EVALUATING GENOMIC EDUCATION FOR HEALTH PROFESSIONAL STUDENTS

A Dissertation

by

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Submitted to the Office of Graduate and Professional Studies of
Texas A&M University
in partial fulfillment of the requirements for the degree of

DOCTOR OF PHILOSOPHY

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August 2019

Major Subject: Health Education

ABSTRACT

Genomics is an emerging discipline, which focuses on the interactions between genetics and environmental factors leading to clinical and public health implications. Integrating genomics within healthcare can ultimately impact the population health ethically and responsibly. While it has been advocated that health professional students need genomics education, information regarding the genomics education status among this group is lacking. After graduating, health professional students can apply what they have learned into practice, become a multidisciplinary team member in genomics, and ultimately meet the public's needs for genetics education and services,

This dissertation reflects two studies. The purpose of the first study, a systematic literature review, is to critically evaluate the existing genomics education curricula available to health professional students. The following questions guided this literature review (1) What are the characteristics of existing genomics education curricula for health professional students? and (2) What are the evaluation findings for those genomics education curricula? Results from this systematic review study provide information on the numbers, findings, and quality of existing genomic education curricula for health professional students.

In the second study, the primary aim of this study is to assess if a web-based short genomics course impacted genomics knowledge as well as attitudes, self-efficacy, and intention for incorporating genomic competencies in future practice among undergraduate health education students at the Texas A&M University. Following the completion of genomics training, participating health education students increased

family health history (FHH) knowledge showed significant and positive improvements in FHH knowledge as well as attitudes, self-efficacy, and intention in adopting FHH into their future practice

The findings from the studies have direct implications and recommendations for researchers, educators, and healthcare professionals. Specifically, it can potentially help (a) healthcare professionals and educators to develop theoretically and methodologically rigorous genetics/genomics curricula for training health professional students, (b) create genomically competent health workforce in the future to assist the genetic service providers with increasing genetic/genomics demands, and (c) overcome the translational gap between genomics advances and its practice.

DEDICATION

Dedicated to my father and mother – for supporting and believing in me, while defying all stereotypes and outdated customs.

My husband – who has been my Rock of Gibraltar. I love you.

ACKNOWLEDGEMENTS

I would like to thank my committee chair, Dr. Lei-Shih Chen for shaping me the researcher I am today. It has been a long journey and I couldn't have accomplished it without you. I will always be grateful for your mentorship, encouragement, patience and rigorous training you provided throughout my doctoral studies. My committee members, Dr. Goodson, who has been helped me develop critical thinking and inculcated a questioning attitude. I will carry this with me, always. Dr. Ward, I can't thank you enough for your long-lasting support through all the ups and downs in my doctoral study period. I would like to express my gratitude to Dr. Lu for your kind support and guidance in my dissertation on so many occasions. I could never thank my wonderful dissertation committee enough for their generous support.

Thanks to my friends and colleagues in the Health Promotion Genomics Lab – Ming, Lei and Shixi, and the department faculty and staff for making my time at Texas A&M University a great experience. I would like to give a special thanks to my friends Miso, Rashi, Nola, Sherry, and Timethia for always being there for me. It takes a village.

I would like to thank Genetics in Medicine for allowing me to use the published chapter as part of this dissertation.

Thanks to my mother, father, sister and brother for their encouragement and believing in my goals. Words fall short to express my love and gratitude to you.

Finally, my husband –without your love and support, all of this would not have been possible. Thanks for sticking with me during through this long ride.

CONTRIBUTORS AND FUNDING SOURCES

This work was supported by a dissertation committee consisting of Drs. Lei-Shih Chen [chair], Patricia Goodson, and Susan Ward of the Department of Health and Kinesiology, and Dr. Wen Luo of the Department of Educational Psychology.

All work for this dissertation was completed by the student, under the supervision of Dr. Lei-Shih Chen of the Department of Health and Kinesiology.

Graduate study was supported by both the Graduate Research Grant at the College of Education and Human Development and the Graduate Student Research Grant at the Sydney and J.L. Huffines Institute for Sports Medicine and Human Performance in the Department of Health and Kinesiology at Texas A&M University. This work was also supported by the Strategic Research Award from the College of Education and Human Development at Texas A&M University.

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CHAPTER I

INTRODUCTION

Imagine a scenario where an underlying risk factor is responsible for nine out of ten leading causes of death in the United States, but an extremely limited number of health professionals have been trained to manage it. This is the current situation in the field of genomics (Centers for Disease Control and Prevention, 2014). Genomics is defined as the study of genes, environment and their interactions-referring to an individuals entire genetic makeup (genome), whereas, genetics is the study of genes and associated inheritance (Center for Genomics and Public Health, 2017). According to the World Health Organization, the difference between the two is that "*genetics scrutinizes the functioning and composition of the single gene where as genomics addresses all genes and their inter relationships in order to identify their combined influence on the growth and development of the organism*."(World Health Organization, 2017, p. 1). As a result, genomics plays a very important role in disease prevention, diagnosis and patient care than genetics (Rehm, 2017).

Genomic Competencies

Genomics plays a significant role in onset of genetic disorders as well as various chronic disorders such as cancer, diabetes and heart diseases. Therefore, training various healthcare professiaonls in genomics and genomics medicine to help them develop genomic competencies is essential (Centers for Disease Control and Prevention, 2010a). Genomic competencies may refer to practice *skills, knowledge* and *attitudes* necessary for practicing genomic initiatives (Centers for Disease Control and Prevention, 2010a). Due to increasing role played by genomics, various organizations have developed discipline-specific competencies such as genetic

counselors (American Board of Medical Genetics and Genomics, 2017b), physicians (Korf et al., 2014), nurses (American Nurses Association, 2012), pharmacists (Roederer et al., 2017), and physician assistants (Goldgar, Michaud, Park, & Jenkins, 2016). Similarly, the Centers for Disease Control and Prevention (CDC) developed genomics competencies for all public health workforce and seven genomic comptencies specifically for health educators (Centers for Disease Control and Prevention, 2010b). In 2007, the National Coalition for Health Professional Education in Genetics (NCHPEG) also developed core competencies for all healthcare professionals (National Coalition for Health Professional Education in Genetics, 2007).

Importance of developing genomic competencies among health education students

As students are the future of the health education workforce, health education discipline needs to train these students in order to achieve their vision of developing a genomically competent workforce. Training health education students at an early stage of their career can help prepare for meeting the increasing demand for genetic services and education in the future. Further, timely training the health education students before they join healthcare workforce can help them be prepared for future job commitments such as implementing evidence-based best practices, providing patient education, and recommending further genetic evaluation and consultations (Talwar et al., 2018). Focusing on health education students will also ensure the continual expansion of genomics application to public health practice and routine healthcare. Thus, promoting and developing genomics competencies among health education students at an undergraduate level can help overcome the translational gap between genomics advances and its practice.

Study Purpose

This dissertation reflects two studies. The purpose of the Chapter II, a systematic literature review, was to critically evaluate the existing genomics education curricula available to health professional students. The following questions guided this literature review: (1) What are the characteristics of existing genomics education curricula for health professional students? and (2) What are the evaluation findings for those genomics education curricula?

In Chapter III, the primary aim of this study is to assess if a web-based short genomics course impacts genomics knowledge as well as attitudes, self-efficacy, and intention for incorporating genomic competencies in future practice among undergraduate health education students at Texas A&M University. Moreover, five appendices are also attached at the end of this dissertation, including Appendix A (Characteristics of genomics education programs for health professional students), Appendix B (Recruitment email), Appendix C (Facebook recruitment message), Appendix D (Pre-test survey instrument), and Appendix E (Post-test survey instrument).

CHAPTER II

CHARACTERISTICS AND EVALUATION OUTCOMES OF GENOMICS CURRICULA FOR HEALTH PROFESSIONAL STUDENTS: A SYSTEMATIC LITERATURE REVIEW

Introduction

Before the mapping of the human genome achieved by the Human Genome Project (HGP) in 2003, genetic competencies for health professionals were limited to the management of single gene disorders such as cystic fibrosis, Huntington's disease, and sickle cell anemia (Khoury & Galea, 2016; Rehm, 2017; Roberts, Kennedy, Chambers, & Khoury, 2017). Only limited and certain specialty medical fields (e.g., genetics, pediatrics, obstetrics, and gynecology) provide direct and/or indirect genetics-related services and education. Since the completion of the HGP, genetic knowledge's application has been linked to nearly all diseases, exceeding far beyond single-gene diseases (Manolio et al., 2013). One of the obvious examples is that there has been a 275% increase in the number of available genetic tests for various diseases since the completion of the HGP (Cashion, 2009). [1]

To keep up with the accelerating and continual advances in genomic science and technology, health professionals are called up to develop comprehensive competencies in genomics. To address this issue, leading organizations in the United States (U.S.) and Europe have outlined genomic competencies for a variety of health professionals. These include competencies for all disciplines, such as the "*Competencies for All Healthcare Professionals*" developed by the NCHPEG and discipline-specific competencies, such as the "*Essential Nursing*

[1] *Reprinted with permission from "Characteristics and evaluation outcomes of genomics curricula for health professional students: a systematic literature review" by Talwar, D., Chen, W. J., Yeh, Y. L., Foster, M., Al-Shagrawi, S., & Chen, L. S, 2018. *Genetics in Medicine*, 10.1038/s41436-018-0386-9, Copyright [2018] by Lei-Shih Chen.

Competencies and Curricula Guidelines for Genetics and Genomics" proposed by the American Nurses Association (Jenkins & Calzone, 2007; National Coalition for Health Professional Education in Genetics, 2007).

There are two complementary viewpoints to consider in fostering the development of a genomically competent health workforce. The first viewpoint is to train practicing health professionals in genomics to optimally educate and treat patients as well as timely refer them to genetic professionals. Continuing education has commonly been utilized for training this group. The second view point is to contribute a genomically competent health workforce by educating health professional students in genomics (Cashion, 2009; Cragun, Lewis, Camperlengo, & Pal, 2016). In doing so, when those students graduate, they are equipped with essential genomic competencies to treat patients and can quickly grasp rapid advanced genomic information. Professional associations and organizations, such as the Association of Professors in Human and Medical Genetics, the European Society of Human Genetics, and the National Academy of Medicine (formerly called the Institute of Medicine) have asserted the importance of incorporating genomics-related content into health professional or health science school education to ensure those students to encompass adequate competencies in genomics (Bean, Fridovich-Keil, Hegde, Rudd, & Garber, 2011; Chen, Kwok, & Goodson, 2008; Hyland et al., 2013).

Currently, genomics education status for practicing health professionals has been reported and summarized in a systematic review (Talwar, Tseng, Foster, Xu, & Chen, 2016). While it has been advocated that health professional students need genomics education, information regarding the genomics education status among this particular group is lacking. To this end, the purpose of this systematic literature review is to summarize the existing genomics

education curricula available to health professional students. In particular, we seek to address the following questions: (1) What are the characteristics of existing genomics education curricula for health professional students? (2) How have these genomics education curricula been evaluated? and (3) What are the evaluation findings for those genomics education curricula?

Methods

Article search and selection

To plan and manage the literature search, Garrard's matrix method (Garrard, 2013) was utilized. In particular, this study consisted of the three steps to search and select articles (shown in Figure 2.1). First, an initial search with four databases, including Medline (OVID), EMBASE, CAB (EBSCO), and Global Health was conducted to identify abstracts focusing on genomics or genetics curricula for health professional students. The search terms used were "genomics," "genetics," "education," "training," "curriculum," "curricula," "health occupation students," "graduate education," "medical education," "dental education," "nursing education," "pharmacy education," "public health professional education," "student," "undergraduate," "graduate," "doctoral," "nursing," "medical," "pharmacy," and "public health." For this comprehensive review, the key terms and Boolean search terms were utilized. The time frame for the search was from January 1, 1990 to October 6, 2017. The year, 1990, was chosen as this is when extensive work in genomics (started with the HGP) was initiated. Furthermore, we also searched through MedEdPORTAL, an open-access peer-reviewed journal published by the Association of American Medical Colleges and American Dental Education Association (MedEdPORTAL, 2016), to identify additional studies. The identified abstracts from the literature search were exported to Refworks for further coding and elimination of duplicates.

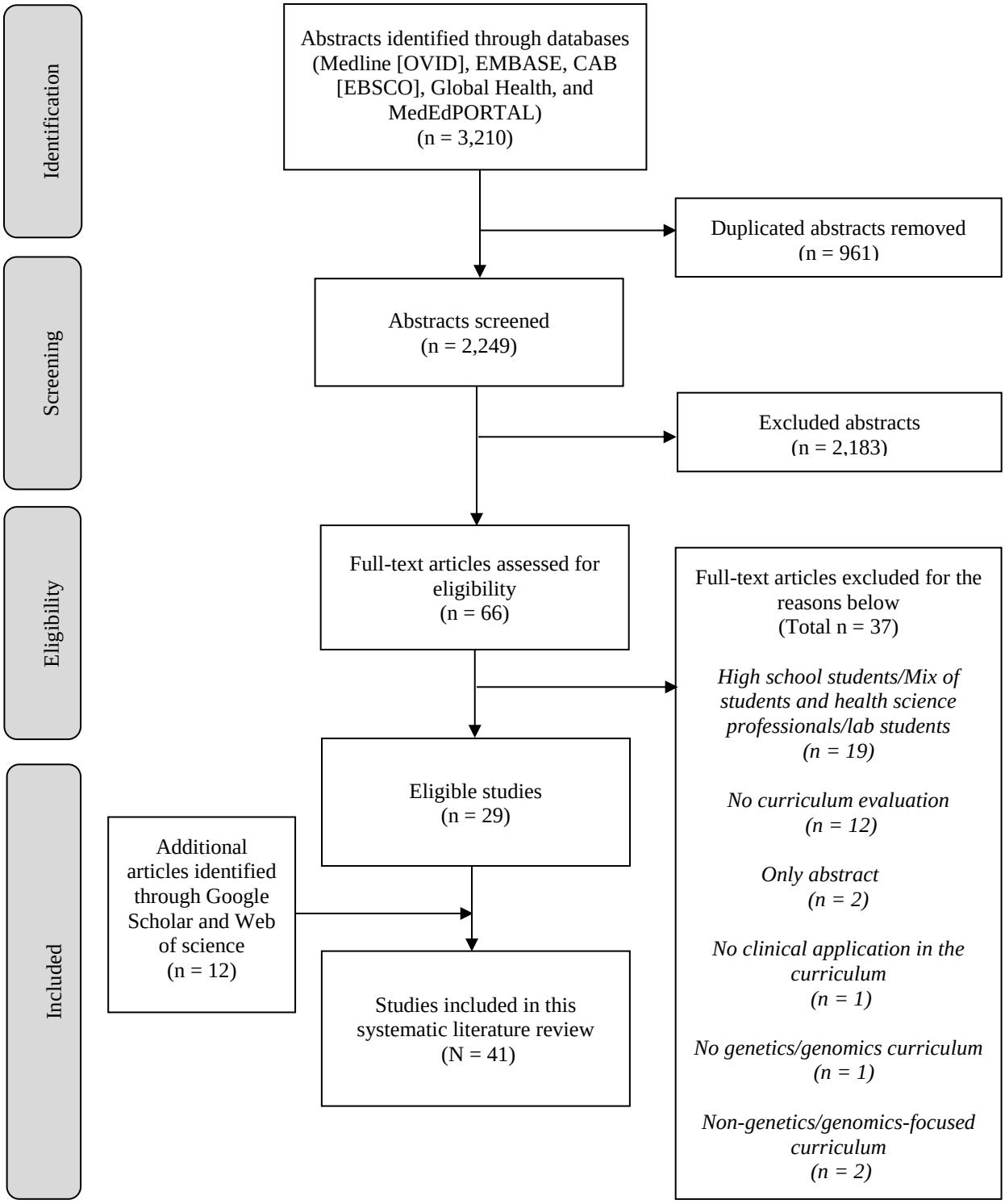

Figure 2.1 Article search and selection procedure.

The second step involves identifying the abstracts that met the inclusion criteria: (1) articles were peer-reviewed and written in English; (2) studies were published after 1990, as 1990 is the beginning of the HGP; (3) participants were undergraduate or graduate health professional students, such as medicine, pharmacy, nursing, physician assistant, and allied health; (4) studies reported both genomics education curricula and evaluation findings; and (5) genomics curricula were clinically relevant because laboratory-focused or basic genomic curricula might not be applicable in a clinical setting. Abstracts were excluded if they met the exclusion criteria: (1) the focus on healthcare professionals, fellows, and/or residents rather than on students; (2) mixed types of participants (e.g., students and health professionals/fellows/residents) and no separate findings for the student group; (3) continuing education programs; (4) non-clinically relevant, laboratory-focused, or basic genomics curricula; (5) lack of comprehensive evaluation outcomes; and (6) reviews, editorials, and conference abstracts. A total of 29 studies were identified in this step.

