Supplemental Digital Appendix 1

Curriculum Development Considerations for Health Systems Science Curriculum organized by Six-Step Approach.[1]

* Note that each curriculum is foundational for the next curriculum; that is, Health Care Delivery builds on Disease-Models of Care, and Community/Population Health/Health Equity builds on Health Care Delivery.

Six Step Approach to Curriculum Development	Biomedical Sciences	Health Systems Science	
	Traditional Disease-Models of Care	**Health Care Delivery**	**Community/Population Health/ Health Equity**
1. Problem Identification/ General Needs Assessment What is the problem and whom does it affect? How is medical education addressing the problem? What is the gap between the ideal and actual performance	How do we provide care for persons with particular risk factors, diseases or in unique settings? What knowledge, attitudes and skills are lacking in health care providers? Are graduates prepared to practice evidence-based, patient-centered care?	How do we provide care for populations? How do we meet the Triple / Quadruple Aim of patient care, population health and low costs?[2,3] Is the value of care as defined by Quality over Costs appropriate?[4] Are graduates prepared to identify gaps in care in patient care, population health	How do we provide for the health of communities? Do populations and communities demonstrate disparities when examined by geography, race, socioeconomic status, etc.?[7-9] Are social determinants of health and population health embedded in the medical school curriculum?

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of the health care provider? What is the gap between the ideal approach to education and the current approach to education of the health care provider?		and value and advocate for change and improvement?[5,6]	Are graduates committed to improving the health of populations? Are medical schools producing graduates serving in underserved communities, able to assess community needs and competent in leadership and advocacy?[10-12] Do regulatory bodies include social accountability criteria?[13-14]
Example Sources of Information For Step 1	Published medical literature Evidence Based Medicine Guidelines - USPSTF:https://www.uspreventiveservicestaskforce.org/uspstf/ - Centre for Evidence Based Medicine: https://www.cebm.net/ - Cochrane Collaborative: www.cochrane.org	Published literature: Quality indicators, Value=Quality/Costs National Academy of Medicine's quality indicators (STEEEP): - Safety - Timeliness - Efficiency measures - Effectiveness - Equity - Patient Centered - Physician Well-Being	Population level / Public Health data (local and state health assessments) Health indicators and trends: SDoH: US Census data poverty rates, housing (www.census.gov) American Community Survey (zip code data) (www.census.gov)

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	• National Institute for Health and Care Excellence: https://www.nice.org.uk/ • Center for Disease Control and Prevention: https://www.cdc.gov/ Ideal Education Approach: • Best Evidence Medical Education: https://www.bemecollaboration.org/ • LCME: https://lcme.org • ACGME: https://acgme.org accreditation standards Current Education Approach: • AAMC Curriculum Inventory: https://aamc.org • MedEdPORTAL: https://www.mededportal.org/	Ideal approach/best practices: • RCPSC CanMeds Framework http://www.royalcollege.ca/rcsite/canmeds/canmeds-framework-e • CMS value-based programs www.cms.gov • Medicare/ Medicaid data base www.CMS.gov Current Education Approach: • Health systems feedback[15] Ideal Education Approach: • ACGME Clinical Learning Environment Review[16]	Health delivery variances, e.g. Dartmouth Atlas of Health Care: https://www.dartmouthatlas.org/ Health disparities, e.g., data.gov, WHO (https://www.who.int/health-topics /, CDC (https://www.cdc.gov/), CMS (www.CMS.gov) Ideal Education Approach: • AAMC Curriculum Inventory reports • LCME/ACGME Standards • RCPSC CanMeds Framework[17] • Expert opinion[18,19] Current Education Approach: • MedEdPORTAL, Diversity and Inclusion Collection • AAMC Mission Management Tool[20]

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2. Targeted Needs Assessment Differences between the ideal and actual characteristics of the targeted learner Differences between the ideal and actual characteristics of the local learning environment	What do we know about the Individual Learner's Knowledge, Attitude and Skills related to this health care problem? What do we know about the local learning environment for this problem? Do the faculty and clinical learning environment practice evidence-based, patient-centered care? Is there faculty expertise in this content area?	What is known about the current curriculum's development of leadership, change agency and teamwork competencies in all health care professionals? What is known about the clinical sites/health systems commitment to quality and systems improvement? Does the affiliate health system prioritize education and the development of future health care professionals? Have all potential stakeholders been engaged in curriculum planning? Is there local health systems expertise?	Does the institutional mission address a commitment to improve community/population health or advance health equity? Has the institution successfully partnered with the community to improve health outcomes? Are there local funders/donors with an interest in improving the health of the community? What is known about the current curriculum's development of equity, diversity and inclusion? [21] Has service learning been successfully implemented in the medical school/University? Who is coordinating service learning?

