in flipped learning instructional methods.*
TS-1	Utilizes Online Learning Management systems (i.e., Canvas, Blackboard)
TS-2	Utilizes digital assessment tools
TS-3	Captures and edits images, audio, and video to engage students
TS-4	Utilizes multimedia in instruction
	CONTENT KNOWLEDGE - HEALTH *Demonstrates knowledge of health-related content.*
H-1	Health data related to obesity and associated chronic diseases, health harms
H-2	Health literacy, general
H-3	Anatomy and physiology related to obesity and associated chronic diseases, health harms
H-4	Causes of obesity
H-5	Consequences of obesity

the STEMI learning community statewide. The STEMI program is actively engaged in developing collaborations with other STEM/health workforce development programs sponsored by the National Institute of General Medical Sciences for states eligible for funding for IDeA (Individual Development Award) grants. These collaborations are intended to develop and enhance transfer along a pipeline of preparation for entry into the STEM/health workforce. The STEMI project is currently aligned with the Mississippi INBRE (IDeA Network of Biomedical Research Excellence) at the University of Southern Mississippi. The collaboration between the Mississippi INBRE and STEMI intersects through the support provided by INBRE for the annual meeting of the Mississippi Academy of Sciences, where STEMI has presented a full day workshop on the genomics education activity, the *Wolbachia* Rodeo, a competition-based team activity that links with the Discover the Microbes Within international educational collaboration now housed at Vanderbilt University. This effort exemplifies the directive from the National Institute of General Medical Sciences that funds both STEMI and INBRE to coordinate a pipeline for health workforce development from K-12 through faculty maturation (Lorsch, 2018). The flipped learning/classroom activities developed by STEMI are intended to be adjuncts to and merged into selected high school courses. An ongoing question is whether this teaching model is better utilized as the sole method and segregated into new elective courses within the high school curriculum. Finally, it is of critical interest to determine whether use of the FL/C method does in fact increase student advancement into the STEM/health workforce. Early exposure to science research experiences influences student career selection for STEM fields (Tai et al., 2006). Is the same true for FL/C use in STEM classes?

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Author Contributions

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ABBREVIATIONS

IDeA: Individual Development Award; INBRE: IDeA Network of Biomedical Research Excellence; NIGMS: National Institutes of General Medical Sciences; STEMI: Science Teaching Excites Medical Interests; UMMC: University of Mississippi Medical Center

REFERENCES

Batalden, P., Leach, D., Swing, S., Dreyfus, H., and Dreyfus, S. (2002). General competencies and accreditation in graduate medical education. Health Affairs, 21(5), 103–111.

Bishop, J. L., and Verleger, M. A. (2013). The Flipped Classroom: A Survey of the Research. Presented at the 120th ASEE Annual Conference and Exposition, Atlanta, GA. Retrieved from http://www.ctdinstitute.org/sites/default/files/file_attachments/Flipped%20Classroom-%20A%20Survey%20of%20the%20Research.pdf

Blömeke, S., and Delaney, S. (2012). Assessment of teacher knowledge across countries: a review of the state of research. ZDM, 44(3), 223–247.

Chetty, R., Friedman, J. N., and Rockoff, J. E. (2013). Measuring the Impacts of Teachers II: Teacher Value-Added and Student Outcomes in Adulthood (Working Paper No. 19424). National Bureau of Economic Research.

Dreyfus, S. E. (2004). The five-stage model of adult skill acquisition. Bulletin of Science Technology and Society, 24(3), 177–181.

Enochs, L. G., and Riggs, I. M. (1990). Further development of an elementary science teaching efficacy belief instrument: a preservice elementary scale. School Science and Mathematics, 90(8), 694–706.

Glasgow, R. E., Vogt, T. M., and Boles, S. M. (1999). Evaluating the public health impact of health promotion interventions: the RE-AIM framework. American Journal of Public Health, 89(9), 1322–1327.

Jilcott, S., Ammerman, A., Sommers, J., and Glasgow, R. E. (2007). Applying the RE-AIM framework to assess the public health impact of policy change. Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine, 34(2), 105–114.

Klesges, L. M., Estabrooks, P. A., Dzewaltowski, D. A., Bull, S. S., and Glasgow, R. E. (2005). Beginning with the application in mind: designing and planning health behavior change interventions to enhance dissemination. Annals of Behavioral Medicine: A Publication of the Society of Behavioral Medicine, 29 Suppl, 66–75.

Lorsch, J. (May, 2018). NIGMS Update. Presented at NIH Sci-Ed 2018: Annual Conference for NIH Science Education Projects, Washington, DC.

Mortensen, C. J., and Nicholson, A. M. (2015). The flipped classroom stimulates greater learning and is a modern 21st century approach to teaching today's undergraduates. Journal of Animal Science, 93(7), 3722–3731.

Richardson, V. (1996). The Role of Attitudes and Beliefs in Learning to Teach. In Handbook of Research on Teacher Education (2nd ed., pp. 102–119). New York: Macmillan.

Shulman, L. S. (1986). Those who understand: Knowledge growth in teaching. Educational Researcher, 15(2), 4–14.

Tai, R., Liu, C., Maltese, A., and Fan, X. (2006). Planning early for careers in science. Science, 312, 1143-1144.

Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of the research. In Handbook of research on mathematics teaching and learning: A project of the National Council of Teachers of Mathematics (pp. 127–146). New York: Macmillan.

Wasserman, S., and Faust, K. Social Network Analysis: Methods and Applications. New York, NY: Cambridge University Press, 1994.

Wieman, C. (2015). A better way to evaluate undergraduate teaching. Change: The Magazine of Higher Learning, 47(1), 6–15.