To ensure a comprehensive literature review, as the final step, references as well as the studies conducted by the first and last authors of those articles identified in the second step were searched via Google Scholar and Web of Science. Using this technique, 12 additional articles were identified. Accordingly, 41 articles formed the final sample for this systematic literature review. To ensure the reliability of the article selection process, two researchers independently reviewed and screened abstracts and articles. Disagreements and concerns were discussed between the two authors to reach a final agreement.

Data extraction and synthesis

Data from the included articles are organized in a matrix shown in Appendix 1, which consists of three parts. Part I summarizes program characteristics, such as author's name,

publication year, country where education was conducted, targeted students, theoretical basis of the course content, educational approaches, and length of curricula. Part II includes program evaluation characteristics, including evaluation design and tools, data analysis, as well as main findings. When studies presented both significant and non-significant results, only the significant findings were reported as major findings. Yet, when studies only had descriptive data, we reported those descriptive results. Two researchers independently coded Part I and Part II of the matrix. The inter-rater reliability was 0.82 calculated using Gwet's AC1, indicating a strong consistency and agreement (Wongpakaran, Wongpakaran, Wedding, & Gwet, 2013). The last section of the matrix, Part III, showed the Methodological Quality Score (MQS). The MQS was developed based on past literature (Buhi & Goodson, 2007; Chen & Goodson, 2007a; Suther & Goodson, 2003; Talwar et al., 2016) by the research team, which presented the overall methodological assessment of each included study with a theoretical range of 0-8 points. It evaluated the sample size, length of the educational courses, theoretical basis of the curricula, and follow-up data collection (shown in Table 2.1).

Table 2.1 Frequency distributions of methodological quality for reviewed articles (N = 41)

Methodological criterion	Description	Score	Distribution of characteristics	
			n	%
Sample size	Not reported	0	0	0.0%
	Small sample size (<100)	1	13	31.7%
	Medium sample size (>100 and <300)	2	19	46.3%
	Large sample size (≥300)	3	9	22.0%

Table 2.1
Continued

Methodological criterion	Description	Score	Distribution of characteristics	
			n	%
Theoretical basis of the curriculum	Did not present theoretical framework	0	28	68.3%
	Presented theoretical framework	1	13	31.7%
Length or duration of curriculum	Not reported	0	6	14.6%
	One hour or less than an hour	1	5	12.2%
	Less than a day but more than one hour	2	7	17.1%
	More than a day	3	23	56.1%
Follow-up	Not reported	0	35	85.4%
	Reported	1	6	14.6%

Results

The characteristics of genomics education courses

As showed in Appendix A, among the 41 reviewed studies, the majority were conducted in the U.S. (n = 35; 85.3%) and the remaining were in the United Kingdom (n = 2; 4.9%), the Netherlands (n = 2; 4.9%), Canada (n = 1; 2.4%), and China (n = 1; 2.4%). The years of publication ranged from 1990-1999 (n = 2; 4.9%), 2000-2009 (n = 13; 31.7%), and 2010-present (n = 26; 63.4%). Moreover, most genomics courses were offered to medical students (n = 14; 34.1%) and pharmacy students (n = 13; 31.7%). Other participants included nursing students (n = 5; 12.2%), physician assistant students (n = 2; 4.9%), health information management students (n = 2; 4.9%), public health students (n = 1; 2.4%), and students with different majors (e.g.,

molecular medicine, nutrition, nursing, and biology; n = 4; 9.8%). The numbers of students in each course ranged from 10 to 2,674 (mean = 275.85; median = 144.00; SD = 528.70), and nearly two-thirds of articles (n = 28; 68.3%) had more than 100 students.

While most studies did not report the types of courses, ten courses (24.4%) were reported as required curricula, three courses were described as elective (7.3%), and two courses (4.9%) were labeled as both required and elective/extra credit. For example, one nationwide pharmacogenomics curriculum by Lee et al., (2015) was characterized as required in some colleges while elective in others (Lee, Hudmon, Ma, & Kuo, 2015). Nearly half of the courses (n = 20; 48.8%) were taught with more than one teaching method (e.g., in-class lectures, videos, computer labs, and self-genotyping exercise). The length of courses ranged from one-time lecture to a full semester.

Regarding the theoretical framework of the curriculum, most curricula (n = 28; 68.3%) did not include any theoretical model or framework. The remaining 13 courses (31.7%) were based on various theories, such as Adult Learning Theory, Social Learning/Cognitive Theory, Theory of Planned Behavior, Diffusion of Innovations, Teach-the-Teacher model, and Bloom's Taxonomy of Learning. While the content of each curriculum was not identical, the content was divided into the 19 topics. These included basic genetics, such as general genetic concepts, genes, and chromosomes (n = 33; 80.5%), genetic risk assessment (n = 28; 66.7%), ethical, legal, and social implications (ELSI) of genomics (n = 23; 56.1%), genetic counseling (n = 23; 54.8%), usage of genomics internet databases, such as Online Mendelian Inheritance in Man (OMIM) and Pharmacogenomics Knowledgebase (n = 15; 36.6%), Mendelian/genetic disorders (n = 15; 36.6%), pharmacogenomics/pharmacogenetics (n = 14; 34.1%), genomics disorders (n = 13; 31.7%), genome data analysis (n = 9; 22.0%), genomics tools and technology (n = 9; 22.0%),

population genetics (n = 4; 9.8%), reproductive genetics (n = 3; 7.3%), bioinformatics (n = 3; 7.3%), business aspects of the genomics field, (n = 3; 7.3%), pediatric genetics (n = 2; 4.9%), nutrigenomics (n = 1; 2.4%), immunogenetics (n = 1; 2.4%), molecular genetics (n = 1; 2.4%), and sexual genetics (n = 1; 2.4%).

The evaluation of genomics education courses

The courses were evaluated using cross-sectional/descriptive design (n = 15; 36.6%), pre- and post-test design (n = 22; 53.7%), quasi-experimental design (n = 2; 4.9%), and experimental/randomized control trial (n = 2; 4.9%). Data were obtained via various methods such as pre- and post-test questionnaires, course evaluation surveys, examinations, quizzes, laboratory reports, in-class exercises, essays, research papers, self-reflective journals, research projects, focus group, and discussion boards. For the most advanced statistical analysis used, more than half of the studies (n = 26; 63.4%) analyzed the data using inferential statistics without controlling for covariates, such as paired *t*-test, chi-square, and Wilcoxon signed-rank test. The remaining studies utilized univariate statistics or qualitative methods (n = 15; 36.6%).

Evaluation findings

The evaluation findings were outlined according to knowledge, self-efficacy, attitudes, intention, comfort level, motivations, behavior, and course feedback. Detailed results of major findings were outlined in Appendix A.

Student Performance

Knowledge

The majority of the studies (n = 36; 87.8%) reported students' genetics/genomics knowledge as an evaluation outcome. Of these 36 studies, 22 studies reported statistically significant increases in knowledge after the course, one study did not find statistical significance,

and 13 studies reported only descriptive results for knowledge. For example, in a pharmacogenomics course delivered to 310 doctorate of pharmacology students, Nickola et al. (Nickola & Munson, 2014) found significant increases from pre- to post-test in students' knowledge of genomics and the NCHPEG genomics competencies (Nickola & Munson, 2014). Another study conducted by Magee et al., (Magee, Gordon, & Whelan, 2001) among 120 first-year medical students indicated that all students showed sufficient knowledge and passed the genetics-based problem sets after the course (Magee et al., 2001). Furthermore, follow-up outcomes for genetics/genomics knowledge were reported in only four studies among which two studies noticed that their students' knowledge decreased in 1- and 2-years post-education, respectively. For instance, Greb et al., (Greb, Brennan, McParlane, Page, & Bridge, 2009) reported that at the 2-year follow-up, 88% of the medical students failed the genetics section on the observed structured clinical examination (OSCE) at the end of their third year of medical school; particularly, less than a quarter of students correctly calculated genetic risks and collected family history in a genetic case study on that exam (Greb et al., 2009). Nevertheless, one study conducted by Goodson et al., (Goodson, Chen, Muenzenberger, Xu, & Jung, 2013) reported a significant increase in knowledge score from baseline to 3-month follow-up among graduate health education students (Goodson et al., 2013).

Attitude

Sixteen studies (39.0%) reported outcomes on students' attitudes toward genetics/genomics and/or future clinical practice in genetics/genomics. Of these 16 articles, eight studies reported statistically significant improvement in attitudes among students after the course, three studies did not find statistical significance for students' attitudes scores, and five

studies reported descriptive findings. For example, Adams et al., (Adams et al., 2016) found a significant change in the participating doctorate of pharmacy students' attitudes toward recommending pharmacogenomic testing to patients after the pharmacogenomics course. Furthermore, in a study on a web-based pharmacogenomics course conducted by Lee et al., (Lee et al., 2015), 80% of the participating doctorate of pharmacy students nationwide believed that pharmacists should conduct patient education about pharmacogenomics testing (Lee et al., 2015). Follow-up data for attitudes were reported in only one study, in which attitudes scores regarding genomics among participating graduate health education students significantly increased from pre-test to 3-month follow-up (Goodson et al., 2013).

Self-efficacy

More than one-third of the studies (n = 14; 34.1%) reported statistically significant changes in confidence levels in performing a variety of genetics tasks (e.g., genetic risk assessments, genetic counseling, and using genetic databases) as well as in implementing genetics/genomics competencies and skills. All studies found positive self-efficacy outcomes. For instance, Makransky et al., (Makransky et al., 2016) reported statistically significant increases in self-efficacy scores from pre- to post-test in performing various medical genetics activities among the participating undergraduate medical and molecular biomedical students (Makransky et al., 2016). Moreover, self-efficacy was reported as a follow-up outcome in three studies. Goodson et al., (Goodson et al., 2013) did not show statistically significant findings for self-efficacy at 3-month follow-up. However, in the study of McGovern et al., (McGovern, Johnston, Brown, Zinberg, & Cohen, 2006) students' self-efficacy scores in pedigree drawing as well as genetic risk assessment and communication remained significantly higher than those of

control group at 6-month follow-up. Williams et al., (Williams & Dale, 2016) also found that their students' self-efficacy scores in performing genetic competencies remained significantly higher at 9-month follow-up compared to their pre-test scores.

Comfort level

Four studies (9.8%) assessed educational outcomes on comfort level with integrating or practicing genetics and genomics in future clinical practice. All these four studies found statistically significant changes in students' comfort level after completing the courses. In a web-based genetics course for nurse practitioner students, for instance, Whitt et al., (Whitt, Macri, O'Brien, & Wright, 2015) stated that students exhibited significant improvements in their comfort level to perform genetics competencies and apply them to clinical practice after the course. No follow-up data on comfort level were reported in the studies included in this review.

Intention

Three studies (7.3%) in this review evaluated intention as an evaluation outcome. Intention was examined by assessing students' willingness to apply genetic/genomics knowledge and skills learned from their courses to their future clinical practice. Among the three studies, two indicated statistically significant increases in students' intention scores from pre- to post-test, and one study presented descriptive data with positive intention outcomes. For instance, in the web-based courses reported in Metcalf et al., (Metcalf, Tanner, & Buchanan, 2010) students' intention related to the practices of genetic testing and counseling in the future increased significantly from pre- to post-test among the 596 participating medical students. Follow-up data

on students' intention were mentioned in only one study, in which no statistical significance was found for students' intention scores at 3-month follow-up (Goodson et al., 2013).

Motivation

Only three (7.3%) articles in this study provided evaluation outcomes related to students' motivation; one of these three studies reported statistically significant findings, while the other two presented only descriptive data on motivation. All three studies suggested that genetics/genomics education led to positive motivation regarding learning genetics and genomics among students. For instance, in a pharmacogenomics training reported in Krynetskiy et al., (Krynetskiy & Calligaro, 2009) open-ended survey results showed that doctorate of pharmacy students expressed further interest in learning about pharmacogenomics after the course (Krynetskiy & Calligaro, 2009). In addition, among the two other studies examining motivation, Busstra et al., (Busstra, Hartog, Kersten, & Müller, 2007) mentioned that 58-75% of participating students majoring in either nutrition and health or biotechnology in the Netherlands postulated a high motivation to study nutrigenomics at 1-year follow-up (Busstra et al., 2007).

Behavior

Merely two studies (4.9%) included in this review reported behavioral outcomes. In particular, at the University of Chicago, Waggoner et al., (Waggoner & Martin, 2006) developed a curriculum focusing on the integration of genetics internet databases into medical curriculum, which was delivered to 324 medical students (Waggoner & Martin, 2006). One-year follow-up data showed that 72% of the students still use genomics databases multiple times in their clinical practice. The other study conducted by Goodson et al., (Goodson et al., 2013) indicated that

students' behavior score did not significantly change compared to the baseline data (Goodson et al., 2013).

Course Feedback

Most studies (n = 35; 85.4%) reported students' feedback for the genetics and genomics courses. All courses were rated positively overall; participating students perceived the courses to be helpful and would be likely to recommend those courses to their peers. For example, Bean et al., (Bean et al., 2011) stated that most of the medical students agreed that the virtual laboratory sessions about genetic testing were useful and suitable as well as that the content and teaching approaches were effective (Bean et al., 2011). Only one study (Busstra et al., 2007) included follow-up data on course content related feedback; the course evaluation scores were above average at 1-year follow up.

Methodological Quality Score

The average MQS for all 41 studies was 4.51 (SD = 1.47; range = 1-7), which was slightly above the mean (4) of the possible theoretical MQS (ranges = 0-8). Specifically, the reviewed studies overall obtained good scores in the sample size and course duration. Over two-thirds of the studies had a sample size higher than 100 students (n = 28; 68.3%), and more than half of the courses were longer than a day (n = 23; 56.1%). Nevertheless, the majority of the curricula were not grounded from a theoretical framework (n = 28; 68.3%) and did not report follow-up data (n = 35; 85.4%).

Discussion

To the best of our knowledge, this study is the first to systematically review the existing genomics programs available to health professional students. A total of 41 peer-reviewed studies that met our inclusion criteria were identified and included in this systematic review. There was a dramatically growing trend in publication years, suggesting increased awareness and perceived importance of this topic in the health science field. Nevertheless, the majority of studies were conducted in the U.S. and were limited to certain few countries, including the United Kingdom, the Netherlands, Canada, and China. It is important for researchers and educators beyond those countries to incorporate genomics into their curricula for health professional students.

Results from our study indicate that most genomics educations were delivered to medical and pharmacy students. A potential explanation is that the field of genomics, such as pharmacogenomics and personalized/precision medicine, has immediate and noticeable impacts on their practice. For instance, metabolism and dosages of some drugs differ among individuals due to genetic polymorphism; thus, knowledge of pharmacogenetics is important to maximize the benefits and minimize adverse events (Kadafour, Haugh, Posin, Kayser, & Shin, 2009). The other possible reason is that the training in pharmacy and medical schools tend to be longer than other health professional or health science disciplines, which might allow more flexibility to diffuse genomics into their curricula. Given that the role of genomics has become more important in the health field, other professional fields, especially those that have not published any studies in this area (e.g., dentistry, physical therapy, occupational therapy, and speech therapy), may need to develop disciplinary-specific genomics curricula and further evaluate the effectiveness for their own students.

Of note, the 41 studies we reviewed reported course feedback (n = 35) as well as assessed behavior (n = 2) and other cognitive variables, including knowledge (n = 36), attitudes (n = 16), self-efficacy (n = 14), comfort level (n = 4), intention (n = 3), and motivation (n = 3). While collecting behavioral data was understandably challenging among students, obtaining both cognitive variables and course feedback was essential for evaluating the effectiveness of the courses. Moreover, although the majority of the reviewed studies reported enhanced knowledge as well as improved self-efficacy, attitudes, intention, comfort level, and motivation immediately after their genomics education, only six studies gathered follow-up data to assess the sustainability of these education effects. Therefore, future studies should not only collect behavior, cognitive variables, and course feedback information, but follow-up data are also needed for this body of literature.

