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MONOGRAPH

Curriculum Mapping: A Comparative Analysis of Two Medical School Models

Scott Cottrell[1] · **Jason S. Hedrick**[1] · **Anna Lama**[1] · **Brian Chen**[2] · **Courtney A. West**[3,4] · **Lori Graham**[3,4] · **Christopher Kiefer**[5] · **Jeffery Hogg**[6] · **Melvin Wright**[7]

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Abstract
Purpose Curriculum mapping is integral to the curriculum oversight process. The purpose of this monograph is to describe two models for implementing curriculum mapping, which educators may adapt or adopt.
Practical Implementation The West Virginia University School of Medicine model is characteristic of a decentralized model. Individual course and clerkship directors are responsible for detailing curriculum data. In contrast, Texas A&M utilizes an external software system to centrally manage the curriculum mapping process.
Discussion Both models are viable strategies to map the medical school curriculum. The databases can provide fundamental information, which can be shared in national databases and leveraged to make informed curriculum changes.

Keywords Curriculum · Mapping

Purpose

Curriculum mapping is integral to the curriculum management process [1]. A comprehensive map makes it possible for educational institutions to monitor coverage of competencies, content, and instructional and assessment methods. Curriculum mapping across medical schools also allows for benchmarking and routine comparisons between one medical school's curriculum and national curricular data. The Association of American Medical Colleges (AAMC) has made substantial efforts to move forward with mapping the medical education curriculum. The AAMC has sponsored workshops and webinars and developed the Medical Academic Performance Services (MedAPS), which includes Curriculum Inventory and Reports that make it possible for medical schools to relay information to a central repository of curriculum maps. By detailing and compiling curricular components of courses, clerkships, and electives with a set of standardized content, medical schools will find better ways

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✉ Scott Cottrell
scottrell@hsc.wvu.edu

[1] Department of Medical Education, West Virginia University School of Medicine, PO Box 9111, Morgantown, WV 26505, USA

[2] West Virginia University School of Medicine, PO Box 9007, Morgantown, WV 26505, USA

[3] Office of Medical Education, Texas A&M Health Science Center College of Medicine, 8447 TX-47, Bryan, TX 77807, USA

[4] Department of Internal Medicine, Texas A&M Health Science Center College of Medicine, 8447 TX-47, Bryan, TX 77807, USA

[5] Department of Emergency Medicine, West Virginia University School of Medicine, PO Box 9007, Morgantown, WV 26505, USA

[6] Department of Radiology, West Virginia University School of Medicine, PO Box 9007, Morgantown, WV 26505, USA

[7] Department of Pediatrics, West Virginia University School of Medicine, PO Box 9007, Morgantown, WV 26505, USA

to integrate topics across the curriculum [2]. These efforts contribute to the Liaison Committee on Medical Education (LCME) standards for accreditation. Curriculum mapping information will also be matched with data from the AAMC Graduation Questionnaire, AAMC Curriculum Inventory Reports, and the United States Medical Licensing Examination (USMLE) performance summaries to generate a comprehensive view of the targeted content of the undergraduate medical education (UME) curriculum [3].

Like most educational challenges, questions often surface about efficient and productive models for successful mapping. How do we use mapping to ensure our curriculum is designed to help students accomplish and demonstrate expected learning objectives? Can medical schools adopt or adapt existing curriculum mapping models? What are the potential consequences of implementing one model instead of another? How can we learn from medical schools' strategies to map the curriculum? Answering these questions is fundamental to moving forward with informed curriculum mapping efforts, which help satisfy accreditation requirements, ensure essential content coverage, and develop a more cohesive learning environment to facilitate students' learning.

The purpose of this monograph is to describe two models of curriculum mapping. These models have elements of similar and contrasting strategies to identify, manage, and report curricular data. Successes, setbacks, and potential changes for future practice are also examined, which may assist educators who are currently struggling to move forward with a curriculum mapping strategy.

Conceptual Background

A curriculum map is a tool that organizes, modifies, and refines a curriculum. A map specific to a medical education curriculum may be defined as describing the relationship and cohesion across courses, clerkships, and electives to help students achieve program-level competencies. Maps represent both a visual depiction of a curriculum as well as a representation of careful and deliberate collaboration between educators with the common goal of understanding how the educational environment is organized and structured. For example, course and clerkship directors align what students are expected to learn with appropriate instructional methods and ascertain what assessment methods and resources can provide useful data and evidence of students' knowledge and skills acquisition.

