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# Educating Future Providers of Personalized Medicine

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No longer isolated specialties, genetics and genomics now span all fields of medicine. However, efforts to improve the genomic literacy of health care providers have struggled to keep pace with this change [1]. Canonical approaches to teaching genetics are not necessarily appropriate for the next generation of providers, who will be expected to implement genomic approaches in the clinic [2]. At the same time, patients increasingly have access to personal genomic information that has the potential to empower them to engage with clinicians and to collaborate on improving their health. Given this situation, how can we equip the provider workforce to meaningfully respond to patients' needs?

A cross-disciplinary team of faculty and staff members of the Duke University School of Nursing and the Duke Center for Personalized and Precision Medicine developed a formal genomics and personalized medicine curriculum for providers, which consists of 2 specialty electives designed for entry-level and advanced students in nursing and other health professionals. These interdisciplinary courses foster professional development and applied learning in key content areas. The focus of the courses is on clinical applications of genomics for the prevention, prognosis, and treatment of complex disease states; optional personal genome testing is made available through an online provider as an experiential learning tool. Overarching themes include ethical and social considerations relating to genome-based information and implications for personal health, public health, and public policy. The courses, which address all core competencies in genomics and genetics for nurses [3] and medical professionals [4] (eg, risk assessment, genetic testing and counseling, clinical management, and ethical implications), focus on underlying genomics concepts, communication with patients, and resources for evaluating technologies and calculating risk [1].

Rather than offering a traditional review of technologies within disease states (eg, cardiovascular risk, cancer, diabetes), the courses take a concept-based approach, discussing topics such as heterogeneity, oligogenicity, and

gene-environment interactions. The courses also provide relevant examples from current literature. Classroom exercises build skills in evaluating the clinical validity and utility of genomic applications. Students emerge armed with real-world skills in using genomic applications and personalized medicine approaches, as well as an understanding of the implications of genomic technologies for society.

Students are given an opportunity to evaluate their own genomes and to gain personal experience with genomic testing through optional, subsidized personal genome testing integrated into the curriculum. Similar approaches have been used to educate graduate and medical students [5-9] and have led to improved learning outcomes [9]. Duke learners also are provided with mock genome profiles that they can substitute for, or use to supplement, their own profile. The personal genome platform serves as a touchstone throughout the courses as students explore different contexts of genomic information, from risk perception to ethical concerns.

To address concerns regarding the inclusion of students' personal genomes as an educational component [6, 10], the following measures were taken and reviewed with an external advisory board: confidentiality of participation; discussion of ethical, legal, and social considerations of direct-to-consumer genetic tests; a requirement that all instructors and students sign confidentiality statements; institutional review board assessment of social science research on the utility of personal genomes in the classroom; establishment of an external advisory board to handle unexpected stress or troubling outcomes; and provision of subsidized telephonic genetic counseling through a third party. The curriculum also establishes foundational principles before students receive their personal genome reports.

In the pilot offering, students unanimously reported that the experiential learning approach enhanced the lessons, noting the advantage of self-reflection within the classroom and acknowledging that both scientific and ethical concepts were reinforced with the personal

genome reports. From an educational perspective, the personal genome testing provided an avenue for applied learning about genomic concepts and allowed for multiple embedded constructs to bridge and spark discussions. The genome platform sets a framework for evaluation of clinical validity and discussion of the personal and clinical utility of genomic tests, which fosters critical thinking and synthesis of concepts in personalized medicine. This approach cultivates a broad adaptive understanding of genomics and personalized medicine, beyond rote review of current technologies or disease-specific genome algorithms for care.

The challenges of translating genomic technologies into health care practice require novel approaches to educate existing and future health care providers. The future provider workforce must be armed with core principles of genomics, the ability to critically evaluate applications, and familiarity with the implications of genomic information in social and personal contexts. Experiential learning via a personal genome analysis can reinforce these concepts. Pedagogical approaches using personal genome testing of health care providers are likely to be beneficial when the focus of the course is on critical evaluation of dynamic concepts in human genomics. **NCMJ**

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