The mean of the MQS for all reviewed studies was 4.51, which was slightly above the mean of the theoretical average (4). While the majority of the studies had more than 100 students in their programs, and the duration of their education was longer than a day, some areas still need improvement. Specifically, developing the curriculum based on a theoretical framework and collecting follow-up data are critical for this body of literature. Future researchers and educators may consider collaborating with statisticians in the planning the stage of genomics curriculum development to gather and present more robust findings.

Nearly half of the courses (48.8%) utilized more than one teaching method to deliver the genomics curricula. Studies with only a single teaching strategy mainly utilized in-class didactic lectures to deliver genomics courses to their students. According to the Adult Learning Theory developed by Malcolm Knowles, students' learning process is maximized when multiple instructional strategies are adopted to meet the different learning styles and needs among their

students (Malcolm S Knowles, 1970, 1978; Malcolm Shepherd Knowles, 1984). Incorporating various teaching strategies, such as a mixture of class lectures, case studies, laboratory exercises, standardized patients, may be useful to facilitate better learning outcomes among students. Thus, it is important for future genomics courses to adopt a variety of teaching strategies to engage and enhance health professional students' learning in genomics.

Interestingly, an emerging pedagogical method we found in our systematic review was the inclusion of students' self-genotyping as a classroom exercise. In particular, several studies in our review reported the utilization of students' own genotyping as an experiential learning technique. This teaching technique has been acknowledged in the literature (Garber, Hyland, & Dasgupta, 2016). This approach successfully improved health professional students' knowledge, attitudes, counseling skills, interpretations of genetic tests, and considerations of the ELSI of genomics. If health professional students underwent personal genotyping, they might also better relate their personal experience to patients while discussing genetic test procedures and results (Boguski, Boguski, & Berman, 2013). Nevertheless, ethical concerns regarding including self-genotyping in curricula may need to be addressed. Cautions may be taken for the potential psychological impacts of genotyping results on the students and their families particularly from disease susceptibility test results. Issues related to the confidentiality and anonymity of the students' genome data should also be considered (Garber et al., 2016). Providing adequate information to ensure students make informed decisions before performing genotyping experiments, teaching students the importance of confidentiality and anonymity issues, and offering genetic counseling and support may minimize these potential risks (Åhman, Runestam, & Sarkadi, 2010; Bernhardt et al., 2013; Garber et al., 2016; Kleinveld, Ten Kate, van den Berg, van Vugt, & Timmermans, 2009; Saskia C Sanderson et al., 2015). Another potential solution

may be to give students options to analyze their personal genome data or anonymous genome data from third-party donors (or cadavers) to minimize the potential harms while meeting the learning objectives in genomics (Gerhard, Paynton, & Popoff, 2016; S. C. Sanderson et al., 2013).

There are three main limitations to this study. First, we had to develop our own MQS based on past literature due to various study designs of the included articles in this review. Second, not all of the “curricula" reported in the articles we reviewed were full, semester-long courses. Thus, the teaching methods reported in such studies might be limited to the ones used for the delivery of their genomics curricula and not the entire course. Finally, we conducted an extensive literature search to include all studies on genomics education among health professional students. Yet, despite our best efforts, there might have been some studies that were overlooked during the searching process. In addition, some genomics courses might have been offered to health professional students as part of school curricula but have neither evaluated their curricula nor published their studies.

Despite the above limitations, there are several remarkable strengths in our review. First, to the best of our knowledge, this is the first systematic review focusing on genomics education for health professional students majoring in diverse disciplines, such as medicine, nursing, allied health, pharmacology, and physician assistants. Second, our study reports the existing genomics curricula, their method of delivering at schools, and the evaluation methods and findings. Results from our study provide information on the quantity and quality of the existing genomics education curricula for health professional students. It may guide future researchers and educators to develop genomics curricula to be tailored to their targeted students. An open access genomics education database may need to be developed, where genomics education articles and

curricula can be shared and disseminated. Third, the MQS suggested that there is a need to improve this body of literature. This systemic review may help future researchers adopt more rigorous methodological approaches to plan and evaluate the outcomes of their education. Lastly, given that genomics education should start from early education, and science, technology, engineering, and mathematics (STEM) education is currently an evolving topic, conducting a systemic review for genomics education among high school students is desired in the future.

CHAPTER III

EVALUATING A GENOMICS SHORT COURSE FOR UNDERGRADUATE HEALTH EDUCATION STUDENTS

Introduction

In 2005, a group of renowned experts in public health genetics/genomics (PHG) met in Bellagio, Italy to discuss the issue of bridging evolving genomic technologies with public health (Burke, Khoury, Stewart, & Zimmern, 2006; Genome-based Research and Population Health, 2015; Séguin, Hardy, Singer, & Daar, 2008). This leading group agreed and commented that for a successful translation, education and training for public health students are essential (Burke et al., 2006; Genome-based Research and Population Health, 2015). In tandem with the consensus of PHG leaders, the CDC has created genomics competencies as a part of the training goal for public health students (Centers for Disease Control and Prevention, 2010b; Chen & Goodson, 2007b). In addition, the National Human Genome Research Institute (National Human Genome Research Institute, 2017) has also launched a national genomics literacy campaign, titled "Genomic Literacy, Education, and Engagement" to increase genomics education and outreach initiatives among college students.

Nevertheless, two main challenges still exist for providing genetics/genomics training for public health students. The first obstacle is that, compared to other health topics, PHG remains a new field in public health. According to a recent systematic review of genomics training for health professional students, there is a significant shortage of curricula targeting public health students (Talwar et al., 2018). The second challenge hindering the provision of genetics/genomics training for public health students is that many of the public health faculties

are not trained in PHG, which may further affect their provision of PHG education for students (McInerney, 2008).

Health education is one of the essential domains of public health. The Coalition of National Health Education Organizations defines health education as, "a social science that draws from the biological, environmental, psychological, physical and medical sciences to promote health and prevent disease, disability and premature death through education-driven voluntary behavior change activities."(Coalition of National Health Education Organizations, 2019) Health education students are the future health education and public health workforce. Training health education students at an undergraduate level – an early stage of their career – can respond to the leading experts and agencies' advocacy of the PHG training needs for public health students. It can also address the deficiency of PHG curriculum in schools. Upon graduation, genomically competent health education students can not only promptly apply the PHG knowledge they have learned in school, but also implement the new PHG information into practice (Talwar et al., 2018). Moreover, trained health education students can become a valuable multidisciplinary team member of the health workforce to work closely with other healthcare and public health professionals. Lastly, the increased number of trained health education students can also help meet the increasing demand for genetics education and associated services among the public and bridge the gap between the healthcare system and underserved and lay communities in the future (Chen & Goodson, 2007b).

In previous research (Chen et al., 2013; Goodson et al., 2013), we developed the first theory-based genomics online training for health educators who hold Certified Health Education Specialist (CHES®) or Master CHES (MCHES®) designations. This three-hour online genomics training focusing on family health history (FHH), which is an easy-to-use PHG tool with a

significant impact in health promotion and disease prevention (Guttmacher, Collins, & Carmona, 2004). Our FHH-based training successfully improved health educators' knowledge, attitudes, self-efficacy, intention, and behavior in FHH-based practice. Based on the success in this study, we adapted and delivered the online training as a genomics short course for health education students. Considering the initial online training was set-up in a plain page view layout (html), the revised course utilized a multimedia format with closed captions and interactive activities. We also modified and updated the content of the original online training and added tables of content, images, and videos. For the pre-course and post-course surveys, we revised the questions from the original training to target the health education students and removed practice questions as participants were not health education practitioners. The purpose of this first study –to the best of our knowledge – is to report the feasibility and evaluate outcomes of the revised online genomics, FHH-focused, short course on undergraduate health education students.

Materials and Methods

Study Participants

This study was approved in accordance with the Institutional Review Board at Texas A&M University. Junior and senior undergraduate students in the Division of Health Education at Texas A&M University were invited to participate in this study. These students were selected because they had taken a majority of the health education courses offered at the university. They were also nearing their graduation, which increased the probability of adequately retaining the newly learned knowledge from our online genomics course and applying this information in the near future.

Theoretical Framework of the Online Genomics Course

The context of the online genomics course was built up on a previously tested theoretical framework with 1,607 health educators (Chen et al., 2008). The theoretical framework consisted of the Social Cognitive Theory, the Theory of Planned Behavior, and the Diffusion of Innovations Theory (Ajzen, 1991; Bandura, 1995; Chen et al., 2013; Chen et al., 2008; Doll & Ajzen, 1992; Rogers, 2010). We also adopted the dual-channel assumption of the *Cognitive Theory of Multimedia Learning* (Mayer, 2014) by providing visual (e.g., videos, images, tables, figures, and pictures) and auditory (i.e., narrative speaking) learning channels to deliver the course. In addition, we used the Kirkpatrick's Evaluation Model (KEM) to summarize the evaluation findings (Kirkpatrick, 1967; Kirkpatrick & Kirkpatrick, 2006; Sanchez-Reilly & Ross, 2012; Sargeant et al., 2011). Specifically, we addressed Level 1 of the KEM ("Reaction") to assess participating students' satisfaction of the course and Level 2 ("learning") to examine the degree in which participants acquired the intended knowledge, attitudes, self-efficacy, and intention based on their participation of the genomics course (Sanchez-Reilly & Ross, 2012).

Content of the Online Genomics Course

The online genomics course consisted of four modules. The training topics of those four modules were: "What is FHH" (Module 1), "Why should health educators apply FHH assessments into health promotion and practice?" (Module 2) "Who should conduct FHH education?" (Module 3), and "How to conduct a FHH and make appropriate behavioral or lifestyle recommendations based on FHH information to clients?" (Module 4). Each module was designed with approximately 2-4 learning objectives and divided into sub-modules. Case studies,

videos, tables, figures, images, resources, references, and relevant guidelines were provided to aid student learning.

Training Delivery Format

The online course was designed using Adobe Captivate 9 and hosted on the college-supported Moodle learning management system with two hours and 36 minutes in duration. At the beginning of the course, students were required to read the course introduction to understand the course structure and technology recommendations. Next, students were required to complete the pre-course survey and then take a self-learning pace by playing, pausing, and stopping the course modules. After the completion of the course modules, students were directed to the post-course survey.

Survey Instruments

Knowledge, attitudes, intention and self-efficacy were measured (Table 3.1) and were identical in both pre-course and post-course surveys. Additional questions asked in the pre-course survey included contact information, demographics (i.e., age, race/ethnicity, and degree classification), and previous courses taken that were related to

Table 3.1 Theoretical Variables Measured in the Pre-Course and Post-course Surveys

Theoretical construct	Theoretical definition	Range of survey data score (theoretical range)	Number of survey items	Interpretation	Example item
Knowledge	"Information dealing with the functioning principles underlying how the innovation works" (*Diffusion of Innovations*) (Rogers, 2010, p. 168)	6-15 (0-15)	15	Higher score = better FHH knowledge	FHH can be useful for health promotion because they: [(a) Provide context for interpreting a person's genetic risk; (b) Provide indicators of potential risk for an illness; (c) Can function as important motivational tools for health promotion; (d) All of the reasons above are correct; (e) Don't know or not sure.]
Attitudes	"The degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior." (*Theory of Planned Behavior*) (Doll & Ajzen, 1992, p.755)	18-80 (5-80)	10	Higher score = More positive attitudes toward adopting FHH in future health education practice	How important is it to you that health educators add FHH assessments to their health education activities? [(a) Not important at all; (b) Not important; (c) Important; (d) Extremely important]
Intention	A motivational construct, which is a proximal measure of (future) behavior (*Theory of Planned Behavior*) (Ajzen, 1991; Sharma & Romas, 2012)	24-32(4-32)	8	Higher score = Higher likelihood of adopting FHH into future health education practice	How likely are you to incorporate FHH assessments in your future practice? [(a) Not likely at all; (b) Not likely; (c) Somewhat likely; (d) Extremely likely]
Self-Efficacy	"Beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations (*Social Cognitive Theory*)" (Bandura, 1995, p. 2)	45-80 (0-80)	8	Higher score = Greater confidence in applying FHH in future health education practice	How confident are you that you can encourage your future clients to consult relevant health care providers about their FHH? [0 (I am not confident at all) – 10 (I am 100% confident)]

genetics, genomics or FHH. The post-course survey questions included additional items regarding students' feedback and suggestions on the course content and delivery.

Data Collection

The online genomics course, along with both pre-course and post-course surveys and recruitment materials, were pilot tested with six junior and senior students in the health education program for its content, user experience, and technological difficulties. Three changes were made based on the pilot testing results: (1) The completion time of the course was revised; (2) FHH training certificate was added as an incentive; and (3) more participant recruitment strategies were included. There were significant improvements in the post-course scores compared to the pre-course scores for knowledge ($p < 0.02$), attitudes ($p < 0.01$), self-efficacy ($p < 0.01$), and intention ($p < 0.02$).

In the formal testing, three strategies were used to recruit potential participants. First, five bulk participant recruitment emails through the university were sent to all junior and senior students in the health education program. In the email, we explained the study background, aims, procedures, duration, and incentives ($25 gift cards and FHH training certificate). Second, we posted recruitment messages on the health education students' Facebook group pages. Third, several health education instructors announced our study opportunity to their students during classes. All potential participants were initially given two weeks to complete the genomics course. If they did not complete their course within two weeks, two reminder emails were sent, and an additional two weeks were given for completion.

A total of 107 students registered for the online genomics course. Seventy-two students completed the pre-course and post-course surveys and the entire course. Three students did not meet our eligibility criteria because one student had already graduated, and two did not major in

health education. Thus, the final sample consisted of 69 junior and senior students enrolled in the health education major.

Statistical Analysis

Utilizing SPSS 24.0, descriptive analyses were conducted to examine the frequency distributions of all collected variables, and the internal consistencies of attitudes, self-efficacy, and intention were assessed using Cronbach's alpha. With the assistance of Mplus 7.0, the construct validities of attitudes, self-efficacy, and intention were evaluated by the confirmatory factor analysis. The internal consistencies and construct validities of attitudes, self-efficacy, and intention were psychometrically sound. Furthermore, using Mplus 7.0, the differences in pre-course and post-course survey data were examined with paired t-tests and maximum likelihood estimation method. The significance level for this study's analyses was set at 0.05. The open-ended questions in the post-course survey were analyzed by the content analysis.

Results

Sample Characteristics

As shown in Table 3.2, among 69 students in our final study sample, the average age was 20.8 years (SD= 1.8). Most were females (n=61; 88.4%) while 11.6% were males (n=8). Slightly more than half of the participants belonged to racial/ethnic minorities, including Hispanics/Latinos (n=21; 30.4%), African Americans (n=7; 10.1%), Asian/Pacific Islanders (n=7; 10.1%) and multi-races (n=2; 2.9%). Additionally, 56.5% of the students were seniors (n=39) and 43.5% were juniors (n=30). The majority of participants had taken neither a genetics course (n=55; 79.7 %) nor a course related to FHH (n=68; 98.6%). None of them had studied a genomics course.

Table 3.2 Demographic Characteristics of Participating Students in our Study (N=69)

Variable	*N*	*Mean*
Gender		
Male	8	11.6%
Female	61	88.4%
Race/ethnicity		
White/Caucasian	32	46.4%
Hispanic/Latino	21	30.4%
Black/African American	7	10.1%
Asian/Pacific Islander	7	10.1%
Multi-races	2	2.9%
Degree classification		
Junior	30	43.5%
Senior	39	56.5%
Had taken course related to genetics		
Yes	14	20.3%
No	55	79.7%
Had taken course related to genomics		
Yes	0	0.0%
No	69	100.0%
Had taken course related to FHH		
Yes	1	1.4%
No	68	98.6%
	Mean	*S.D.*
Age	20.8	1.8

Note: N: Number; S.D.: Standard Deviation

Level 1 of the KEM: Findings

As shown in Table 3.3, participating students were overall satisfied with the online course in terms of the enjoyment (91.3%), organization (100%), difficulty level (97.1%), order of the concepts (100%), timeliness of the topic (95.7%), and assistance in understanding of FHH assessment (100%). One student in particular wrote the comment: "*This training was awesome. It reinforced my desire to attend graduate school for Public Health Education!*". Similarly,

another student commented on the course by stating "*I enjoyed this training a lot and learned a lot! thank you*!"