Curriculum mapping can play a substantial role in the interplay between curriculum development and student learning. Daly and Torre argue that meaningful curriculum mapping promotes learning, provides additional resources for learning, enables instructors to provide feedback to students, and facilitates assessment of learning and performance [4]. Educators can also redirect the curricular lens toward a macro view of the map and ask: How does this learning experience and my course fit into the overall curriculum? Does my course build on previous content? Does it prepare the way for new content in future coursework? Does it target content that would be otherwise missed or neglected? These questions help drive curriculum development and match an overall curricular design with its potential to further student learning. Educators emphasize that the primary benefit of understanding a curriculum's organization and structure is to focus on student learning and its improvement. Faculty can leverage mapping data to continuously adjust and modify a curriculum in a way that maximizes students' ability to achieve and demonstrate learning.

Realizing curriculum mapping as a coordinated process across medical schools requires a common language. A standard lexicon is an evolving thread that helps educators make sense of diverse frameworks and terminology [5]. The literature is replete with terms such as competencies, milestones, capabilities, and core entrustable professional activities (EPAs) [6–8]. Indeed, efforts like the MedBiquitous working group have made significant contributions to standardize and define instructional methods, assessment methods, and resources [9]. The ability to distinguish the proverbial apples from oranges makes it possible to evaluate how curricula compare to each other.

Mapping also lends opportunities to investigate whether a curriculum is cohesive and integrated. The medical curriculum hinges on competencies that detail what students are expected to know and demonstrate before graduating with a medical degree. The extent that a curriculum is designed for vertical and horizontal integration is another distinguishing feature requiring a detailed analysis of how each learning event or "part" contributes to the whole. Hassan notes that vertical integration of content relates to deliberate and proper sequence of learning events. However, horizontal integration relies on the integration of disciplines and content [10]. Educators also rely on the triangulation of assessment methods to answer important questions of how well the curriculum functions [11]. As educators seek to understand their own curriculum better and compare it with other curricula, efforts to inventory and map curricular components are underway.

One of the central challenges related to curriculum mapping is how to bring the curriculum management system and separate competency-based assessments into greater alignment. Some schools are using commercial tools such as E*Value, One45, Curriculum Management for Healthcare Education (LCMS), and Entrada, while other schools rely on home-grown strategies to answer fundamental questions about when, where, and how students learn specific content and demonstrate knowledge and skills. Schools also struggle with how to identify who is responsible to collect mapping

data and leverage reports, while allowing a school's curriculum committee to provide curriculum oversight.

Practical Implementation

Curriculum Mapping at West Virginia University School of Medicine

During the 2013–2014 academic year, the Curriculum Committee for the Doctor of Medicine Degree sought to further enhance and structure curriculum-mapping efforts. An initial challenge was explaining the benefits of curriculum mapping to faculty and students. Faculty, in particular, were skeptical and questioned whether valuable resources and time were worth investing in curriculum mapping. To allay concerns and emphasize the benefits, the Associate Dean for Curriculum used case examples to explain how a concise map can be leveraged to answer important questions about the curriculum. One case included a request by a state senator to identify where and when medical students learn about prescription drug abuse. The state of West Virginia is struggling with a high incidence of opioid prescription abuse. The state legislators wanted to ensure that medical students were being educated to recognize this important issue and learn, among other things, appropriate prescription writing and drug regulations related to controlled substances, including opioids. While we were able to find several learning opportunities that target prescription drug abuse across the medical school curriculum, it was a laborious process. A curriculum map could have expedited the process and would likely result in a much more accurate analysis.

Another example included National Board of Medical Examiners (NBME) reports that suggested our students were not being adequately prepared for questions that target nutrition. A curriculum map could surface a report and lead to informed ways to improve how nutritional content is taught and assessed. Case examples like these were used to illustrate the benefits of curriculum mapping and encouraged faculty and student buy-in.

Once faculty and students on the Curriculum Committee were convinced that a curriculum map could serve as an important tool, they created a subcommittee: the Curriculum Inventory Management Subcommittee (CIMS). CIMS is composed of course and clerkship directors, the associate dean for curriculum, medical education staff, and at least one medical student. The responsibilities of the CIMS committee are detailed in a charter. The director of assessment, who works closely with an information technology specialist, chairs the committee. The charge of CIMS is twofold: satisfy the mapping needs of external organizations such as AAMC and the LCME and serve the curriculum mapping needs of medical educators at the school.

