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New Course Proposal Form

1. **Program: __Graduate Program in Health – Health Management and Health Data Analytics_____**

2. **Course Number:** HLTH 6240

3. **Credit Value:** 3.0

4. **Long Course Title:** Health Data Visualization

5. **Short Course Title:** Health Data Visualization

6. **Effective Session:** Fall 2022

7. **Calendar (Short) Course Description:**
   This course will introduce the fundamental concepts and principles of data visualization and its application in healthcare. We will explore the history of data visualization and its current uses in healthcare: from infographics informing patients and consumers, to EHR dashboards aiding providers in decision-making, to detailed epidemiology maps driving policymaking aimed at protecting population-health. Students will learn best practices for designing and evaluating health data visualizations, and learn to think critically about literacy, ethics, and the future of the field. By the end of this course, students will be able to use online tools to create powerful visuals that tell a story and inform diverse stakeholders.

8. **Expanded Course Description:**
   The following describes the (A) course topics (B) course learning objectives, and a (C) description of experiential education (EE) and/or technology-enhanced learning activities.

A) course topics/theories

1. Importance of visuals for human understanding
2. History of (health) data visualization
3. Current uses of health data visualization
    i. When/ how and by whom are visualizations used (stakeholders)?
4. Visualization literacy (how to properly interpret visualizations)
5. Ethics of/ Bias in visualization (what are the limitations and considerations of visualizations)
6. Design principles
7. How to combine and clean data for visualizations
8. How to use Tableau to create health visualizations
9. Identify and understand the needs of various user-groups.
    i. Patients and consumers
    ii. Health care providers and Hospital mgmt.
    iii. Policy and decision makers
10. Future trends in health data visualization (AI, Big Data)

B) Course learning objectives

1) Depth and breadth of knowledge

- Demonstrate understanding of the key concepts underlying Health Data Visualization
- Engage with Visualization tools and techniques

2) Knowledge of methodologies

- Demonstrate understanding of health data visualization (e.g. which graphs are best suited for what data)
- Grasp the fundamentals of design data visualization (colours, font, layout)

3 Application of knowledge

- Employ critical analytics skills
    - when appraising real-life health visualizations
    - when analyzing health data
    - when making decisions about how to visually represent the data in order to tell a story and/or aid in decision making
- Conduct research of print, electronic, and visual resources
- Learn to use visualization technologies

4) Communications skills

- Work collaboratively and ethically with others
- Effectively research, develop, and present data visualizations
- Write rigorous, critical and convincing reports
- Constructively give peer feedback

5) Awareness of limitations of knowledge

- Understand the ethical limitations of data visualizations and specific implications for Healthcare contexts
- Understand the benefit of interprofessional collaboration (working together with designers and researchers to best convey data)

6) Autonomy and professional capacity

- Develop a disciplined and rigorous practice
- Learn to present visualizations confidently, accepting and applying constructive criticism

C) Description of experiential education (EE) and/or technology-enhanced learning activities.

The course will contain classroom-focused EE that exposes students to concrete data visualization activities in the form of “in the news” class discussions (contributing to participation grade), weekly reflection assignments, and lab exercises.

Every class will begin with some time dedicated to “in the news” where students will have a few minutes to look through recent media posts/publications and identify a recent visualization that we will dissect collectively as a class. Individually, students will be required to find real-world examples and apply concepts and theories covered each week, summarizing their thoughts in 5 brief “reflection assignments” that will be submitted online. Lab exercises will be completed collaboratively in teams, a real dataset will be provided and teams will be encouraged to create appropriate visualization for their target audience using online tools and techniques learned in class, and present the following week. Students are expected to respectfully provide feedback to their peers and submit their work online for correction and feedback.

Note that special computer labs will not be required for this course. Online software (Tableau) will be used which is free to students. Use of online software can sustain capacity in data visualization that students build during the course.