Students' willingness to learn FHH and/or genomics (98.6%) in the future was high. The top five topics that they were most interested were: (1) application of FHH in practice (2) FHH in genetic risk assessments, (3) the role of FHH in disease prevention (4) FHH considerations in marriage and dating, and (5) collaborations with professionals in other disciplines to implement FHH. Furthermore, 95.7% of students in this study would recommend the course to their peers. Most also believed that other health education students would be interested in taking the online course (95.7%) due to the foreseen benefits in future career, a short course duration and attractive incentives. The qualitative data in the post-course survey revealed that students particularly liked the following top five aspects in the genomics course: (1) videos embedded in the course ("*The video tutorials really helped me work through exactly what was needed to correctly preform the tasks needed for the future*"), (2) organization of the course ("*Content was very well detailed and organized!"*), (3) the interactive presentation style ("*I enjoyed the interactive parts of the training, specifically learning*

Table 3.3 Participating Students' Evaluation of the Online Genomics Course

Variable	*N*	*Mean*
Enjoyability ("How enjoyable, would you say, was your experience learning about FHH through the course?")		
Extremely not enjoyable	1	1.4%
Not enjoyable	5	7.2%
Enjoyable	47	68.1%
Extremely enjoyable	16	23.2%
Course organization ("How would you rate the organization of the course?")		
The training was very poorly organized	0	0.0%
The training was not as well-organized as it could have been	0	0.0%
The training was somewhat organized	8	11.6%

Table 3.3
Continued

Variable	*N*	*Mean*
The training was very well organized	61	88.4%
Difficulty level ("How appropriate was the level [degree of difficulty of the materials] of the course for you?")		
Not appropriate	0	0.0%
Somewhat appropriate	2	2.9%
Appropriate	33	47.8%
Extremely appropriate	34	49.3%
Order of concepts ("Think of the order in which the main concepts were presented at the course. How would you rate the ordering of the concepts?")		
The concepts were very poorly ordered	0	0.0%
The concepts were not as well-ordered as they could have been	0	0.0%
The concepts were somewhat in order	7	10.1%
The concepts were very well ordered	62	89.9%
Timeliness in current public health and health education practice ("The course was timely in terms of current public health and health education practice")		
Strongly disagree	0	0.0%
Disagree	0	0.0%
Neutral	3	4.3%
Agree	17	24.6%
Strongly agree	49	71.0%
Assistance in understanding FHH assessments ("How well did the course assist you in understanding how to use FHH assessments in health education?")		
Not well at all	0	0.0%
Not well	0	0.0%
Well	26	37.7%
Very well	43	62.3%
Willingness of future learning ("After taking this course, how willing are you to learn more about FHH and/or genomics in the near future?")		
Not willing at all	0	0.00%
Not willing	1	1.4%
Willing	27	39.1%
Very willing	41	59.4%
Recommendation to peers ("How likely are you to recommend the course to your colleagues or friends?")		
Not likely at all	0	0.00%
Not likely	3	4.3%
Likely	29	42.0%
Very likely	37	53.6%

Table 3.3
Continued

Variable	*N*	*Mean*
Beliefs about other students' willingness to take the online course ("In your opinion, how willing would other health education students be to take the course?")		
Not willing at all	0	0.00%
Not willing	3	4.3%
Willing	46	66.7%
Very willing	20	29.0%

Note: N: Number

about the My Family Health Portrait tool and the research articles"), (4) literature and resources ("*Lifestyle Recommendation Table- if people don't learn anything else from the training, it is great to have this table on hand to know when to get tested and how to prevent various diseases*"), and (5) duration of the course ("*I liked how the modules were short and to the point*").

Nevertheless, some participants raised suggestions that could help improve the online genomics course in the future. The top five suggestions included: (1) Adding more interactive activities ("*Overall I thought it was great...maybe more interactive stuff*"), (2) alternating speakers in different modules ("*Maybe have different people read the slide*s"), (3) having a quiz at the end of each module ("*Quizzes after every module would be cool. Help the reader stay on track and feel refreshed after reading so much information*"), (4) adding audiovisual support for references and resources ("*I would suggest going through the different articles through the audio since some people learn best when listening to the material rather than just reading it."*), and (5) being able to download the module presentation slides ("*It would be very convenient if the slide for the PowerPoint were able to be downloaded in order to study them*").

In terms of the learning objectives of the online genomics course, all modules on average had received a high satisfaction score from students (an average rate = 93.6% for strong

satisfaction and satisfaction). The module that received the highest score was Module 1.1, for which all students (100%) either agreed or strongly agreed that this learning objective ("*define the term "FHH" as the term is currently used in health promotion")* was met. Module 4.4 received the second highest rating with 98.2% participants who either agreed or strongly agreed that they would be able to encourage clients to edit and/or add information to their FHH and consult relevant healthcare providers about their FHH. Only two modules had less than a 90% satisfaction rate from participants: Module 3.2 – an 83.2% satisfaction rate (learning objective: "*describe what has been done so far in health education related to genomics and FHH and identify some of the resources available for (and developed by) health educators"*) and Module 3.1 – an 89.1% satisfaction rate (learning objective: "*distinguish how genetic counselors and health educators differ in terms of the skills and approaches they use when incorporating FHH assessments in their practice"*).

Level 2 of the KEM: Findings (Table 3.4)

Knowledge of FHH

The average knowledge score at the post-course survey ($Mean_{Post}$=11.4; SD=2.0), which was equal to a 76.0 (a "C" in an academic setting), was significantly higher than the pre-course knowledge mean score, which was equal to a 46.0 (an "F" in an academic setting) ($Mean_{Pre}$=6.9; SD=2.7). Specifically, after taking the genomics course, over 90% of students correctly answered the questions pertaining to the uses of FHH for health promotion (97.1%), the history of using FHH in the health field (94.2%), the interpretation of FHH for a cancer risk (91.3%), and the inclusion of genetics in the PRECEDE-PROCEED model (91.3%). Nevertheless, after the completion of the course, only a small percentage of students correctly answered the questions

regarding the differences between health educators and genetic counselors (15.9%), and the definition of FHH (37.7%).

Table 3.4. Comparison of Pre-Course and Post-Course Mean Scores for Knowledge, Attitudes, Self-Efficacy, and Intention Among Participating Students

Measured Variable	*N*	*Pretest*		*Posttest*		*P value*
		Mean	*S.D.*	*Mean*	*S.D.*	
Knowledge	69	6.9	2.7	11.40	2.0	<0.001
Attitudes	69	59.9	12.0	69.5	14.8	<0.001
Self-Efficacy	69	49.8	16.5	71.8	8.3	<0.001
Intention	69	26.9	3.1	30.2	2.0	<0.001

Attitudes

Students' mean attitudes scores improved significantly after completion of the genomics course. The mean attitudes score in the pre-course survey was 59.9 (SD=12.0), while the mean score in post-course survey was 69.5 (SD =14.8). The highest change from pre-course to post-course was regarding "health educators can help meet public's demand for information about genetic testing", which was presented to explain its complement use with FHH ($Mean_{Pre}$=10.5; SD_{Pre}=3.3; $Mean_{Post}$=13.1; SD_{Post} =3.5; $p < 0.001$). Yet, the lowest changes were related to two questions: (1) "health educators should collect FHH information of their clients, communities, and/or the people they serve" ($Mean_{Pre}$=12.8; SD_{Pre}=3.3; $Mean_{Post}$=13.9; SD_{Post} =3.3; $p < 0.05$), and (2) "health educators should make appropriate behavioral or lifestyle recommendations to clients based on their FHH" ($Mean_{Pre}$=13.5; SD_{Pre}=3.0; $Mean_{Post}$=14.6; SD_{Post} =3.2; $p < 0.05$).

Self-efficacy

After finishing the genomics course, students' self-efficacy scores showed a significant and positive improvement from the pre-course mean score ($Mean_{Pre}$=49.8; SD_{Pre}=16.5) to the post-course mean score ($Mean_{Post}$=71.8; SD_{Post} =8.3; $p < 0.001$). The individual item that exhibited the highest mean change was students' confidence to "assist future client to draw a FHH using the U.S. Surgeon General's 'My Family Health Portrait' tool" ($Mean_{Pre}$=4.3; SD_{Pre}=3.3; $Mean_{Post}$=9.1; SD_{Post} =1.3; $p < 0.001$). The self-efficacy item that showed the lowest change was associated with students' likelihood to "begin using FHH assessments in your first job after you graduate" ($Mean_{Pre}$=6.5; SD_{Pre}=2.7; $Mean_{Post}$=8.6; SD_{Post} =1.7; $p < 0.001$).

Intention

The average pre-course intention score was 26.9 (SD=3.1) and average post-course score was 30.2 (SD=2.0). Students' mean score of the intention scale increased significantly from pre-course to post-course ($p < 0.001$). The individual intention item that indicated the highest improvement was the students' likelihood to "assist future client to draw FHH using the U.S. Surgeon General's 'My Family Health Portrait' tool" ($Mean_{Pre}$=2.9; SD_{Pre}=0.7; $Mean_{Post}$=3.7; SD_{Post} =0.5; $p < 0.001$). The question that showed the least change was the likelihood to begin using FHH assessments at student participants' first job once graduated ($Mean_{Pre}$=3.4; SD_{Pre}=0.5; $Mean_{Post}$=3.6; SD_{Post} =0.6; $p < 0.001$).

Discussion

PHG is a relatively new and emerging field in public health. Training health education students in PHG at an early stage of their career can help establish their genetic/genomic

competencies. After graduating, students can apply what they have learned into practice, become a multidisciplinary team member in genomics, meet the public's needs for genetics education and services, and close the gap between the healthcare system and underserved communities (Chen & Goodson, 2007b). Nevertheless, until now, there is a dearth of PHG education programs for health education students (Talwar et al., 2018). To the best of our knowledge, this is the first study which provides genomics training for health education students. The study has two aims. The first aim is to report the feasibility of revising the existing online genomics training for health educators who hold CHES® or MCHES® designations to undergraduate health education students. The second aim is to use the KEM to present evaluation outcomes among the 69 junior and senior students in the health education program.

According to the findings of Level 1 of the KEM, overall, participating students were satisfied with the genomics course. Nearly all modules' learning objectives were achieved and rated highly by students. Students were especially in favor of the videos embedded in the course, the literature and resources, and the organization, duration, and the interactive presentation style of the course. Yet, our qualitative data findings suggested that some students would prefer the addition of more interactive activities, audiovisual supports for resources, quiz at the end of each module, the alternation of speakers in different modules, and the capacity of downloading presentation slides for future reference. Accordingly, future revisions of the genomics course may be needed to improve the quality of the training.

Based on Level 2 of the KEM, after the completion of the genomics course, students demonstrated significant and positive improvements in attitudes, intention, and self-efficacy in adopting FHH in future health education practice. Interestingly, the question of using FHH assessments in the first job after graduation had the lowest enhancement in both self-efficacy and

intention. A potential explanation was that although participants overall might have the confidence and desire to adopt FHH in their future practice, they were unsure if this would happen in their first job. Revising this question, such as changing the wording of "first" job to "future" job might be better in capturing participants' intention and self-efficacy.

Furthermore, while there was a significant improvement in our students' mean knowledge score after taking the course (from an "F" to a "C"), it is worthy to notice that the post-course average knowledge score was not as high as we desired. This could be that the knowledge questions were adopted from our previous FHH training for health educators who hold CHES® or Master CHES MCHES® designations (63.8% of them also had a master's degree (Chen et al., 2013)). Therefore, despite using similar knowledge questions that might have addressed the fidelity issue for the purpose of program evaluation, those questions might have been challenging for undergraduate students in this study. Future training may be needed to simplify the knowledge questions and/or change the format of the question (e.g., reducing the number of choices for multiple-choice questions or making all questions as a true and false format.)

Notably, along with Levels 1 and 2, the KEM has two additional levels. Level 3 is associated with trainees' behavioral changes, such as incorporating genomic competencies into professional duties. Level 4 assesses the impacts at the organization level and clients' health behavior. Given that our study sample was undergraduate health education students who were not health educators as practitioners, it was a challenge to measure the effects of Levels 3 and 4 of the KEM. A previous study conducted by Grebs et al., (Greb et al., 2009) however, reported that two years after taking a required medical genetics course, only 12% of the medical students

passed the genetics section on their clinical examination. As such, follow-up surveys distributed to our sample may be needed to examine the long-term effect of the genomics course.

This study has two limitations. First, our study was carried out in the end of spring semester and the beginning of the summer semester. The competing timing with examinations in spring and unavailability at school in the summer might have contributed to a smaller sample size than we anticipated. Nonetheless, for the sample size calculation, using $\alpha=0.05$, power $=0.9$, a medium effect size of 0.5 defined by Cohen (Cohen, 2013; Rice & Harris, 2005), a minimal sample size of 55 participants completing both pre- and post-course surveys was required. Thus, our sample size of 69 had a sufficient power to detect the differences between pre- and post-course scores. Second, participants' baseline mean scores for attitudes, intention, and self-efficacy were high, suggesting a potential sample bias. According to the Rogers' Diffusion of Innovations theory (Rogers, 2010), there are five types of adopters when facing an innovation (i.e., FHH/genomics) - innovators, early adopters, early majority, late majority and laggards. As this is the first genomics course for health education students, our study might have attracted those innovators and early adopters who were interested in adopting FHH into their future career practice. Due to the importance of establishing genomic competencies for all health education students, it remains essential to attract other types of adopters. Making PHG a required course and offering several elective courses related to PHG, for instance, may help train health education students regardless of their adopter statuses.

Despite the above limitations, our study postulated several strengths. First, this study is the first to offer genomics training for undergraduate health education students. According to the Department of Labor (Bureau of Labor Statistics, 2019), the health education workforce is projected to grow by 14% in the next decade. Given that health education students are future

health educators, our study serves as an initiative to build up a prospective growing genomically competent health education workforce. Second, our genomics course was based on several theoretical constructs. Past studies (Glanz, Rimer, & Viswanath, 2008; Goodson, 2010) indicate that theoretically grounded education is more likely to produce successful outcomes than those that do not have such component. Third, our course was web-based, which not only allowed students to take the course at their own pace anywhere, but was also easily disseminated to health education programs at other universities. Lastly, 53.6% of our participating students were racial/ethnic minorities. Racial/ethnic minority communities often face challenges in FHH collection (Beene-Harris, Wang, & Bach, 2007; Chen, Li, Talwar, Xu, & Zhao, 2016; Goergen et al., 2016; Kaphingst, Lachance, Gepp, D'Anna, & Rios-Ellis, 2011; Thompson et al., 2015). Students trained through our course may be able to provide health education services and advocate for their communities.

In conclusion, to develop a genomically competent public health workforce, training health education students – future health educators – is important. Adapted from an existing Web-based genomics training for health educators, we developed and evaluated the first theoretically grounded genomics course focusing on FHH to undergraduate health education students at a research-intensive university. Our study addresses the shortage of genomics curricula for public health students. Based on the outcomes of Levels 1 and 2 of the KEM, participating students (over half were racial/ethnic minorities) were overall satisfied with the course. After completing our course, students also showed significant and positive improvements in FHH knowledge as well as attitudes, self-efficacy, and intention in adopting FHH into their future practice. Thus, offering our genomics course to more undergraduate health education

students and incorporating it as part of the curricula in the health education programs at various universities in the future are recommended.

CHAPTER IV

CONCLUSION

Genomics is a unique and emerging discipline, which focuses on the interactions between genetics and environmental factors leading to clinical and public health implications (Chen et al., 2008; Khoury, 2014; National Human Genome Research Institute, 2012). Even though the rapid pace in genomics has led to translation of genomic discoveries to public health, there is still a significant gap to train public health students (Talwar et al., 2018). The overall purposes of this dissertation are to (1) evaluate existing genomic education programs available for health professional students and (2) evaluate an online Web-based course focusing on FHH among junior and senior health education undergraduate students at Texas A&M University.

In Chapter II, results from this systematic review study provided information on the numbers, findings, and quality of existing genomic education curricula for health professional students. Specifically, 41 programs exist in providing genomics trainings to health professional students. The majority were conducted in the U.S. and offered to pharmacy and medical students (the number of students ranged from 10-2,674). Although, overall results were generally positive, 68.3% of the genomics curricula were not theory-based, and most studies did report follow-up data (85.4%). The mean of the methodological quality score for all reviewed studies was 4.51, which was slightly higher the theoretical mean (4.0).

In chapter III, following the completion of Web-based FHH training, 69 undergraduate junior and senior health education students at Texas A&M University increased FHH knowledge. Further, participants reported positive attitudes and intention in adopting FHH in future health education practice, and confidence in applying FHH in future health education practice. Most participants (95.5%) believed that the training was timely in terms of current

public health education practice. All participants agreed/strongly agreed that the training assisted them to understand how to use FHH assessments.