CIMS implemented a curriculum mapping system that utilizes a homegrown web-based system, the Secure Online Learning Environment (SOLE). Within SOLE, each course and clerkship has a dedicated SOLE site that includes the course or clerkship learning objectives, grading policy, and a schedule of learning events (e.g., lectures, team-based learning sessions, simulations). A "Core Content" folder also includes lectures, presentations, and educational content.

CIMS recognized that the majority of the curriculum design was described and shared in SOLE. Accordingly, CIMS implemented a system for course and clerkship directors to distinguish each learning event with "tags" to identify what specific core content was targeted and what instructional methods, assessment methods, and resources (e.g., standardized patients, laboratory, educational technology) were implemented. The tags could then be pulled into a report to answer questions about the curriculum.

Before proceeding, CIMS members agreed that a reasonable and concise list of tags was necessary. CIMS leaned on MedBiquitous terminology to differentiate lists of instructional and assessment methods and resources. The list of content tags that a learning event can target was also devised by borrowing terms used in United States Medical Licensing Examination (USMLE) Step 1 and Step 2 examination year-end profile reports. The Curriculum Committee identified curricular "threads," which are unique content areas that are vertically and horizontally integrated throughout the four years of the curriculum. Example threads include radiology and ultrasound, communication skills, and diversity. CIMS decided to embed curricular threads in the list of content tags. The catalogue of tags was then relayed into each course and clerkship SOLE site, allowing directors to select from the lists of instructional methods, assessment methods, resources, and content tags to distinguish the details of each learning event (see Appendix A: West Virginia University (WVU) SOLE Tag event Worksheet).

CIMS also tasked course and clerkship directors to help identify how each learning event contributes to the broader school's six core competencies: patient care, medical knowledge, practice-based learning and improvement, interpersonal and communication skills, professionalism, and systems-based practice. Each core competency has a list of program-level objectives (PLOs). Directors identify each learning event's objectives and tag them to the course- and clerkship-level learning objectives, and ultimately to the PLOs. With event-level objectives "tagged" in the SOLE database, it is now possible to track and search how each course and clerkship contributes to the PLOs. Directors can now utilize SOLE as a searchable database to consider the flow and consistency of learning objectives between the levels of event, course/clerkship, and the overall program. This system also become an invaluable tool for our Curriculum Committee to actively search and understand how the aims and objectives of a

specific day's activities ultimately translate to a students' journey toward being a competent and reflective physician.

To ensure that course and clerkship directors are properly tagging learning events and supplying mapping data, the director of assessment, serving as the chair of CIMS, is also a member of the Assessment Subcommittee of the Curriculum Committee. As delineated in its charter, the Assessment Subcommittee is expected to "Advise the Curriculum Committee on the continuous review of the overall curriculum." Unless warranted, the typical cycle for review of each course and clerkship is three years. At that time, the assessment subcommittee reviews the tagging progress of the course/clerkship. The Curriculum Committee has also instituted a regular "audit" of course/clerkship tagging. The director for academic operations and accreditation reviews each course/clerkship SOLE site on an annual basis and reports to the Assessment Subcommittee. If there is evidence that tagging is not occurring, or is not occurring at a level consistent with the expectations of the Curriculum Committee, the Assessment Subcommittee will require the director to report to the Curriculum Committee with progress reports to meet tagging requirements. This reporting structure has created a level of accountability among directors.

Curriculum Mapping at Texas A&M HSC College of Medicine

The need for more comprehensive mapping of the curriculum at Texas A&M Health Sciences Center (HSC) College of Medicine was identified when they conducted a self-study in preparation for their LCME visit. At the time, their "map" consisted of a matrix including the medical education courses' coverage of the College's competency-based learning objectives (CBLOs), which are based on Accreditation Council for Graduate Medical Education (ACGME) competencies. While this document provided course-level information, they did not have session-level details regarding content coverage. The only session information available consisted of the session title, the faculty member's name, and the discipline. Therefore, they did not have the ability to examine content alignment or identify gaps and redundancies in the medical education curriculum.

Due to the lack of session-level data and the need for a comprehensive view of the curriculum, the Office of Medical Education (OME) was tasked with gathering information and creating a detailed curriculum map. The Texas A&M curriculum mapping model includes the following: First, the focus is on mapping USMLE content coverage. However, competency alignment data are collected as faculty are required to link session-level objectives to the College's CBLOs. An internally developed session plan template is utilized to gather session-level data (see Appendix B: Texas A&M Teaching Session Form). Second, the session plan includes a short description of the session, session objectives linked to course objectives, identification of USMLE content coverage, modality utilized, assessment types, and a hot topic checklist.