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			What is the impact of Community Partnerships (academic medical centers, University, Community) e.g., Public health, community members, interfaith leaders, school districts, CBOs (community based organizations)
Examples Sources for Step 2	Medical audits Focus groups and surveys of learners and local stakeholders Local Clinical Expertise LCME/ACGME standards (Milestones/ EPA)	Quality indicators/ performance metrics Utilization/costs: https://www.medicare.gov/hospitalcompare/search.html https://www.healthcarebluebook.com/ JCAHO reports Focus groups and surveys of patients/families/caregivers Health systems' quality management reports	Focus groups and surveys of community members/community leaders/CBOs, e.g., United Way reports Health Department Data Health Consortium groups IRS-required Health System Community Health Needs Assessments and Community Benefit

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	Review of current curriculum Progress on milestones and EPAs	Identification of content experts in Lean Six Sigma, QI, Teamwork, Organizational Behavior	Identification of local community partners SDoH database (NEOCANDO http://neocando.case.edu/) Community/Policy CDC, WHO, local expertise, AHRQ https://www.ahrq.gov/data/index.html
3. Goals and objectives Write overall goals as well as specific measurable objectives for the curriculum, which usually drive the content, educational methods, and evaluation strategies for the curriculum.	Is there an overall goal statement for the curriculum, e.g.: (For this health problem) learners will appropriately manage – evidence-based prevention, acute and chronic care – of individuals presenting for care. Do the learning objectives specify the learner Knowledge, Attitude and Skills to be achieved?	Is there an overall goal statement for the curriculum, e.g.: Medical students will demonstrate achievement in Systems-Based Practice competency and be prepared to be change agents and leaders in the field of healthcare? Do the learning objectives specify the knowledge, attitude and skills to be achieved, that are **unique** to HSS? For example, do they include the core domains of HSS: team skills, change	Is there an overall goal statement for the Population Health/Health Equity curriculum, e.g. The program will provide a workforce that reflects and impacts population health outcomes. Do the learning objectives specify the knowledge, attitude and skills to be achieved that are **unique** to Population Health and Health Equity? For example, do they address: • Community/Population outcomes

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	Are individual skills in managing patients and panels included in these objectives? Are individual team (intra and interprofessional) skills included in these objectives? Do the learning objectives map to the overall program objectives/competencies? Do the learning objectives support/map to consensus competencies, e.g. ACGME, IPEC (ipecollaborative.org)?	agency, advocacy, leadership and systems thinking? If a longitudinal curriculum is planned, are there developmental milestones written for these core domains? Do the learning objectives support/map to consensus competencies in HSS?	• Cultural competence/humility • Diversity and Inclusion in learning environment • Knowledge of power structures • Leadership skills • Social Determinants of Health
4. Educational Strategies What is the content of the curriculum?	Do the learning objectives detail content congruent with evidence-based practice and clinical guidelines?	Does the content of the HSS curriculum reinforce foundational learning without redundancy to other parts of the curriculum?	Is the content of the population health/health equity curriculum unique and built on the foundational and HSS learning?

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What educational methods facilitate achievement of the goals / objectives? Is there evidence for effectiveness of the method or are they supported by learning theories?	Do the educational methods support professional identity formation as well as mastery of knowledge and skills, for individual patient encounters? Are the educational methods supported in the literature?	Does the content imply a "spiral" approach in a longitudinal curriculum? Do the educational methods support professional identity formation as well as mastery of new knowledge, changes in attitude and skills for effective health care delivery?	Does mastery of the content require longitudinal experiences? Do the educational methods support professional identity formation as well as mastery of new knowledge, changes in attitude and skills for population health care or community care?
Example Educational Methods for Step 4	Small group case-based learning Didactics, readings Simulation and skills practice Clinical/patient-based experiences	Quality Improvement Projects Engagement of interprofessional teams and teamwork building workshops Clinical experiences Reflective learning Panel Management Sessions Experiential learning	Exposure opportunities: community, advocacy groups, policymakers Authentic relationships with community/building trust relationships[22] Longitudinal experiences with defined populations/CBOs[23,24] Community Service

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		Longitudinal relationships

Change Management | Service Learning[25]

Critical Service Learning[26,27]

Population level data sets |
| 5. Implementation

What are the resources to support the implementation of this curriculum?

• Physical learning spaces
• Online and reference materials
• Funding
• Faculty
• Administrative Support | Does the learning environment support the objectives and educational methods?

Are there sufficient classroom, clinic, simulation, online resources, and clinical sites?