Recommendations

At present, genetics and genomics play an important role in everyday life of general public. To meet these growing needs, National Human Genome Research Institute (NHGRI) has launched Genomic Literacy, education and engagement (GLEE) initiative for students up to K16 to enhance their genomic knowledge (National Human Genome Research Institute, 2017). One of the key goals of this groups is to "*Promote the* ***role of genomics education in workforce development by informing students, educators****, and other relevant personnel* ***how genomics integrates into future jobs and careers****, including and beyond research and medical careers*."(National Human Genome Research Institute, 2017, p. 2), In order to reach this vision, it requires increased collaborations between instructors and college students.

There are few implications and recommendations based on the findings of this dissertation:

First, based on the findings of Chapter II, it is essential to training more health education students in the future to assist genetic service providers with increasing genetic/genomics demands. There are two important reasons. First, health education workforce is projected to grow 14% increase in next decade (Bureau of Labor Statistics, 2019), however, there are limited genomics education initiatives to help with growing genomic literacy needs (Talwar et al., 2018). Second, there are only 1,600 clinical geneticists (American Board of Medical Genetics and Genomics, 2017a) and 2,720 genetic counselors (Bureau of Labor Statistics, 2016) (most of them employed at large healthcare systems) to provide the genomic-related services for the US population of 313.9 million. Failure to train more health education students may result in the

underutilization and reduced provision of genetic services and education (Cragun et al., 2016). Due to the success of the Chapter III study, health education workforce can support the development of a genomically competent healthcare workforce along with sharing the responsibility for providing adequate genetic service delivery. This recommendation is an echo of a previous study which stated that integrating genomic science in the health field successfully is not only dependent on research discoveries but also on developing educational paradigms and practices (Plunkett-Rondeau, Hyland, & Dasgupta, 2015).

Second, even though the majority of the studies reported positive knowledge, attitudes, and behavioral outcomes after their genomics training, students did not always retain those outcomes during the study follow-up period. Moreover, in Chapter II, only six studies reported follow-up data after their curriculum/training was delivered. Therefore, future studies should assess students' performance at six months and one year after the training.

Third, Chapter II study showed that only less than one-third of the 41 included studies had theoretical basis. This finding was also supported in a systematic review assessing genomics education programs for non-genetic healthcare professionals; theoretical constructs underlying the genomics education training/program/curricula were also assessed (Talwar et al., 2016). Yet, underlying theoretical basis is important for genomics/genetics education. According to the *Theory in Health Promotion Research and Practice*,(Goodson, 2010) incorporating theoretical thinking is a professional responsibility – being able to identify factors that can influence healthcare outcomes. Thinking theoretically in genomics would firmly instill continual questioning of the status quo and aid self-reflection on genomics/genetics practices among healthcare professionals. Thus, future genomics training studies should have theoretical basis.

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APPENDIX A

CHARACTERISTICS OF GENOMICS EDUCATION PROGRAMS FOR HEALTH PROFESSIONAL STUDENTS

Citation Number	Authors (Location)	Target Students	Theoretical Basis of the Curriculum & Main Content	Education Approaches	Curriculum Length	Evaluation Design[a]	Evaluation Tools	Data Analysis[a]	Main Evaluation Findings[b]	MQS
19	Moore and Barnett, 1992 (United States)	164 medical students (158 completed course evaluations)	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, Mendelian/genetic disorders, genomic disorders, and molecular genetics	Computer tutorial in second year and in-class lectures, problem-based group discussions with case scenarios and legal cases in fourth year	Second-year course: 6-12 hours of computer tutorial Fourth-year course: 4-hour lectures, 16 hours (4 sets of 4 hours each) for students divided into 6 groups	Cross-sectional	Tutorial evaluation for second year students and course evaluation for fourth year students	Univariate statistics	Knowledge: Fourth-year students reported increased knowledge in solving genetic problems and communicating genetic risks after the course. Course feedback: The computer tutorial received positive ratings from the second year students, although a few students reported technical difficulties with the tutorial. Furthermore, fourth-year students gave positive feedback on the course structure and perceived course content to be useful.	5/8
20	Teague et al., 1996 (United States)	173 medical students (62 completed pre-test survey, and 100 completed post-test survey)	Theoretical basis: Not reported Content: genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, and genomic disorders	In-class group discussions with 4 case scenarios	Total of 2 hours	Pre- and post-test design	Pre- and post-test questionnaires and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students reported a significant increase in genetic knowledge after completion of the course. Attitudes: Students with affected first-degree relatives were significantly more likely to support genetic testing. Students with higher knowledge scores were significantly more likely to (a) support laws that protect individuals with genetic disease predisposition and (b) inquire to find out if they are at risk for cancer based on their genes. Students with higher total knowledge score were significantly more likely to believe that genetic testing is associated with psychological impacts and believed that they reserve the right not to undertake cancer genetic testing. Course feedback: Students rated the course positively and found it helpful.	4/8

21	Miedzybrodzka et al., 2001 (United Kingdom)	48 medical students: Intervention group (n=16) and control group (n=32)	Theoretical basis: Not reported Content: Genetic risk assessment, genetic counseling, and genomic disorders	Intervention group received Computer Assisted Learning (CAL) training. The control group received a 20-minute mini-lecture on breast cancer genetics	Intervention group: 16.4 minutes on average Control group: 20 minutes on average	Randomized control trial	Written assessment using questions with Likert-type scales, multiple-choice questions, essays, and course evaluation	Inferential statistics *without* controlling for covariates	Course feedback: 75% of the students in intervention group found the course enjoyable/very enjoyable compared to the 50% in the control group.	2/8
22	Magee et al., 2001 (United States)	120 first-year medical students	Theoretical basis: Not reported Content: Basic genetics, genomic Internet databases, and bioinformatics	In-class lecture (equipped for computer and Web access). Problem-based learning module, with 2 case studies and handouts about National Center for Biotechnology Information (NCBI) databases	Total of 1 hour	Cross-sectional	Genetics-based problem sets and course evaluation	Univariate statistics	Knowledge: Students demonstrated proficient knowledge after the course and correctly solved the assigned genetics-based problem sets. Course feedback: Students reported positive feedback for the learning method and experience.	3/8
23	Cragun et al., 2005 (United States)	108 students; the 75 participants who completed the pre- and post-test surveys included nursing (n=57) and dietetics students (n=18)	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, genetic counseling, and genomic disorders	Web-based tutorial and an in-class lectures with case-based scenarios	In-class lecture: 1 hour Web-based tutorial: not reported	Pre- and post-test design	Pre- and post-test questionnaires and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' knowledge scores significantly increased after completing the course. Self-efficacy: Students' confidence in practicing genetics significantly increased after the course. Course feedback: Students rated the course positively.	3/8
24	Brazeau and Brazeau, 2006 (United States)	526 doctorate of pharmacy students and pharmaceutical science students who attended the course during the semesters from 2002 to 2005	Theoretical basis: Not reported Content: Basic genetics, ethical, legal, and social implications (ELSI), genomic Internet databases, pharmacogenomics/ pharmacogenetics, genomic disorders, genomics tools and technology, and population genetics	12 weekly in-class lectures including guest seminars, class activities, and case studies	2-credit course with an 100-minute lecture per week	Cross-sectional	Examinations, research paper, in-class exercises, and course evaluation	Inferential statistics *without* controlling for covariates	Course feedback: Students' course evaluation ratings significantly increased from 2002 to 2005 in general.	6/8
25	McGovern et al., 2006 (United States)	199 medical students: Intervention group (n=136) and control group (n=63)	Theoretical basis: Not reported Content: Genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, and genomic disorders	Intervention group: 2-part standardized patient sessions for participants followed by group-based discussion at the end Control group: received orientation lecture only with no standardized patient sessions	Intervention group: 2-part sessions; the first session was 45 minutes, and the second session was 25 minutes Control group: Not reported	Quasi experimental with 6-month follow-up	Intervention group: (1) Rating of two standardized patient sessions using checklists by the standardized patient regarding student communication, (2) Rating of two standardized patient sessions by students, (3) Knowledge test after the first	Inferential statistics *without* controlling for covariates	Knowledge: Students in the intervention group showed significantly increased self-rated competency skills in drawing pedigree analysis, genetic risk assessment, and genetic risk communication from pre- to post-test. Self-efficacy: Comparing to the control group, students in the intervention group showed significantly higher (1) confidence in pedigree drawing, genetic risk assessment, and	6/8

							standardized patient session, and (4) Course evaluation Control group: Rating of orientation lecture For both groups: Pre- and post-test questionnaire regarding self-rated skills		genetic risk communication with patients; and (2) perceived usefulness of the program. Course feedback: Students in the intervention group reported gaining valuable experience.	
26	Waggoner and Martin, 2006 (United States)	324 medical students: 210 first-year students attended session 1 (100 completed the evaluation) 114 third-year students completed session 2 and evaluation (25 students completed follow-up survey)	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, genetic counseling, genomics Internet databases, and bioinformatics	Computer lab sessions. Students were given handouts and a short introductory tutorial. Session 1 included introduction to Internet databases Session 2 included multiple case-based scenarios	Not reported	Cross-sectional with a follow-up (follow-up only for session 2, and time of follow-up not specified)	Session 1: Course evaluation over a two-year period Session 2: (1) Course evaluation immediately after the session and (2) follow-up survey	Univariate statistics	Intention: Students in session 2: 96% strongly agreed/agreed that they would apply course information to their practice. Behavior: At the follow-up, 72% of the students, who completed the follow-up survey, reported the use of genomics Internet databases in their clinical practice. Course feedback: Session 1: Most students strongly agreed or agreed that this session should be included in curriculum and that session was clinically useful and helpful. Session 2: Most students strongly agreed or agreed that the session (including computer lab) was medically and clinically useful and that they would apply the information to their clinical practice.	4/8
27	Busstra et al., 2007 (The Netherlands)	22 students from nutrition and health programs as well as biotechnology programs completed first evaluation; 15 completed second evaluation	Theoretical basis: 4-component instructional design Content: Basic genetics, genomics Internet databases, genomic disorders, genomics tools and technology, and nutrigenomics	Web lecture consisting of 2 case studies supported by interactive multimedia and video visuals along with lab-based experiments	8 weeks for the entire course, and each case took 8-24 hours	Cross-sectional with 1-year follow-up	Examination, nutrigenomics experiment design, and course evaluation	Univariate statistics	Knowledge: Students' exam scores were satisfactory. However, the 1-year follow-up scores slightly dropped. Motivation: At 1-year follow-up, 58-75% of the students thought that the exercises and activities increased their motivation to study nutrigenomics. Course feedback: Students enjoyed the course and found it suitable. The course feedback results were still above average at 1-year follow-up.	6/8

28	LeLacheur et al., 2007 (United States)	30 physician assistant students (24 completed post-test survey)	Theoretical basis: Not reported Content: Genetic risk assessment, genetic counseling, Mendelian/genetic disorders, and genomic disorders	6 in-class lectures and standardized patient sessions	Not reported	Pre- and post-test design	Pre- and post-test questionnaires	Inferential statistics *without* controlling for covariates	Knowledge: There was a significant increase from pre- to post-test in genetic knowledge. Comfort level: Students significantly increased from pre- to post-test scores in comfort level in predicting children's chances of having particular genetic diseases.	1/8
29	Newcomb and Riddlesperger, 2007 (United States)	13 nursing students	Theoretical basis: Role play Content: Basic genetics, ethical, legal, and social implications (ELSI), Mendelian/genetic disorders, and business aspects of the genomics field	Students enacted genetics case study on a clinical day as part of improvisational theatre and games. Students were trained via readings and references before theatre session.	6-hour theatre session	Cross-sectional	Observation and course evaluation	Qualitative	Knowledge: Students applied knowledge in basic genetics, policies, and ethical concepts in practice during their enactment. Course feedback: Students gave positive comments to the class overall.	4/8
30	O'Brien et al., 2009 (United States)	40 students, who finished their basic science and pre-medicine prerequisite courses, enrolled in the 2-semester pharmacogenomics program	Theoretical basis: Bloom's Taxonomy of Learning Content: Basic genetics, ethical, legal, and social implications (ELSI), genome data analysis, and pharmacogenomics/ pharmacogenetics	In-class lectures with self-genotyping exercise. The program was divided into 2 classes over 2 semesters. Each class included group-based case studies and lectures. Class I (Introduction to Pharmacology and Toxicology) in the first semester focused on basic pharmacology. Class II (Genome-Based Medicine and Pharmacology) in the second semester focused on pharmacogenomics.	14 weeks per class	Cross-sectional	Class I/first semester: In-class examinations, drug-designing activity, formative assessment (self-reflection paragraph after each class), and course evaluation Class II/second semester: In-class examinations, papers based on self-genotyping exercise, and course evaluation	Univariate statistics	Knowledge: Students' average knowledge scores after the courses were 82.2 for Class I and 77.6 for Class II. Course feedback: Students reported positive course evaluations.	5/8
31	Greb et al., 2009 (United States)	212 medical students	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, Mendelian/genetic disorders, population genetics, and reproductive genetics	In-class case study group discussions, documentary, and four patient case panels focusing on cystic fibrosis	30 hours spread over 5 weeks	Cross-sectional with 2-year follow-up	Genetic exam at Year 1 and Observed structural clinical examination (OSCE) at Year 3	Univariate statistics	Knowledge: Students' average genetic exam score was 81% at Year 1. At 2-year follow-up, 88% students failed the genetics section of the Observed Structured Clinical Examination (OSCE) assessment.	6/8

32	Knoell et al., 2009 (United States)	115 doctorate of pharmacy students (110 students completed evaluation survey)	Theoretical basis: Not reported Content: Genetic counseling, pharmacogenomics/ pharmacogenetics, genomic disorders, and genome data analysis	In-class lecture, simulated genetic counseling discussion based on self-genotyping results	Two 1.5-hour lectures per week for a semester, and 5 hours for lab analysis	Cross-sectional	Genotyping exercise survey, open-ended questions, and course evaluation	Univariate statistics	Knowledge: Students reported a better understanding of the pharmacogenomics concepts after the course. Attitudes: 54.6% students strongly agreed/agreed that pharmacogenomics would impact their career. Course feedback: The feedback was overall positive, and most students reported the genotyping exercise to be helpful.	5/8
33	Krynetskiy and Calligaro, 2009 (United States)	144 doctorate of pharmacy students (108 completed evaluation survey)	Theoretical basis: Not reported Content: Basic genetics, ethical, legal, and social implications (ELSI), genomics Internet databases, pharmacogenomics/ pharmacogenetics, and genome data analysis	Laboratory exercise, in-class exercise, deoxyribonucleic acid (DNA) extraction, and self-genotyping exercise	Two 3-hour laboratory sessions, each accompanied with 30-minute presentations and two 1-hour discussion sessions spread over a semester	Cross-sectional	Laboratory report, survey, and course evaluation	Univariate statistics	Knowledge: Students reported increased knowledge after completing the labs. Motivation: Students expressed further interest in learning about pharmacogenomics. Course feedback: 74% of the students strongly agreed/agreed that the laboratory sessions were useful, and 96% strongly agreed/agreed that the topics were integrated well with the lectures.	5/8
34	Metcalf et al., 2010 (United States)	596 medical students completed at least one of the five web-based genetics modules	Theoretical basis: Adult Learning Theory, Social Learning Theory, and Cognitive Theory Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genomic disorders, reproductive genetics, and pediatric genetics	5 web-based genetics modules, case studies, video vignettes, and interactive resources	1 hour per module	Pre- and post-test design	Pre- and post-test questionnaires and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' knowledge scores significantly increased from pre- to post-test. Attitudes: There was a significant increase in attitudes scores from pre- to post-test. Self-efficacy: Self-efficacy scores among students significantly increased from pre- to post-test. Intention: Students showed a significant improvement in intended behavior scores from pre- to post-test. Course feedback: Students rated the program highly, particularly in the learning experience and its usefulness.	6/8