At Texas A&M, the comprehensive curriculum map of the Doctor of Medicine program is a large visual representation of step content coverage. Gaps are highlighted in the map and redundancies are quantified and emphasized. This enables faculty to see exactly where gaps and redundancies exist and have meaningful conversations regarding content and planned and/or unplanned redundancies. The session plan data are manually entered into the One45 software for reporting purposes. This allows faculty to search key words and provides stakeholders with the opportunity to investigate and quickly identify competency coverage.

Consistent with WVU's experience, an initial challenge with the Texas A&M mapping process was to convince faculty that it was necessary. The term mapping had been used for years, and faculty and administration considered the curriculum matrix that already existed a "map." The majority thought that mapping had already been done and wondered why faculty were being asked to do additional work. While it seemed overwhelming at first, showing faculty the purpose and breaking the steps into manageable chunks promoted buy-in. The process began with asking the course leadership to go through the step content guide and identify which content was covered in their courses. This task was introduced as part of a working meeting, following an explanation about how and why mapping the curriculum was needed. Beginning the process in this manner was essential because it enabled OME to offer direct support and facilitate the process. After this was completed, OME compiled the data into one document that provided baseline information regarding what the leadership thought was being covered in their respective courses. Showing the outcomes of the baseline data was an important step. When mapping, make sure to provide visual progress updates in order to show and not just tell. Faculty needed to see, as time went by, what was being accomplished in this process.

When OME started distributing session plan templates, the office quickly learned several things. First, the template needed to be a pdf document instead of a word document due to formatting problems. Second, one person needed to distribute and collect the plans for tracking purposes. The session plan also did not need to be called a lesson plan. The term lesson plan and the idea of having to complete a long, detailed, elementary task was not viewed favorably by faculty despite the fact that they were not school-type lesson plans. Many faculty members did not know the difference and associated what OME was asking for as a "lesson plan." Presenting the session plan template to faculty during curriculum subcommittee meetings and having a few examples to utilize as models were also essential elements. Block and course leaders also wanted to receive regular updates regarding missing session plans. It

is essential to prepare and have a plan ahead of time for tracking and routine follow-up.

At Texas A&M, monitoring, tracking, and requiring session plan completion presented the biggest challenges. Faculty were not accustomed to this type of requirement, and with their busy schedules, it was usually not a priority. In order to encourage completion, various types of support were offered. In some cases, faculty and staff in OME sat and walked faculty through the process. Group presentations were conducted, and OME even populated certain elements based on materials faculty provided. Something that ultimately facilitated session plan completion was when OME began including the session plan information for each course in the course assessment reports, which are presented to the Curriculum Committee each month. This was viewed as an accountability component, and course directors did not want to see session plans for their courses reported as missing. The directors worked diligently to make sure session plans were all accounted for, usually prior to the Curriculum Committee meeting. Texas A&M just completed the second year of their curriculum mapping process. Currently, most courses have a session plan completion rate of 100 %. Mapping is not an easy process, but the information it yields is invaluable. As Texas A&M is undergoing curricular reform, the current map has been utilized to make important decisions. It is essential that faculty understand that mapping is not a one-time practice, but an ongoing process which is conducted to ensure curriculum content coverage is transparent. As the institution continues the mapping process and implements their new curriculum, it will be an essential ongoing tool for curriculum management and should be viewed as such by faculty and administration alike.

Discussion

A comparative analysis of the two curriculum mapping models suggests both similar and disparate characteristics. First, the West Virginia University School of Medicine model is a decidedly decentralized model. Directors are responsible for detailing learning events in the SOLE sites. The process of "tagging" each event complements the directors' monitoring of the course or clerkship curriculum. Directors continuously gauge how individual learning events contribute to the overall course- and program-level objectives. Furthermore, through a comprehensive reporting feature in SOLE, directors can more readily consider deficiencies, redundancies, and gaps in the curriculum. For example, the National Board of Medical Examiners subject examinations provide year-end reports. Students' performances for specific content areas can be monitored by reviewing these reports, which may lead to the investigation of when and where students learn particular content. This process has made it possible to examine opportunities to improve learning events that may benefit students' performance on specific NBME subject examination content areas. In contrast, Texas A&M utilizes an external software system, One45, to centrally manage the curriculum mapping process. This centralized model identifies one or two points of contact which are responsible for identifying, collecting, and reporting curriculum mapping data, which other schools have implemented. For example, Masaryk Medical University created a web-based curriculum management system called OPTIMED where the faculty, curriculum designers, administration, and students are able to efficiently view the curriculum database for specific topics and learning outcomes, how they are addressed, and how education objectives are being met [12]. Using a system designed for curriculum mapping may be ultimately more efficient. However, it is clear that in both cases, the need for manpower dedicated specifically to curriculum mapping is a necessity. A major hurdle for a homegrown system such as SOLE system is requiring a software designer, who has been able to commit time and resources to build a mapping process.