Lab exercises will allow student to achieve the following learning outcomes

1- Engage with multiple data visualization techniques (infographics, graphs, dashboards, maps)
2- Grasp the fundamentals of design related to data visualization
3- Provide students with "real" messy data to learn to clean and analyze
4- Work collaboratively and ethically with others
5- Effectively research, develop, present, and give peer feedback on visualizations in healthcare
6- Meet deadlines and develop a rigorous discipline

In addition, guest lecturers will be invited to the class when possible, to review and interact with the students about concrete health data visualization applications and (un)successful cases (E.g., invite UX designers of EHR dashboards, and patient reports on smartphone apps).

9. Course Learning Outcomes

After completion of the course students will be able to:

- **Apply theoretical and practical knowledge** of Data Visualization in Healthcare
- **Evaluate Data Visualizations** in Healthcare (e.g. in research papers, government inforgraphics) according to their expressiveness and effectiveness
- Be able to **understand (literacy) and identify bias (ethics etc.)** in health visualizations
- **Choose appropriate visualization tools** and methods for a given data set and presentation problem
- **Inspect Accuracy**, Discriminability, Salience, and Separability, and their implications for design.
- Examine, navigate, and **learn to use the various features of Tableau** (or other online tools)
- Combine the data to and follow the **best practices to present your story**
- **Create and design visualizations and dashboards** for diverse audiences using Tableau (or other online tools)

10. Rationale:

"The purpose of computing is insight, not numbers."

Health care is becoming more data driven than ever before. The collection, organization, and interpretation of increasingly large volumes and types of data from multiple sources is integral to nearly every aspect of healthcare.

From replacing a patient's medical chart with a lifelong electronic medical record, to wearable devices that capture quantified self, alongside an expanding trove of digital data captured through social media, geographic information systems (GIS) and advancements in research (e.g. DNA sequencing of data), and technologies (such as biomedical imaging and Machine learning for health), data is growing in volume and diversity making analysis and interpretation increasingly complex. Healthcare professionals, researchers, patients, families, caregivers, and consumers need information to be presented in an accessible, useful, and usable manner.

Data visualization is the graphical representation of information and data. By using visual elements like icons, charts, graphs, and maps, data visualization tools provide an accessible and engaging way to see and understand trends, outliers, and patterns in data. Data visualization helps to tell stories by curating data into a form easier to understand, helping diverse stakeholders make more informed decisions. Today every hospital uses data visualization solutions to manage their in-house process ranging from maintaining the patient record, to capacity planning, every smartphone health app uses data visualizations to push "personalized goals" to their consumers in the hope that they will change their

behaviours, and local and national governments employ interactive maps to try and educate citizens and manage the spread of disease across entire countries and the world, as was the case with the COVID-19 pandemic.

This course aligns with the faculty educational objectives, providing up-to-date content using cutting edge technologies, and preparing students with hands-on skills that are highly marketable in the workplace. Students will further their critical thinking, data literacy, visualization, and presentation skills, as well as gain experience using novel technologies, and EE experience; all of which are core to the SHPM objectives and will prepare students to fill a need for data analytics skills in the healthcare system. There are no other graduate courses on offer that focus on health data visualization.

This course, along with another new course on Maching Learning in Health constitute two of the new field-specific courses in the new field in health management and health data analytics in the Graduate Program in Health. These two analytics oriented courses are unique to the program and complement existing health management and knowledge utilization courses already approved in the program.

The Graduate Program in Health's learning outcomes are included in Appendix X.

11. Evaluation:

Assignment	Percentage Value
The Good, the Bad, and the Ugly of Data Visualization	20%
5 weekly reflections, 6% each	30%
3 Tableau visualization assignments - > different stakeholder groups, 5% each	15%
data for patients & consumers	5%
data for healthcare providers & healthcare/ hospital mgmt	5%
data for policy & decision makers	5%
Final project: Pick data set (your capstone?), make visualization, explain choices	30%
Final Paper	20%
Final presentation	10%
Participation (attendance, "In the news", class conversations/ contributions)	5%
TOTAL	**100**

12. Integrated Courses:

N.A.

13. Crosslisted Courses:

N.A.

14. Faculty Resources:

Faculty members qualified to teach this course: Lora Appel; Liane Ginsburg; Hannah Wong
Frequency with which you expect this course to be offered: Approximately every other year.