35	Ludwig et al., 2010 (United States)	39 health information management students (32 completed post-test survey)	Theoretical basis: Not reported Content: Basic genetics, ethical, legal, and social implications (ELSI), genomics Internet databases, genome data analysis, and genomics tools and technology	A general introduction to genomics, 2 computer lab sessions, and 2 in-class lectures in a semester	1.5 hour for the general introduction, 2 hours per lecture, and 2 hours per lab session	Pre- and post-test design	Pre- and post-test questionnaires, class exam, and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' knowledge scores significantly increased from pre- to post-test. Course feedback: The majority of the students enjoyed the course.	4/8
11	Bean et al., 2011 (United States)	140 medical students, and a random sample of 25 evaluated each session	Theoretical basis: Flipped classroom approach Content: Basic genetic, genetic risk assessment, genetic counseling, Mendelian/genetic disorders, and genomics tools and technology	In-class lectures, a workshop, 2 virtual laboratory discussion sessions on case studies and learning resources	2 hours and 2 cases per laboratory session (durations for lectures and workshop not reported)	Cross-sectional	Course evaluation	Univariate statistics	Course feedback: 92% strongly agreed/agreed that the virtual laboratory sessions were educational; 94% of the students strongly agreed/agreed that the materials were useful for genetics education; and students reported that the format was effective.	6/8
36	Springer et al., 2011 (United States)	47 doctorate of pharmacy students completed pre-test survey, and 45 completed post-test survey	Theoretical basis: Not reported Content: Basic genetic, ethical, legal, and social implications (ELSI), pharmacogenomics/ pharmacogenetics, genomic disorders, genomics tools and technology, and business aspects of the genomics field	8 in-class lectures with discussions spread over 10 weeks (1 lecture included a computer lab session with the GeneScription software for training students in determining drug dosage based on pharmacogenomic data)	2 hours per lecture for 10 weeks	Pre- and post-test design	Pharmacogenomics paper and pre- and post-test questionnaires	Inferential statistics *without* controlling for covariates	Knowledge: Students' understanding of how to perform deoxyribonucleic acid (DNA) analysis significantly increased. Attitudes: Students' attitudes significantly improved in regards to pharmacogenomics sampling, procedure, and data management.	4/8
37	Zhou et al., 2013 (United States)	Health information management students: 52 participated in the 2-session course module (32 completed the evaluation) 76 participated in the 4-session course module (38 completed the evaluation) 16 participated in the stand-alone computational genomics course (all completed the evaluation) The students in the 90-minute tutorial were not reported	Theoretical basis: Not reported Content: Basic genetics, genomics Internet databases, genome data analysis, and genomics tools and technology	4 different educations: 2-session course module was incorporated into a health data management and analysis course and comprised of 1 lecture and 1 lab session. 4-session course module was incorporated into a health information quality management course and comprised of 2 lectures and 2 labs. Stand-alone course was a computational genomics course that lasted a full semester and comprised of 10 lectures and 4 labs. 90-minute tutorial on the importance of	2-session course module: 2 hours per lecture and lab (total of 4 hours) 4-session course module: 2 hours per lecture and lab (total of 8 hours) Stand-alone computational genomics course: total of 42 hours (durations for each lecture/lab were not specified) Tutorial: 1.5 hour (90 minutes)	Pre- and post-test design was used for the 2-session course module and stand-alone computational genomics course	2-session course module: Pre- and post-test questionnaires and exam 4-session course module: Background survey prior to course and research project Stand-alone computational genomics course: Pre- and post-test questionnaires, research project, and course evaluation 90-minute tutorial: No evaluation	Univariate statistics	Knowledge: For the 2-session course module, students showed an improvement in knowledge as indicated by the completeness of their answers between pre- and post-test surveys. For the 4-session course module, students were able to use the online genomics tools and databases after the course, and 86.8% completed or partially completed their projects. For the stand-alone computational genomic course, all students completed their research projects. Course feedback: Students in the stand-alone computational genomic course reported that the research projects made them active learners.	5/8

				genomics was presented in a health information clinical education course.						
38	Goodson et al., 2013 (United States)	12 graduate health education students (10 completed post-test survey, and 7 completed 3-month follow-up survey)	Theoretical basis: Social Cognitive Theory, Theory of Planned Behavior, and Diffusion of Innovations Content: Basic genetics, genetic risk assessment, and ethical, legal, and social implications (ELSI)	3-hour presentation in a class	Total of 3 hours	Pre- and post-test design with 3-month follow-up	Pre- and post-test questionnaires and 3-month follow-up survey with presentation evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' genetic knowledge scores significantly increased from pre- to post-test and to 3-month follow-up. Attitudes: Students showed a significant increase in attitudes scores from pre- to post-test and to 3-month follow-up. Self-efficacy: Students' self-efficacy scores significantly improved from pre- to post-test. Intention: Significant increases in students' intention to practice genomics were found from pre- to post-test. Course feedback: Students found the presentation to be new and cutting-edge.	5/8
39	Nickola and Munson, 2014 (United States)	310 doctorate of pharmacy students	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genomics Internet databases, genome data analysis, pharmacogenomics/ pharmacogenetics, and business aspects of the genomics field,	4 in-class lecture modules and self-genotyping exercise	Not reported	Pre- and post-test design	Pre- and post-test for genomics knowledge, research paper, journal exercise, and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' knowledge scores significantly increased from pre- to post-test. Course feedback: Students gave positive feedback regarding what they learned in the course and through the process of working on their research papers.	3/8
40	Diehl et al., 2015 (United States)	120 medical students (80 completed post-test survey)	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, genomics Internet database (Online Mendelian Inheritance in Man [OMIM]), and Mendelian/genetic disorders	In-class lectures, take-home modules, three clinical vignettes, and one optional clinical vignette	Not reported	Pre- and post-test design	Pre- and post-test questionnaires and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: From pre- to post-test, students significantly increased in knowledge of using the Online Mendelian Inheritance in Man (OMIM) database as a first source for genetic materials. Attitudes: From pre- to post-test, students significantly increased in perceived importance of the use of the Online Mendelian Inheritance in Man (OMIM) database for medical students.	2/8

									Self-efficacy: From pre- to post-test, students' confidence significantly increased in regards to clinical genetic concepts and use of the Online Mendelian Inheritance in Man (OMIM) database. Course feedback: Students were significantly more satisfied with the education on the use of medical databases after the course.	
41	Munson and Pierce, 2015 (United States)	319 doctorate of pharmacy students: Intervention group in 2014 (n=113; 89 completed post-test survey) and control groups (n=206; n=81 in 2012 and n=125 in 2013)	Theoretical basis: Shulman's concept of pedagogical content knowledge; flipped classroom approach Content: Basic genetics, genetic risk assessment, and pharmacogenomics/ pharmacogenetics	Both flipped and traditional sessions were integrated into a 3-credit, 8-week course. Flipped session in 2014 (intervention group): 6 pre-recorded mini-lectures, hands-on activities/practices, and active discussions Traditional sessions in 2012 and 2013 (control groups): 2 live lectures	Flipped session (intervention group): total of 2 hours for the 6 mini-lectures Traditional sessions (control groups): total of 2 hours for the 2 live lectures	Quasi-experimental	Flipped session (intervention group): Pre- and post-test questionnaires and examination Traditional sessions (control groups): Examination	Inferential statistics *without* controlling for covariates	Knowledge: Significant increase in knowledge from pre- to post-test was shown in flipped intervention group.	7/8
42	Lee et al., 2015 (United States)	2,674 doctorate of pharmacy students (2,542 completed post-test survey)	Theoretical basis: Rogers' Diffusion of Innovations Content: Basic genetics, genetic risk assessment, genetic counseling, and genomic disorders	9 topics in web-based modules and patient cases	Total of 3 hours	Pre- and post-test design	Pre- and post-test questionnaires and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' self-reported knowledge significantly increased from pre- to post-test in the ability to conduct patient education on pharmacogenetics and pharmacogenomics testing. Self-efficacy: Students' self-efficacy significantly increased from pre- to post-test in identifying areas where pharmacogenomics testing may be applicable. Course feedback: Students believed that the pharmacogenomics modules would be beneficial to their peers.	6/8
43	Whitt et al., 2016 (United States)	232 nurse practitioner students (140 completed post-test survey)	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, genomics Internet databases,	Web-based lectures with case studies, role playing, standardized patients, genetics problem sets, and group discussions	3-credit, 15-week course	Pre- and post-test design	Quizzes, exams, pre- and post-test questionnaires, written assignments, and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' knowledge scores for basic genetics concepts significantly increased from pre- to post-test. Self-efficacy:	5/8

			Mendelian/genetic disorders, and pharmacogenomics/ pharmacogenetics						Students' confidence level significantly increased from pre- to post-test in regards to the clinical application of genetics. Comfort level: Students' comfort level significantly increased from pre- to post-test in regards to their genetics competencies and clinical application of genetics. Course feedback: Most course component and materials received positive ratings.	
44	Calinski and Kisor, 2016 (United States)	71 pharmacy students and 25 physician assistant students	Theoretical basis: Not reported Content: Basic genetics and pharmacogenomics/ pharmacogenetics	Lab-based session with case studies and lectures	Total of 1 hour	Pre- and post-test design	Pre- and post-test questionnaires and observational analysis	Inferential statistics *without* controlling for covariates	Self-efficacy: Students' confidence significantly increased from pre- to post-test (a) in interpreting pharmacogenomic data to themselves and other health professionals and (b) in the ability to recommend drug dosages based on available pharmacogenetics data.	2/8
45	Adams et al., 2016 (United States)	122 doctorate of pharmacy students (100 underwent self-genotyping test)	Theoretical basis: Teach-the-Teacher model Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, genomics Internet databases, and pharmacogenomics/ pharmacogenetics	In-class lectures, videos, and self- and population-based genotyping exercise	1 semester (duration per lecture not reported)	Pre- and post-test design	In-class exercises, objective assessments, pre- and post-test questionnaires, and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students who underwent genotyping showed a significant increase in knowledge scores from pre- to post-test. Attitudes: Students significantly changed in (a) their attitudes toward recommending pharmacogenomic testing to patients and (b) their belief towards patient's accurate interpretation of genetic testing results. Self-efficacy: Students who underwent genotyping significantly increased in confidence from pre- to post-test in regards to their ability to understand test results and patients' feelings. Course feedback: Majority of the students strongly agreed/agreed that the course was useful and that the self-genotyping exercise helped them understand pharmacogenomics better.	6/8

46	Jamie et al., 2016 (United Kingdom)	21 masters of pharmacy undergraduate students	Theoretical basis: Not reported Content: Basic genetics, ethical, legal, and social implications (ELSI), and pharmacogenomics/ pharmacogenetics	In-class lectures, lab sessions, and self-genotyping exercises	5-hour lectures and three 4-hour laboratory sessions	Cross-sectional	Focus groups	Qualitative	Course feedback: Students gave positive feedback regarding the inclusion of ethical, legal, and social implications (ELSI) topics, and they perceived the laboratory practical sessions as useful.	4/8
47	Weitzel et al., 2016 (United States)	53 doctorate of pharmacy students: Course 1 (n=34) and Course 2 (n=19) (Of note, 16 students completed both courses)	Theoretical basis: Flipped classroom approach Content: Genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, genomics Internet databases, pharmacogenomics/ pharmacogenetics, and genome data analysis	Course 1: pharmacogenomics Course 2: Genomic Medicine For both courses: In-class lectures with pre-recorded videos, patient case discussions, role playing, and self-genotyping exercises	For both courses: 1-hour pre-recorded video and 1-hour live lecture with discussion weekly for 8 weeks	Pre- and post-test design	In-class exercises, online quizzes, essay, exams, discussion boards, pre- and post-test questionnaires, and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: In both courses, students' knowledge scores significantly increased from pre- to post-test. Attitudes: In Course 1, students had a significant increase from pre- to post-test in beliefs regarding the importance of pharmacogenomics in clinical practice. Self-efficacy: In Course 1, students' confidence in communicating pharmacogenomics significantly increased from pre- to post-test. Comfort level: In Course 1, students' comfort level in answering questions about pharmacogenomics testing from patients and health care professionals significantly increased from pre- to post-test. Course feedback: For both courses, students perceived the course to be helpful.	5/8
48	Williams and Dale, 2016 (United States)	10 nursing students (7 completed 9-month follow-up survey)	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, genomics Internet databases, Mendelian/genetic disorders, genomic disorders, pediatric genetics, and immunogenetics	Web-based modules, reading material, videos, discussion board, and weekly assessments	14 weeks in 1 semester (duration per module not reported)	Pre- and post-test design with 9-month follow-up	Exercises, online quizzes, essay, and pre- and post-test questionnaires	Inferential statistics *without* controlling for covariates	Self-efficacy: Students' confidence in applying all genetic competencies significantly increased from pre- to post-test, and such finding was maintained at 9-month follow-up.	5/8
49	Makransky et al., 2016 (The Netherlands)	300 undergraduate health students majoring in medicine or molecular biomedicine	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, Mendelian/genetic disorders, and genomics tools and technology	Web-based training session with case based scenarios	2-hour simulation based training session with 1-hour pre-course simulation lecture	Pre- and post-test design	Pre- and post-test questionnaires and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' knowledge scores significantly increased from pre- to post-test. Self-efficacy:	5/8

									Students' self-efficacy significantly increased from pre- to post-test. Motivation: Students in high and medium knowledge groups showed a significant increase in intrinsic motivation from pre- to post-test. Course feedback: Students rated the simulation positively and indicated that the simulation was beneficial to their understanding of and interests in medical genetics.	
50	Gunder-McClary and Lorilee, 2016 (United States)	239 physician assistant students	Theoretical basis: Not reported Content: Basic genetics	Web-based lectures with videos, case based scenarios, and discussion board	18 lectures over 10 weeks (duration per lecture not reported)	Cross-sectional	Multiple choice exams, family pedigree project, discussion boards, and course evaluation	Univariate statistics	Knowledge: Students achieved high exam scores with average scores above 90. Course feedback: In general, students were satisfied with the course.	5/8
51	Xu et al., 2016 (China)	2,326 medical students participated in the genetic counseling training program during 2009-2011. Students were randomly selected to complete the questionnaires (324 completed attitudes survey post education [attitude group]; 200 completed different pre- and post-test surveys [pre- and post-test group]) 614 students from 2006-2008 (prior to the start of the program) were selected as the comparison group.	Theoretical basis: Role play Content: Basic genetics, genetic risk assessment, genetic counseling, and Mendelian/genetic disorders	In-class lectures with case based scenarios and role-playing sessions	30 hours for lectures and 2-hour case based scenarios and role play with approximately 2-week preparation for students	Pre- and post-test design	In-class exam, attitudes survey, pre- and post-test questionnaires, and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: The pre- and post-test group scored significantly higher for key concepts in genetic counseling after the course. This group also had a significantly higher exam score compared to the comparison group. Course feedback: 97% of the students in the attitude group reported positive ratings for the training program and role-playing sessions.	7/8
52	Frick et al., 2016 (United States)	145 second-year pharmacy students (39 completed post-test survey; 23 went through the voluntary	Theoretical basis: Not reported Content: Genetic risk assessment, genetic counseling, genomics Internet databases, pharmacogenomics/	In-class lectures, group discussions, and self-genotyping exercise	15 weeks of an 1-hour lecture and a 4-hour group based discussion session (duration of the genotyping	Pre- and post-test design	Pre- and post-test questionnaires and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: There was a significant increase from pre- to post-test in knowledge regarding risks and benefits of genetic testing.	5/8

		personal genome test)	pharmacogenetics, and genome data analysis		exercise not reported)				Attitudes: From pre- to post-test, students (regardless of the participation in genotyping) significantly increased in their beliefs that (a) medical records should consist of pharmacogenomic information and (b) pharmacogenomics is essential to their future career. Moreover, after completing the course, students who underwent genotyping significantly decreased in their initial agreement that pharmacogenomics could improve patient medication. Self-efficacy: Students were significantly more confident in the clinical application of pharmacogenomics after the course, particularly for those who completed genotyping. Course feedback: Overall students rated the course positively.	
53	St-Martin et al., 2016 (Canada)	32 nursing students: Control group (n=26; 11 completed post-test survey) and intervention group (n=6; all completed post-test survey)	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, genetic counseling, and Mendelian/genetic disorders	Intervention group: 1-hour lecture Control group: No lecture	Intervention group: 1-hour lecture	Randomized control trial	Pre- and post-test questionnaires and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students in the intervention group had a significant increase in genetic knowledge from pre- to post-test; their post-test scores were also significantly higher than those of control group. Comfort level: Students in the intervention group were significantly more comfortable with tasks related to genetics after the course compared to the control group. Course feedback: Students perceived the lecture to be helpful and comprehensive.	2/8
54	Remsberg et al., 2017 (United States)	133 doctorate of pharmacy students (94 completed post-test survey)	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, genomics Internet databases, pharmacogenomics/ pharmacogenetics, genome data analysis, and bioinformatics	In-class lectures, lab exercises, and self-genotyping exercise	One 2-hour lecture per week for 13 weeks	Pre- and post-test design	Group paper, exams, pre- and post-test questionnaires, and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' self-reported knowledge in pharmacogenomic testing and patient education and consultation significantly increased from pre- to post-test. Self-efficacy: Students had increased confidence in conducting genetic counseling and genetic risk assessment as well as finding pharmacogenomic	5/8