There are potential advantages and disadvantages to both a centralized and decentralized model. A centralized model may help ensure timely and consistent monitoring of curriculum data by relying on just a few individuals and reduces the day-to-day mapping responsibilities required of directors. A centralized system may also require less monitoring of whether curriculum data are being mapped, as the responsibilities fall to only one or two individuals as opposed to several directors. The one or two individuals bear the responsibility of contacting those who need to be aware of any difficulties in receiving the curriculum data. Equipping educators with the skills and understanding to map curriculum data is also not a concern. In the centralized model, a continuous method of involving others throughout the process is required. Faculty and administration were given specific information regarding exactly how they needed to contribute. Presenting how the "building" of the curriculum was taking place provided the opportunity to explain the complexity and importance of vertical and horizontal alignment. Consistent and clear communication was essential, so the mapping work would not be viewed as futile and/or its purpose misunderstood.

A decentralized model requires course and clerkship directors to invest time and resources into the mapping process. As the process and the list of tags are modified, it is vital to keep directors fully apprised of any changes in mapping procedure. A decentralized model also requires that directors be given direction on how to tag curriculum data. For instance, some educators have asked, when is it appropriate to tag specific content? The director of assessment at WVU has responded with an explanation that content (e.g., anatomy, pharmacology) should be tagged when it is a target of an event's learning objectives. Content areas that are incidental should not be tagged. For example, a lecture may present statistical findings

to describe research findings; however, the content tag of "biostatistics" is merely tangential and is not something that is a target of the instruction or assessment method.

A decentralized model also supposes that curriculum mapping may be a healthy exercise for educators. For instance, concept mapping can be applied to curriculum development and shifts the concept of a map from understanding a curriculum to creating meaning to a curriculum's organization and structure. As educators consider content and how it threads across the curriculum, the exercise of mapping encourages integration of content across courses and disciplines. Weiss and Levison, for example, mapped the content of women's health issues, inviting course and clerkship directors to target specific material, integrate it across the curriculum, and collectively be responsible for a broad content area [13]. Curriculum mapping, then, is about more than evaluation and analysis. It is a process that challenges educators to document why the curriculum is built in a particular manner as much as how it is built.

A future challenge will be using curriculum mapping reports to encourage faculty to engage in concept mapping exercises, which could ultimately influence curricular changes. For example, the West Virginia University Curriculum Committee has identified curriculum threads. The Curriculum Committee characterized threads as emerging or important content areas that should be advanced across the curriculum to benefit student learning. Example threads include radiology and ultrasound, oral health, and healthcare disparities. Faculty have been assigned as "thread directors," who plan to implement concept mapping exercises to oversee the organization and implementation of the threads. Thread directors will be able to identify redundancies and potential gaps, which will assist course and clerkship directors to create new learning opportunities to target the threads.

Both models also implement a concise list of tags to distinguish each learning event. Students and faculty can search the collected data to find specific learning events that target specific content. Educators can monitor learning events and aligned learning objectives. This creates opportunities for educators to indicate to students about what they are expected to know and be able to do as a result of each learning event. The WVU model also allows students to search content across courses and clerkships using the tags. For example, students take several NBME subject examinations throughout the curriculum. Each NBME exam supplies students a report of content areas that may not be understood as well as other content areas. While the NBME reports do not have much specificity, students can identify general areas of content that were poorly understood. Students can then search the content in the curriculum across courses and clerkships, revisit the material, and exercise more self-directed learning. While students have been oriented on how to conduct tag searches, a future challenge is to identify how often students utilize this functionality of the curriculum mapping process and whether students found it helpful to their learning.

The ultimate benefits of one model over another remain to be seen. Further research from institutions already involved in curriculum mapping efforts could provide continuing help to others regarding successes and challenges revealed through their own institutional experiences. Future areas of investigation should target the extent mapping efforts have led to specific curriculum modifications. It is also important to track how changes made may impact assessment data, allowing educators to judge the value and potential of curriculum mapping to ultimately improve student learning and development.

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