We have several health informatics and health management faculty members with the School equipped to teach at the graduate and undergraduate levels. Offering this course in alternate years will not detract from the School's ability to continue to have full-time faculty deliver undergraduate health studies courses. The addition of this area to our graduate program will also help alleviate currently high supervision loads experienced by SHPM faculty members in the health policy and equity area and allow us to share faculty supervision resources more equitably across the School.

15. Physical Resources:

No additional physical resources are needed.

16. Bibliography and Library Statement:

session	topic	assignment
1	"A picture is worth 1000 words"	
2	History and current uses of (Health) Data Visualization	weekly reflection 1
3	From Data to Viz	weekly reflection 2
4	Data visualization literacy and ethics	weekly reflection 3
5	Design Principles	good bad ugly
6	Introduction to tools (e.g. Tableau) + Lab work	weekly reflection 4
7	Visualizations for Patients & Consumers + Lab work	Tableau assignment i
8	Visualization for Providers & Healthcare/Hospital mgmt + Lab work	Tableau assignment ii
9	Visualization for Policy & Decision Makers + Lab work	Tableau assignment iii
10	Future of data visualization	weekly reflection 5
11	Final Project Prep/ Bonus show and tell	
12	Final Presentations	Final Projects & Presentations

Books (or chapters in books) under consideration:

Wexler, S., Shaffer, J., & Cotgreave, A. (2017). *The big book of dashboards: visualizing your data using real-world business scenarios*. John Wiley & Sons.

Steele, J., & Iliinsky, N. (2010). *Beautiful visualization: looking at data through the eyes of experts*. " O'Reilly Media, Inc.".

Session 1: "A picture is worth 1000 words"

Evergreen, S., & Metzner, C. (2013). Design principles for data visualization in evaluation. *New directions for evaluation*, *2013*(140), 5-20. Accessed from: https://onlinelibrary.wiley.com/doi/pdf/10.1002/ev.20071?casa_token=dRbsGsfBofMAAAA:rdWyPYM6lvS5ci0F2QIAowBW6g-JZVUHXv1szVMBMnkBHbla8LivR4PG5Jak5R3vOjLCtXdvG8q_Gu8

Ottino, J. M. (2003). Is a picture worth 1,000 words?. *Nature*, *421*(6922), 474-476. Accessed from: https://www.nature.com/articles/421474a

Shneiderman, B., Plaisant, C., & Hesse, B. W. (2013). Improving healthcare with interactive visualization. *Computer*, *46*(5), 58-66. doi: 10.1109/MC.2013.38. URL: https://ieeexplore.ieee.org/stamp/stamp.jsp?arnumber=6415893&casa_token=rGFi8pt-HiEAAAAA:XhrbNbMF1ffUQv18Q4UXxZVGo9Csx70LfM2n0nsvpdNG5t1ikomPP78eRelCWe_ff7GKbXlWsQ

Martin, L. J., Turnquist, A., Groot, B., Huang, S. Y., Kok, E., Thoma, B., & van Merriënboer, J. J. (2019). Exploring the role of infographics for summarizing medical literature. *Health Professions Education*, *5*(1), 48-57. URL: https://www.sciencedirect.com/science/article/pii/S2452301117300792

Session 2: History and current uses of (Health) Data Visualization

Friendly, M. (2008). A brief history of data visualization. In *Handbook of data visualization* (pp. 15-56). Springer, Berlin, Heidelberg.

Tableau. (n.d.) The 5 Most Influential Vizzes of All Time [White paper]. (https://www.tableau.com/sites/default/files/whitepapers/5_most_influential_visuals_wp.pdf

Comello MLG, Qian X, Deal AM, Ribisl KM, Linnan LA, Tate DF (2016). Impact of Game-Inspired Infographics on User Engagement and Information Processing in an eHealth Program J Med Internet Res 2016;18(9):e237 URL: https://www.jmir.org/2016/9/e237 DOI: 10.2196/jmir.5976 PMID: 27658469 PMCID: 5054233

Strecker, J. (2012). Data visualization in review: summary; evaluating IDRC results-communicating research for influence. Accessed from: https://idl-bnc-idrc.dspacedirect.org/bitstream/handle/10625/55598/IDL-55598.pdf?sequence=1

Session 3: From Data to Viz

Nevo, D. (2014). *Making sense of data through statistics - An introduction*: Legerity Digital Press.