									resources for patients after completing the course. Course feedback: Students provided positive comments regarding the learning experience and usefulness of the course.	
55	Thatcher et al., 2017 (United States)	400 medical students	Theoretical basis: Team-based learning Content: Basic genetics, genetic risk assessment, Mendelian/genetic disorders, population genetics, and sexual genetics	Preparation (reading assignments and lecture review), questions-and-answers session, and team-based learning session	Not reported	Cross-sectional	Individual readiness assurance test (IRAT), team readiness assurance test (TRAT), course exam, and course evaluation	Univariate statistics	Knowledge: The mean score of TRAT was higher than those of IRAT and course exam. Course feedback: Students enjoyed the team-based learning in genetics.	4/8
56	Dasgupta, 2017 (United States)	180 first-year medical students	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, Mendelian/genetic disorders, and genomics tools and technology	Case-based group discussions (with and without interactive clicker questions)	Not reported	Cross-sectional	Course evaluation and observation	Qualitative	Course feedback: Students gave strong positive course evaluations. During the course, students were highly engaged in the discussions.	2/8
57	Jin and Dasgupta, 2017 (United States)	180 first-year medical students enrolled in a genetics course (63 completed pre-test survey, and 30 completed post-test survey)	Theoretical basis: Flipped classroom approach and progressive disclosure model Content: Genetic risk assessment, ethical, legal, and social implications (ELSI), and reproductive genetics related to lesbian, gay, and bisexual cultural issues, basic genetics, genetic counseling, Mendelian/genetic disorders, genomics tools and technology, and population genetics	Preparation (pre-session reading, textbook chapter reading, and video viewing) and case-based group discussions with an audience response system led by facilitators	2 to 2.5 hours (1 to 1.5-hour preparation and 1-hour class session)	Pre- and post-test design	Pre- and post-test questionnaires, in-class assessments via an audience response system, and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Students' knowledge in genetic risk assessment significantly increased from pre- to post-test. Course feedback: Students appreciated the genetic course materials on lesbian, gay, and bisexual cultural issues.	5/8
58	Kronk et al., 2017 (United States)	227 undergraduate nursing students: Second degree nursing student (n=139) and traditional undergraduate nursing students (n=88)	Theoretical basis: Not reported Content: Basic genetics, genetic risk assessment, ethical, legal, and social implications (ELSI), genetic counseling, and Mendelian/genetic disorders	In-class lectures, case based scenarios, storytelling, and group discussions	3-credit, 15-week course	Pre- and post-test design	Student reflections, pre- and post-test questionnaires, and course evaluation	Inferential statistics *without* controlling for covariates	Knowledge: Both the second degree and traditional undergraduate students significantly increased their self-reported genetic competencies after the course. Course feedback: Students perceived the course content to be influential to their clinical practice.	5/8

MQS, Methodological Quality Score.

[a]The most advanced evaluation design and statistical analysis used in each study are reported in the table.

bWhen a study presented both statistically significant and non-statistically significant results, only the significant findings are reported as main evaluation findings. Yet, when a study had only descriptive data, we report those descriptive results. Moreover, although course feedback was descriptive only, as it was an important evaluation component, we still include course feedback in the key findings when evaluations of the course/session/presentation were reported in the study.

APPENDIX B

RECRUITMENT EMAIL

Subject Line: Family Health History Training—Get $25, chance to win iPad, and a Certificate

Dear Health Education Student

You are invited to participate in a graduate research study through the Texas A&M University,

Department of Health & Kinesiology.

The goal of the study is to develop genomic competencies/skills among students in Health & Kinesiology at Texas A&M University by adopting a theoretical and evidence based genomic training material. Specifically, you will learn how to collect family history information, create a pedigree, assess family history information, and make lifestyle recommendations. In this course we use cancer as an example to illustrate many concepts in this course, but the information you will learn here apply to other diseases as well (e.g., diabetes).

The anticipated time taken for completion of the training is approximately 2.6 hours. Your participation is voluntary. You may refuse to answer the questions asked in the survey or terminate participation at any time you wish.

WHAT YOU GET FOR YOUR PARTICIPATION:

After your completion of training, pre-, and post-test survey you will have a chance to:
(a) get $25 amazon gift card for first 60 participants
(b) earn certificate of family health history training,
(c) enter a drawing for 2 iPads.
(d) enhance your resume. By completing this training, health education students would gain additional skills and competencies that can be applied to future patient services and job duties. This is especially beneficial if you are applying for your future jobs or professional/graduate schools (e.g. nursing, physician assistant schools)

You can take the course at your own pace and save your progress in the training at any time. You will have two weeks to complete this training.

The records of this study will be kept private and only shared with the research team. If you are

interested in participating in this study, please be sure you have read the information above, and

contact Divya Talwar at divtalwar@gmail.com or talwar@exchange.tamu.edu with the following information:

First Name: _____

Last Name: _____

TAMU Email address: _____

UIN: _____

Thank you very much!

Divya Talwar, Ph.D. candidate, MPH, BDS
Department of Health and Kinesiology
Texas A&M University
4243 TAMU
College Station, Texas, 77843-4243
E-mail: talwar@exchange.tamu.edu

APPENDIX C

FACEBOOK RECRUITMENT MESSAGE

Dear HLKN Student

You are invited to participate in a graduate research study through the Texas A&M University, Department of Health & Kinesiology. The goal of this project is to develop, implement, and evaluate a theory- and evidence-based family health history education and training program for health educators and students. This is the first family health history education training program primarily designed by health educators for health educators and students, and tailored to meet their needs, education/training, responsibilities, and credentials.

After your completion of training and pre- and post-test survey, you may have the following benefits BUT on completion of all designated steps (training and pre- and post-test) you will have a chance to: (a) win $25 amazon gift card for first 60 participants (b) earn certificate of family health history training, (c) enter a drawing of 2 iPads (d) enhance your resume. By completing this training, health education students would gain additional skills and competencies that can be applied to future patient services and job duties. **This is especially beneficial if you are applying for your future jobs or professional/graduate schools (e.g. nursing, physician assistant schools)**

The anticipated time taken for completion of the training is approximately 2.6 hours. Your participation is voluntary. You may refuse to answer the questions asked in the survey or terminate participation at any time you wish.

If you are interested in participating in this study, please be sure you have read the information

above, and contact Divya Talwar at divtalwar@gmail.com.

Thanks for your time and consideration.

Divya Talwar, MPH, BDS
PhD Candidate
Texas A&M University, College Station
Email – divtalwar@gmail.com

APPENDIX D

PRE-TEST SURVEY INSTRUMENT

Family Health History Training Program

Thank you for participating in the Family Health History Training Program being conducted by the Department of Health & Kinesiology at Texas A&M University.

The goal of this project is to develop, implement, and evaluate a theory- and evidence-based family health history education and training program for health educators and students.
This is the first family health history education training program primarily designed by health educators for health educators and students, and tailored to meet their needs, education/training, responsibilities, and credentials.

Information Sheet

The purpose of this information sheet is to provide you (as a prospective research study participant) information that may affect your decision as to whether or not to participate in this research.

You have been asked to participate in a research project studying the development, implementation, and evaluation of a genomics training program for Health & Kinesiology students at Texas A&M. The purpose of this study is to develop, implement, and evaluate a theory- and evidence-based family health history (FHH) training for health educators and students to develop genomic competencies and incorporate family health history into your future health education practice.

Q WHAT WILL I BE ASKED TO DO?

If you agree to participate in this study, you will be asked to receive 2.5 hours FHH training. You will also be asked to fill out pre-test and post-test surveys regarding your knowledge, attitudes, self-efficacy and intention of utilizing family-history-based genomics education. This study will take approximately 2.5 hours.

Q WHAT ARE THE RISKS INVOLVED IN THIS STUDY?

The risks associated in this study are minimal, and are not greater than risks ordinarily encountered in daily life. Some individuals may suffer emotional discomfort with some questions if they are unsure about the answer.

Q WHAT ARE THE POSSIBLE BENEFITS OF THIS STUDY?

The possible benefits of participation include an opportunity to increase your genomics competency (as recommended by CDC) and to provide clients-based family history education in

the future. This study will benefit the society by adding to existing knowledge in the field of family history and genomics.

Q DO I HAVE TO PARTICIPATE?

No. Your participation is voluntary. You may decide not to participate or to withdraw at any time without your current or future relations with Texas A&M University being affected.

Q WILL I BE COMPENSATED?

Participants on completion of all designated steps (training and pre- and post-test)

(1) Gift card worth $25 for first 60 participants who complete both the training and pre- and post-test $25

(2) Awarded certificate of family health history training

(3) Eligible for a drawing of 2 mini-iPads after completing both the training and pre- and post-test.

(d) enhance your resume. Since the training focuses on clinical application of genomic skills, it you can add this training to your resume. This is especially beneficial for you if you are applying for your future jobs/professional or graduate schools (e.g. nursing, physician assistant schools)

Q WHO WILL KNOW ABOUT MY PARTICIPATION IN THIS RESEARCH STUDY?

This study is confidential. The records of this study will be kept private and only shared with the research team. Data from this study may be published in peer-review journals or presented at scientific meetings, but no identifiers linking you to this study will be included.

Q WHO DO I CONTACT WITH QUESTIONS ABOUT THE RESEARCH?

If you have any complaints or concerns regarding this study, you may contact the study Principal Investigator, Dr. Lei-Shih Chen at 979-862-2912 or lace@hlkn.tamu.edu or the study contact: Divya Talwar (Ph.D. candidate) at 518-248-8572 or divtalwar@gmail.com.

Q WHOM DO I CONTACT ABOUT MY RIGHTS AS A RESEARCH PARTICIPANT?

This research study has been reviewed by the Human Subjects' Protection Program and/or the Institutional Review Board at Texas A&M University. For research-related problems or questions regarding your rights as a research participant, you can contact these offices at 979-458-4067 or irb@tamu.edu.

PARTICIPATION

Please be sure you have read the above information, asked questions, and received answers to your satisfaction. If you would like to be in the study, please print this page for you records and proceed to the survey by continuing to the next page

DEMOGRAPHIC INFORMATION

1. Full Name _____

2. Please provide the e-mail address (We will send your electronic $25 Amazon.com gift card/iPad drawing results notification this this email address, so make sure you have the correct and updated e-mail address)_____

3. Mailing address:
_____

4. Phone number:_____

5. Please check your education classification
☐ Freshman
☐ Sophomore
☐ Junior
☐ Senior
☐ Other (please specify) _____

6. What is your program major?

☐ Student majoring in Community Health
☐ Student majoring in Allied Health

☐ Student majoring in School Health
☐ Other (please specify) _____

7. What is your age? _____

8. What is your gender?
☐ Female
☐ Male

9. How do you describe yourself?
☐ White/Caucasian
☐ Hispanic/Latino
☐ Black/African American
☐ Asian/Pacific Islander
☐ Alaskan/Native American (Indian)
☐ Other (please specify) _____

10. What is your religious identity?
☐ Christian (including Catholic, Protestant, and all other Christian denominations)
☐ Jewish
☐ Muslim
☐ Hindu
☐ Buddhist
☐ Atheist
☐ Other (please specify) _____

11. Have you ever taken any courses related to genetics?
☐ No
☐ Yes

12. If you answered "yes" in the above question, please list the course name: _____

13. Have you ever taken any courses related to genomics?
☐ No
☐ Yes

14. If you answered "yes" in the above question, please list the course name: _____

15. Have you ever taken any courses related to FHH?
☐ No

☐ Yes

16. If you answered "yes" in the above question, please list the course name: _____

ATTITUDES

The following questions ask about your attitudes toward family health history.

Click the appropriate box you select for each statement

How much do you agree or disagree with the following statements?	Strongly Disagree	Disagree	Agree	Strongly Agree
Health educators should add family health history assessments to their health education				
Health educators can help meet the public's demand for information about genetic testing.				
Health educators should learn about the genomic competencies developed by the CDC for health education professionals.				
Health educators should collect family health history information of their clients, communities, and/or the people they serve.				
Health educators should make appropriate behavioral or lifestyle recommendations to clients based on their family health histories.				

How important is it to you…	Not Important At All	Not Important	Important	Extremely Important
that health educators add family health history assessments to their health				
that health educators can help meet the public's demand for information about genetic testing?				
that health educators learn about the genomic competencies developed by the CDC for health education professionals?				

How important is it to you…	Not Important At All	Not Important	Important	Extremely Important
that health educators should collect family health history information of their clients, communities, and/or the people				
that Health educators should make appropriate behavioral or lifestyle recommendations to clients based on				

SELF-EFFICACY

The following questions ask about your confidence in utilizing family health history in your future practice. Select one number between 0 and 10 and click the circle for each statement to answer the questions below.

0 10

"I am not confident at all" "I am 100% confident!"

How confident are you that you can…

1. Incorporate family health history assessments in your **future** practice?

0 1 2 3 4 5 6 7 8 9 10

2. Schedule on your calendar a day/time to begin using family health history assessments with your **future** clients?

0 1 2 3 4 5 6 7 8 9 10

3. Begin using family health history assessments in your future job?

0 1 2 3 4 5 6 7 8 9 10

4. Assist a **future** client to draw a family health history using the U.S. Surgeon General's "My Family Health Portrait" tool?

0 1 2 3 4 5 6 7 8 9 10

5. Encourage your **future** clients to edit and/or add information to their family health histories?

0 1 2 3 4 5 6 7 8 9 10

6. Make appropriate behavioral or lifestyle recommendations to your **future** clients based on their family health histories?

0 1 2 3 4 5 6 7 8 9 10

7. Encourage your **future** clients to consult relevant health care providers about their family health histories?

0 1 2 3 4 5 6 7 8 9 10

8. Encourage your **future** clients to discuss their family health histories with other family members?

0 1 2 3 4 5 6 7 8 9 10

INTENTION

The following questions ask about your likelihood to incorporate family health history into your future practice. So think about your future practice and answer the questions for each statement

How likely are you to…	**Not Likely At All**	**Not Likely**	**Somewhat Likely**	**Extremely Likely**
incorporate family health history assessments in your **future** practice?				
schedule on your calendar a day/time to begin using family health history assessments with your **future** clients?				
begin using family health history assessments at your future job?				
assist a **future** client to draw a family health history using the U.S. Surgeon General's "My Family Health Portrait"?				
encourage your **future** clients to edit and/or add information to their family health				

How likely are you to…	Not Likely At All	Not Likely	Somewhat Likely	Extremely Likely
make appropriate behavioral or lifestyle recommendations to your **future** clients based on their family health histories?				
encourage your **future** clients to consult relevant health care providers about their				
encourage your **future** clients to discuss their family health histories with other				

KNOWLEDGE

The following multiple-choice questions ask about your knowledge of family health history.

Please click the best answer.