Are there enough faculty in the basic and clinical sciences? How is their teaching effort supported? | Where are concepts introduced or taught in the traditional classroom, clinical and simulation location (e.g. health systems science, quality improvement processes, panel management or population health in EMR systems)?

Are there health system learning venues that support experiential learning with patients and navigating the health care system? (see Figure 1)

If there is a longitudinal or spiral curriculum, does the program support | Are there workplace experiences in teams based in community to apply skills learned in classroom?

Is there additional credentialing of students required to work/learn in these environments? Does it require funding? How will it be implemented?

Are faculty from non-traditional departments and schools, e.g., Social Work, Public Health, City/County Public Health Departments, government leadership, foundation leaders, community leaders available |

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Should implementation be phased in or piloted?	Do the clinical environments and faculty support and model patient-centered, evidence-based medicine? Is administrative support sufficient?	Personal Learning Plans to track longitudinal achievement? Are faculty available from non-traditional departments, e.g., health system quality improvement and patient safety institutes, Schools of Management/Business, health system leadership? How will their teaching be supported? Is there a plan for additional administrative support for a complex, longitudinal curriculum?	for teaching? How will their teaching be supported? Do community partners require additional resources to support learning? Is there funding to support community partners? Is there enough administrative support for this curriculum to facilitate communications between the program and community partners, support students and faculty, and recruit new partners?
6. Evaluation How will evaluation results be used? Are there different evaluation users who	How is achievement of learning objectives assessed? Is there sufficient formative assessment to promote mastery of knowledge, attitude, and skills? Is there a portfolio system that documents professional competencies and EPAs?[28-30]	What additional portfolio evidence can learners use to document achievement of HSS goals and objectives? Does the student's portfolio demonstrate evidence of systems thinking?[31] Does the student's portfolio document systems-based practice and practice-	What additional portfolio evidence can learners use to document achievement of Population Health/ Health Equity goals and objectives? How can the value added of student participation with community partners

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require different data? What resources are available for evaluation in terms of time, personnel, facilities, funds and existing measures? Have the instruments to measure knowledge, attitudes, skills and competencies been validated? What Kirkpatrick level is being measured? Are there unique evaluation questions that should be explored?	Is the aggregate achievement of learners tracked and benchmarked with national norms? Are graduate outcomes tracked beyond matriculation in the program? Is there evidence of quality of care for graduates of the program?	based learning and improvement competency? Are there attitudinal instruments that address motivation, change agency, commitment to improvement? Does tolerance for uncertainty change with this curriculum? How are non-traditional faculty evaluated and supported in their teaching roles?	be measured? How will those results be communicated? Does this curriculum impact learner outcomes beyond matriculation in the program, e.g. serving in underserved communities, engaging in health policy and advocacy, ongoing volunteerism? Does the institution benchmark its social mission and if so how does it measure community impact? How does this curriculum impact those measures?

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Example Evaluation Methods for Step 6	MCQ, National Benchmarks, e.g. Licensing Board Exams Comprehensive/Milestone Clinical Skills Exams Direct Observation with Patients Program Director Questionnaires Education data warehouses[32] Medicare/Medicaid databases (for practicing graduates)	Quality Improvement Project (QIKAT R[33]), QIPAT-7[34] Systems thinking (Systems thinking scale[31]) Direct observation of team skills[35] Portfolio documentation of systems-based practice and practice-based learning improvement competency, change agency[28,29,36] Outcome: Patient Level Metrics[37,38]	Reflective writing[24,39] Portfolio documentation of systems-based competency, practice-based learning improvement[28,29] Demonstration of systems thinking Recognition of context of care and its role in health (Structural Foundations of Health Survey[40]) Awareness of Social Determinants of Health and its role in health (Structural Vulnerability Assessment [41]) Outcomes data- systems, community and population health outcomes

AAMC- Association of American Medical Colleges, ACGME- Accreditation Council for Graduate Medical Education, CBOs- community business organizations, CDC- Centers for Disease Control, CMS- Centers for Medicare and Medicaid Services, EMR- Electronic Medical Records, EPA- Entrustable Professional Activity, HSS-Health Systems Science, IPEC- Interprofessional Education Collaborative, JCAHO-Joint Commission on Accreditation of Healthcare Organizations, LCME- Liaison Committee on Medical Education, MCQ- multiple choice questions, QIKAT-R-Quality Improvement Knowledge Application Tool-Revised, QIPAT- Quality Improvement Proposal Assessment Tool, RCPSC

CanMeds Framework-Royal College of Physicians and Surgeons of Canada, SDoH- Social Determinants of Health, USPSTF- United States Preventive Services Taskforce, WHO- World Health Organization,

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