Dunlap, J. C., & Lowenthal, P. R. (2016). Getting graphic about infographics: design lessons learned from popular infographics. *Journal of Visual Literacy*, *35*(1), 42-59. URL: https://www.tandfonline.com/doi/pdf/10.1080/1051144X.2016.1205832

Pettiross, J. Tableau. (n.d.) How to Build Dashboards that Persuade, Inform, and Engage. [White paper]. (https://www.tableau.com/sites/default/files/whitepapers/goodenoughtogreat.pdf)

Healy, Y. (2018). Find the graphic you need. Retrieved January 31, 2021, from https://www.data-to-viz.com/

Ferdio. (n.d.). Collection of data visualizations to get inspired and finding the right type. Retrieved January 31, 2021, from https://datavizproject.com/

Session 4: Data visualization literacy and ethics

McCrorie, A. D., Donnelly, C., & McGlade, K. J. (2016). Infographics: healthcare communication for the digital age. *The Ulster medical journal*, *85*(2), 71. URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4920488/

Arcia, A., Suero-Tejeda, N., Bales, M. E., Merrill, J. A., Yoon, S., Woollen, J., & Bakken, S. (2016). Sometimes more is more: iterative participatory design of infographics for engagement of community members with varying levels of health literacy. *Journal of the American Medical Informatics Association : JAMIA*, *23*(1), 174–183. https://doi.org/10.1093/jamia/ocv079

Neuhaus, F., & Webmoor, T. (2012). Agile ethics for massified research and visualization. *Information, Communication & Society*, *15*(1), 43-65. URL: https://www.tandfonline.com/doi/pdf/10.1080/1369118X.2011.616519?casa_token=AJZHPsRcGKgAAAAA:CNElykaNbq51wccAeOOQd0XxQgMvRgonuUEvtySZcr7bls19DwIS0InIjaqmI-MabrbDwHUnQe2VEQ

Hepworth, K., & Church, C. (2018). Racism in the Machine: Visualization Ethics in Digital Humanities Projects. *DHQ: Digital Humanities Quarterly*, *12*(4).

Dasgupta, A., Maguire, E., Abdul-Rahman, A., & Chen, M. (2014, November). Opportunities and challenges for privacy-preserving visualization of electronic health record data. In *Proc. of IEEE VIS 2014 Workshop on Visualization of Electronic Health Records* (Vol. 13). URL:

Session 5: Design Principles

Few, S., & Edge, P. (2008). Practical rules for using color in charts. *Visual Business Intelligence Newsletter*, *11*. Accessed from: https://nbisweden.github.io/Rcourse/files/rules_for_using_color.pdf

Senay, H., & Ignatius, E. (1990). *Rules and principles of scientific data visualization*. Institute for Information Science and Technology, Department of Electrical Engineering and Computer Science, School of Engineering and Applied Science, George Washington University.

Tableau. (n.d.) Good Enough to Great: A Quick Guide for Better Data Visualizations. [White paper]. (https://www.tableau.com/sites/default/files/whitepapers/goodenoughtogreat.pdf)

Session 6: Introduction to tools (e.g. Tableau)

Tableau. (n.d.). Welcome to Tableau Desktop. Retrieved January 31, 2021, from https://www.tableau.com/learn/get-started/creator

Tableau. (n.d.). Next steps. Retrieved January 31, 2021, from https://help.tableau.com/current/guides/get-started-tutorial/en-us/get-started-tutorial-next.htm

Session 7: Viz for Patients & Consumers

Browne S, Behzadi Y, Littlewort G. Let Visuals Tell the Story: Medication Adherence in Patients with Type II Diabetes Captured by a Novel Ingestion Sensor Platform JMIR Mhealth Uhealth 2015;3(4):e108 URL: https://mhealth.jmir.org/2015/4/e108 DOI: 10.2196/mhealth.4292