1. The term "family health history" has different meanings. When health educators or public health professionals use the term they are thinking about:

a. Patterns of inherited traits (some of them positive), risks, and illnesses.
b. A system for classifying people according to how much genetic risk they have.
c. A risk factor only for illnesses.
d. The structure and the relationships within a biological family.
e. All options above are correct.
f. Don't know or not sure

2. A _____ family health history helps determine if a family has any patterns of major medical issues. A _____ family health history focuses on specific details of that family's health history.

a. Comprehensive, Targeted
b. Targeted, Comprehensive
c. Specific, General
d. General, Specific
e. None of the options listed above are correct
f. Don't know or not sure

3. Family health histories are useful for eliciting patterns of traits or illnesses among families with:

a. Biological children.
b. Adopted children.

c. No children.
d. All options above are correct.
e. Don't know or not sure

4. Using family health histories for the purpose of identifying and treating illnesses can be traced back to the time of Hippocrates.
a. True
b. False
c. Don't know or not sure

5. Family health histories can be useful for health promotion because they…
a. Provide context for interpreting a person's genetic risk.
b. Provide indicators of potential risk for an illness.
c. Can function as important motivational tools for health promotion.
d. All of the reasons above are correct.
e. Don't know or not sure

6. Family health histories can be used by health educators because:
a. If there's no family health history of a disease, a person knows he/she will not develop that disease.
b. Persons with a first- or second-degree relative who has a genetically-linked illness have a lower risk of developing that same illness.
c. Family health histories can become motivational tools for behavior change.
d. Family health histories alone can predict a person's risk of developing an illness.
e. All options above are correct.
f. Don't know or not sure

7. If a person has a family health history of lung cancer, he/she:
a. Will, most likely, develop lung cancer.
b. Has inherited a predisposition to lung cancer.
c. Will, most likely, develop a cancer of the respiratory system (not necessarily lung cancer).
d. Will, most likely, develop some form of cancer.
e. None of the options above is correct.
f. Don't know or not sure

8. Health educators should care about adding family health history to their practice because:
a. The public needs to be educated about the new genetic tests available.
b. If people are aware of their risk for a genetically related illness, they can become motivated to change their unhealthy behaviors.
c. Health educators are the professionals best qualified to help the public adopt healthy behaviors that may prevent genomic illnesses.
d. All options above are correct.
e. Don't know or not sure

9. There are well-defined professional competencies to guide health educators in adopting genomics into their practice.

a. True
b. False
c. Don't know or not sure

10. Health educators have a unique contribution to make regarding genomics and public health because:

a. The number of licensed genetic counselors in the U.S. is relatively small.
b. The demand for genetic service providers is increasing, and cannot be met by genetic counselors or geneticists, alone.
c. Health educators bring unique skills to an inter-disciplinary team of providers.
d. All options above are correct.
e. Don't know or not sure

11. When we compare health educators and genetic counselors we find that:

a. Genetic counselors are not trained to educate, only to provide psychological counseling.
b. The CDC's list of genomic competencies for health educators includes genetic counseling as one of the competencies.
c. Health educators and genetic counselors are trained to work collaboratively (with each other).
d. Health educators are not trained to provide psychological counseling regarding risk of an illness.
e. All options above are incorrect.
f. Don't know or not sure

12. Ten years before the completion of the Human Genome Project, scholars were calling the attention of health educators to the needs related to the ethical, legal, and social implications of genomic technologies and developments.

a. True
b. False
c. Don't know or not sure

13. The PRECEDE-PROCEED model contains "Genetics" as one of its many factors.

a. True
b. False
c. Don't know or not sure

14. One reason genomics has been added to the Healthy People 2020 goals and objectives is:

a. Genomics has raised many challenges and opportunities for improving the health outcomes of the nation.
b. Genomics plays a role in 8 out of the 10 leading causes of death in the U.S.
c. The first two responses are correct.
d. Healthy People 2020 does not have genomics as a goal or objective.
e. All options above are incorrect.

f. Don't know or not sure

15. When using the U.S. Surgeon General's "My Family Health Portrait," which disease/condition can you choose to focus on?

a. Sudden Infant Death
b. Heart Disease
c. Septicemia
d. Kidney Disease
e. All of the above are correct
f. Don't know or not sure

APPENDIX E

POST-TEST SURVEY INSTRUMENT

Family Health History Training Program

Thank you for participating in the Family Health History Training Program being conducted by the Department of Health & Kinesiology at Texas A&M University.

The goal of this project is to develop, implement, and evaluate a theory- and evidence-based family health history education and training program for health educators and students.

This is the first family health history education training program primarily designed by health educators for health educators and students, and tailored to meet their needs, education/training, responsibilities, and credentials.

1. Full Name_____

2. Please provide the e-mail address (We will send your electronic $25 Amazon.com gift card/iPad drawing results notification this this email address, so make sure you have the correct and updated e-mail address)_____

3. Mailing address:
_____

4. Phone number:_____

ATTITUDES

The following questions ask about your attitudes toward family health history.

Click the appropriate box you select for each statement

How much do you agree or disagree with the following statements?	Strongly Disagree	Disagree	Agree	Strongly Agree
Health educators should add family health history assessments to their health education				
Health educators can help meet the public's demand for information about genetic testing.				
Health educators should learn about the genomic competencies developed by the CDC for health education professionals.				
Health educators should collect family health history information of their clients, communities, and/or the people they serve.				
Health educators should make appropriate behavioral or lifestyle recommendations to clients based on their family health histories.				

How important is it to you…	Not Important At All	Not Important	Important	Extremely Important
that health educators add family health history assessments to their health education activities?				

How important is it to you…	Not Important At All	Not Important	Important	Extremely Important
that health educators can help meet the public's demand for information about genetic testing?				
that health educators learn about the genomic competencies developed by the CDC for health education professionals?				
that health educators collect family health history information of their clients, communities, and/or the people				
that health educators make appropriate behavioral or lifestyle recommendations to clients based on their family health				

SELF-EFFICACY

The following questions ask about your confidence in utilizing family health history in your future practice. Select one number between 0 and 10 and click the circle for each statement to answer the questions below.

0 10

"I am not confident at all" "I am 100% confident!"

How confident are you that you can…

9. Incorporate family health history assessments in your **future** practice?

0 1 2 3 4 5 6 7 8 9 10

10. Schedule on your calendar a day/time to begin using family health history assessments with your **future** clients?

0 1 2 3 4 5 6 7 8 9 10

11. Begin using family health history assessments in your first job after you graduate?

0 1 2 3 4 5 6 7 8 9 10

12. Assist a **future** client to draw a family health history using the U.S. Surgeon General's "My Family Health Portrait" tool?

0 1 2 3 4 5 6 7 8 9 10

13. Encourage your **future** clients to edit and/or add information to their family health histories?

0 1 2 3 4 5 6 7 8 9 10

14. Make appropriate behavioral or lifestyle recommendations to your **future** clients based on their family health histories?

0 1 2 3 4 5 6 7 8 9 10

15. Encourage your **future** clients to consult relevant health care providers about their family health histories?

0 1 2 3 4 5 6 7 8 9 10

16. Encourage your **future** clients to discuss their family health histories with other family members?

0 1 2 3 4 5 6 7 8 9 10

INTENTION

The following questions ask about your likelihood to incorporate family health history into your future practice. So think about your future practice and answer the questions for each statement

How likely are you to…	**Not Likely At All**	**Not Likely**	**Somewhat Likely**	**Extremely Likely**
incorporate family health history assessments in your **future** practice?				
schedule on your calendar a day/time to begin using family health history assessments with your **future** clients?				
begin using family health history assessments at your first job when you				

How likely are you to…	Not Likely At All	Not Likely	Somewhat Likely	Extremely Likely
assist a **future** client to draw a family health history using the U.S. Surgeon General's "My Family Health Portrait"?				
encourage your **future** clients to edit and/or add information to their family health				
make appropriate behavioral or lifestyle recommendations to your **future** clients based on their family health histories?				
encourage your **future** clients to consult relevant health care providers about their				
encourage your **future** clients to discuss their family health histories with other				

KNOWLEDGE

The following multiple-choice questions ask about your knowledge of family health history.

Please click the best answer.

16. The term "family health history" has different meanings. When health educators or public health professionals use the term they are thinking about:

a. Patterns of inherited traits (some of them positive), risks, and illnesses.
b. A system for classifying people according to how much genetic risk they have.
c. A risk factor only for illnesses.
d. The structure and the relationships within a biological family.
e. All options above are correct.
f. Don't know or not sure

17. A _____ family health history helps determine if a family has any patterns of major medical issues. A _____ family health history focuses on specific details of that family's health history.

g. Comprehensive, Targeted
a. Targeted, Comprehensive
b. Specific, General
c. General, Specific
d. None of the options above are correct
e. Don't know or not sure

18. Family health histories are useful for eliciting patterns of traits or illnesses among families with:

a. Biological children.
b. Adopted children.
a. No children.
b. All options above are correct.
c. Don't know or not sure

19. Using family health histories for the purpose of identifying and treating illnesses can be traced back to the time of Hippocrates.

a. True
b. False
c. Don't know or not sure

20. Family health histories can be useful for health promotion because they…

a. Provide context for interpreting a person's genetic risk.
b. Provide indicators of potential risk for an illness.
c. Can function as important motivational tools for health promotion.
d. All of the reasons above are correct.
e. Don't know or not sure

21. Family health histories can be used by health educators because:

a. If there's no family health history of a disease, a person knows he/she will not develop that disease.
b. Persons with a first- or second-degree relative who has a genetically-linked illness have a lower risk of developing that same illness.
c. Family health histories can become motivational tools for behavior change.
d. Family health histories alone can predict a person's risk of developing an illness.
e. All options above are correct.
f. Don't know or not sure

22. If a person has a family health history of lung cancer, he/she:

a. Will, most likely, develop lung cancer.
b. Has inherited a predisposition to lung cancer.
c. Will, most likely, develop a cancer of the respiratory system (not necessarily lung cancer).
d. Will, most likely, develop some form of cancer.
e. None of the options above is correct.
f. Don't know or not sure

23. Health educators should care about adding family health history to their practice because:

a. The public needs to be educated about the new genetic tests available.
b. If people are aware of their risk for a genetically related illness, they can become motivated to change their unhealthy behaviors.

c. Health educators are the professionals best qualified to help the public adopt healthy behaviors that may prevent genomic illnesses.
d. All options above are correct.
e. Don't know or not sure

24. There are well-defined professional competencies to guide health educators in adopting genomics into their practice.
a. True
b. False
c. Don't know or not sure

25. Health educators have a unique contribution to make regarding genomics and public health because:
a. The number of licensed genetic counselors in the U.S. is relatively small.
b. The demand for genetic service providers is increasing, and cannot be met by genetic counselors or geneticists, alone.
c. Health educators bring unique skills to an inter-disciplinary team of providers.
d. All options above are correct.
e. Don't know or not sure

26. When we compare health educators and genetic counselors we find that:
a. Genetic counselors are not trained to educate, only to provide psychological counseling.
b. The CDC's list of genomic competencies for health educators includes genetic counseling as one of the competencies.
c. Health educators and genetic counselors are trained to work collaboratively (with each other).
d. Health educators are not trained to provide psychological counseling regarding risk of an illness.
e. All options above are incorrect.
f. Don't know or not sure

27. Ten years before the completion of the Human Genome Project, scholars were calling the attention of health educators to the needs related to the ethical, legal, and social implications of genomic technologies and developments.
a. True
b. False
d. Don't know or not sure

28. The PRECEDE-PROCEED model contains "Genetics" as one of its many factors.
a. True
b. False
c. Don't know or not sure

29. One reason genomics has been added to the Healthy People 2020 goals and objectives is:

a. Genomics has raised many challenges and opportunities for improving the health outcomes of the nation.
b. Genomics plays a role in 8 out of the 10 leading causes of death in the U.S.
c. The first two responses are correct.
d. Healthy People 2020 does not have genomics as a goal or objective.
e. All options above are incorrect.
f. Don't know or not sure

30. When using the U.S. Surgeon General's "My Family Health Portrait", which disease/condition can you choose to focus on?

a. Sudden Infant Death
b. Heart Disease
c. Septicemia
d. Kidney Disease
e. All of the above are correct
f. Don't know or not sure

TRAINING EVALUATION

For our evaluation purposes, we are interested in your feedback on

our family health history training.

General Questions

Learning Objectives

For each of the following questions, mark (X) in the column that best represents your opinion regarding this training. Use the rating scale of 1-5 (1=strongly disagree, 5=strongly agree).

Learning Objectives	Strongly Disagree		Neutral		Strongly Agree
As a result of this training, I am able to:	1	2	3	4	5
define the term "family health history" as the term is currently used in health promotion.					
briefly describe the different ways in which family health history can be (and has been) used.					
briefly explain why nearly all diseases are genomic					
explain why family health history assessments can be useful tools for health promotion and disease prevention.					
explain why health educators should develop genomics competencies to routinely include family health history assessments in their health education efforts.					
distinguish how genetic counselors and health educators differ in terms of the skills and approaches they use when incorporating family health history assessments in their practice.					
describe what has been done so far in health education related to genomics and family health history and identify some of the resources available for (and developed by) health educators.					
practice developing a simple family health history using the U.S. Surgeon General's "My Family Health Portrait" tool.					
make appropriate behavioral or lifestyle recommendations to clients at risk for the common types of diseases based on their family health history information.					
develop a plan to add family health history assessment into your routine health education practice.					
encourage clients to edit and/or add information to their family health history and consult relevant health care providers about their family health history.					

Overall training evaluation:

The training was timely in terms of current public health and health education practice.

a. Strongly disagree
b. Disagree

c. Neutral
d. Agree
e. Strongly agree

For the following questions, please circle the best answer.

Content

1. How appropriate was the level of the training for you (by "level" we mean the degree of difficulty of the materials)?
   a. Not appropriate
   b. Somewhat appropriate
   c. Appropriate
   d. Extremely appropriate

2. How well did the training assist you in understanding how to use family health history assessments in health education?
   a. Not well at all
   b. Not well
   c. Well
   d. Very well

3. Think of the order in which the main concepts were presented at the training. How would you rate the ordering of the concepts?
   a. The concepts were very poorly ordered.
   b. The concepts were not as well-ordered as they could have been.
   c. The concepts were somewhat in order.
   d. The concepts were very well ordered.

4. How would you rate the organization of the training?
   a. The training was very poorly organized.
   b. The training was not as well-organized as it could have been.
   c. The training was somewhat organized.
   d. The training was very well organized.

5. After taking this training, how willing are you to learn more about family health history and/or genomics in the near future?
   a. Not willing at all
   b. Not willing
   c. Willing
   d. Very willing

6. What do you want to learn more about, related to family health history and/or genomics?

Experience

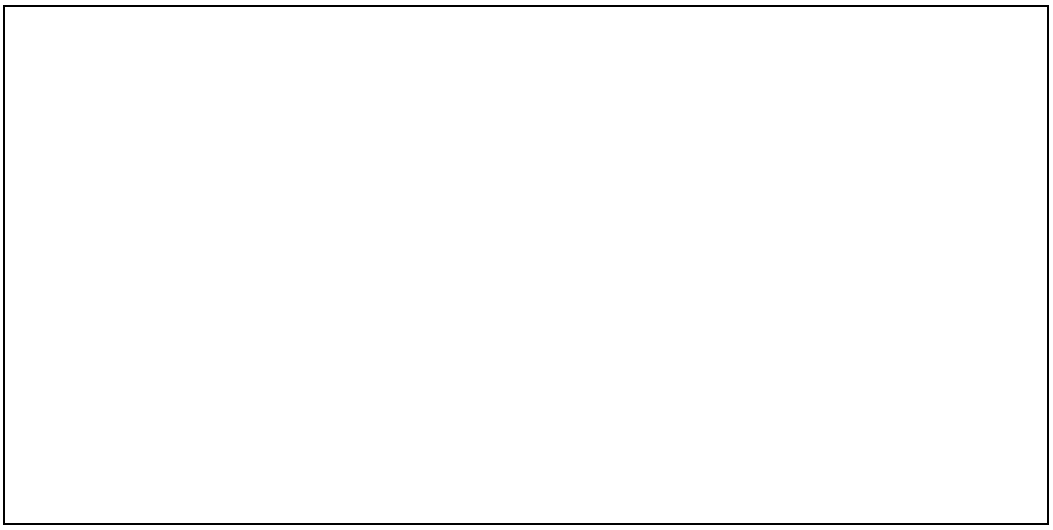
1. How enjoyable, would you say, was your experience learning about family health history through the training?

a. Extremely not enjoyable (not fun at all!)
b. Not enjoyable (not fun)
c. Enjoyable (somewhat fun)
d. Extremely enjoyable (I had a lot of fun!)

2. On a scale of 1 to 10, where 1 is "absolutely hated it!" and 10 is "absolutely loved it!", what was your impression of the training?

0 1 2 3 4 5 6 7 8 9 10

3. What would you recommend we KEEP in the training (what's working really well)?



4. What would you recommend we DISCONTINUE in the training (what's not working)?

5. What are your specific suggestions/recommendations to improve this training?

Dissemination

1. How likely are you to recommend the training to your colleagues or friends?
   a. Not likely at all
   b. Not likely
   c. Likely
   d. Very likely

2. In your opinion, how willing would other health education students be to take the training?
   a. Not willing at all
   b. Not willing
   c. Willing
   d. Very willing

3. List 2-3 reasons why you believe health education students would be interested in taking this training.

4. List 2-3 reasons why you believe health education students would NOT be interested in taking this training.

5. What are your suggestions for the "next steps"? In other words, what else could we do to improve the impact of this training and ensure its dissemination?

Suggestions

1. Is there anything else you think we should be aware of, as we implement this training with health education students across the state of Texas and nation-wide?