Theis S, Rasche P, Bröhl C, Wille M, Mertens A Task-Data Taxonomy for Health Data Visualizations: Web-Based Survey With Experts and Older Adults. JMIR Med Inform 2018;6(3):e39 URL: https://medinform.jmir.org/2018/3/e39 DOI: 10.2196/medinform.9394

Faisal S, Blandford A, Potts HW. Making sense of personal health information: Challenges for information visualization. *Health Informatics Journal*. September 2013:198-217. doi:10.1177/1460458212465213

Pack, A. P., Golin, C. E., Hill, L. M., Carda-Auten, J., Wallace, D. D., Cherkur, S., ... & Kashuba, A. D. (2019). Patient and clinician perspectives on optimizing graphical displays of longitudinal medication adherence data. Patient education and counseling, 102(6), 1090-1097. URL: https://doi.org/10.1016/j.pec.2018.12.029.

Session 8: Viz for Providers & Healthcare mgmt/ Hospitals

Stadler, J. G., Donlon, K., Siewert, J. D., Franken, T., & Lewis, N. E. (2016). Improving the efficiency and ease of healthcare analysis through use of data visualization dashboards. *Big Data*, *4*(2), 129-135.

Kopanitsa, G., Hildebrand, C., Stausberg, J., & Englmeier, K. H. (2013). Visualization of medical data based on EHR standards. *Methods of information in medicine*, *52*(01), 43-50. Accessed from: https://pdfs.semanticscholar.org/0cf2/2fdf7c1d86ce2f7a1462a2b08c015289c8e1.pdf

Lamy, JB., Duclos, C., Bar-Hen, A. *et al.* An iconic language for the graphical representation of medical concepts. *BMC Med Inform Decis Mak* **8,** 16 (2008). https://doi.org/10.1186/1472-6947-8-16

Rind, A., Wang, T. D., Aigner, W., Miksch, S., Wongsuphasawat, K., Plaisant, C., & Shneiderman, B. (2013). Interactive information visualization to explore and query electronic health records. Foundations and Trends in Human-Computer Interaction, 5(3), 207-298. URL: http://www.cs.umd.edu/hcil/trs/2010-19/2010-19.pdf

West, V. L., Borland, D., & Hammond, W. E. (2015). Innovative information visualization of electronic health record data: a systematic review. *Journal of the American Medical Informatics Association*, *22*(2), 330-339. URL: https://academic.oup.com/jamia/article/22/2/330/695186

Session 9: Viz for Policy & Decision Makers

Concannon, D., Herbst, K., & Manley, E. (2019). Developing a data dashboard framework for population health surveillance: widening access to clinical trial findings. JMIR formative research, 3(2), e11342. Accessed from: https://formative.jmir.org/2019/2/e11342

Chishtie JA, Marchand JS, Turcotte LA, Bielska IA, Babineau J, Cepoiu-Martin M, Irvine M, Munce S, Abudiab S, Bjelica M, Hossain S, Imran M, Jeji T, Jaglal S
Visual Analytic Tools and Techniques in Population Health and Health Services Research: Scoping Review. J Med Internet Res 2020;22(12):e17892 URL: https://www.jmir.org/2020/12/e17892 DOI: 10.2196/17892 PMID: 33270029 PMCID: 7716797

Sopan, A., Noh, A. S. I., Karol, S., Rosenfeld, P., Lee, G., & Shneiderman, B. (2012). Community Health Map: A geospatial and multivariate data visualization tool for public health datasets. *Government Information Quarterly*, *29*(2), 223-234. URL: https://doi.org/10.1016/j.giq.2011.10.002

Session 10: Future of data visualization

Saket, B., Moritz, D., Lin, H., Dibia, V., Demiralp, C., & Heer, J. (2018). Beyond heuristics: Learning visualization design. *arXiv preprint arXiv:1807.06641*. URL: https://arxiv.org/pdf/1807.06641.pdf

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