AN ASSESSMENT OF HEALTH EDUCATORS' LIKELIHOOD OF ADOPTING GENOMIC COMPETENCIES FOR THE PUBLIC HEALTH WORKFORCE

A Dissertation

by

LEI-SHIH CHEN

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

DOCTOR OF PHILOSOPHY

May 2007

Major Subject: Health Education

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Approved by:

Chair of Committee,	Patricia Goodson
Committee Members,	B.E. Pruitt
	B. Lee Green
	James R. Wild
Head of Department,	Robert B. Armstrong

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ABSTRACT

An Assessment of Health Educators' Likelihood of Adopting Genomic Competencies for the Public Health Workforce. (May 2007)

Lei-Shih Chen, B.S., National Taiwan University;

M.S., National Taiwan University

Chair of Advisory Committee: Dr. Patricia Goodson

Although the completion of the Human Genome Project helps develop efficient treatment/prevention programs, it will raise new and non-trivial public health issues. Many of these issues fall under the professional purview of health educators. Yet, no studies have evaluated if health educators (HEs) are ready to adopt genomic competencies into health promotion. This dissertation addresses this issue by examining three research questions in three separate studies: 1) Why must HEs develop genomic competencies? 2) What are HEs' knowledge of, and attitudes toward genomic competencies? And 3) what is HEs' likelihood of adopting genomic competencies into health promotion?

The first theoretical study proposed five arguments supporting the need for HEs to develop their genomic competencies and integrate public health genomics into health promotion. These arguments touched on various dimensions of HEs' professional goals and ranged from professional responsibilities and competencies, to the availability of funding for genomic-related research or interventions and opportunities for future employment.

For the second study, a web-based survey was developed and distributed to all members of four major health education organizations. A total of 1,925 HEs' completed the survey and 1,607 responses were utilized in the final analysis. This study indicated that participants had deficient knowledge and unfavorable attitudes toward the CDC-proposed genomic competencies.

In the third study, a theoretical model was developed to predict HEs' likelihood to incorporate genomic competencies into their practice. Using techniques from Structural Equation Modeling (SEM), the model was tested with the same data of the second study. Findings supported the proposed theoretical model. While genomic knowledge, attitudes, and self-efficacy were significantly associated with HEs' likelihood to incorporate genomic competencies into their practice, attitudes was the strongest predictor of likelihood.

In summary, these studies indicated that participating HEs had deficient genomic knowledge, unfavorable attitudes toward a set of CDC-proposed genomic competencies, and low likelihood to adopt genomic competencies into health promotion. Relevant training should be developed and advocated. As the SEM analysis results indicated the survey findings supported the proposed theoretical model, which can be utilized to steer future training for HEs.

Many thanks to my parents and Wu

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1. INTRODUCTION

This dissertation addresses the question whether practicing health educators, in the U.S., are willing and ready to adopt genomic competencies into health promotion research and practice. Specifically, this study examines three questions: 1) Why must health educators develop genomic competencies? 2) What are practicing health educators' knowledge of, and attitudes toward genomic competencies? And 3) What is health educators' likelihood of adopting genomic competencies into health promotion research and practice?

These three questions are examined and answered in three studies. The first is a theoretical treatment exploring a rationale for health educators' development of their genomic competencies. The second study is an empirical report, based on a survey of practicing health educators in the U.S., presenting findings related to health educators' genomics knowledge and their attitudes toward the set of CDC-proposed genomic competencies. The third study utilized structural equation modeling analyses (SEM) to test a theoretical model (with the same sample used in the previous study) regarding health educators' likelihood of adopting genomic competencies into health promotion research and practice.

The completion of the Human Genome Project is generating increased genomic information and genomic technologies, which, in turn, can raise new public health issues in this "post-genomic" era.[1] These new issues include the lack of genetic literacy, the

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This dissertation follows the style of the *Genetics in Medicine.*

lack of informed consent for genomic testing, the intricate decision-making process of genomic testing, public fears about genetic discrimination, the lack of access to genetic intervention services, the maintenance of healthy lifestyles after genomic profiling, and insufficient knowledge and awareness of genomic information and technologies among health care providers.[2, 3] To train public health professionals to deal with these issues, the Institute of Medicine's 2002 report[4], "*Who Will Keep the Public Healthy*?" identified *genomics* among eight new content areas that should be mastered by public health education professionals.

Genomics, as an expansion of Genetics, is the study of the entire human genome. It encompasses the research of a single gene's structure and function, the exploration of multiple genes' interactions and functions, and the investigation of environment-genes' interactions. Human diseases, such as cardiovascular diseases, cancer, and diabetes, are mostly the consequence of environment-gene(s) interactions. Only a small number of diseases are not related to environmental factors. Tay-Sachs disease is one such example.[4]

Public health genomics (PHG) is defined as "the study and application of knowledge about the elements of the human genome and its functions, including interactions with the environment, in relation to health and disease in populations."[5] In other words, PHG is an interdisciplinary field requiring that public health professionals be able to integrate genomic information, technologies and environmental elements into public health research, policy, and practice.[6]

The Centers for Disease Control and Prevention (CDC) recommends health educators establish their genomic competencies to 1) translate health-related information to lay communities, given cultural and social considerations; 2) identify factors influencing the lay public's learning of genomics; 3) distinguish genomic education from genetic counseling; 4) facilitate genomic education for stakeholders, including administrators, communities, and volunteers; 5) utilize social marketing strategies to develop genomics-related health education services with the commitment of communities, experts, and other resource people; 6) critically analyze current and future community genomic education needs; and 7) advocate for genomic education and/or adding genomic components into existing programs.[7]

Although identifying health care professionals' attitudes and knowledge regarding genomic medicine has been conducted by other scholars[8], to the best of our knowledge, no studies have evaluated practicing health educators' likelihood of adopting genomic competencies into health promotion research and practice. Thus, this dissertation addressed this issue by conducting three studies.

This dissertation was organized into five sections, three of which (Section 2, Section 3, and Section 4) are formatted as journal manuscripts. Section 2 is a theoretical study exploring a coherent and data-based rationale for health educators' development of professional genomic competencies. Five arguments were proposed to support the need for health educators to develop their genomic competencies and integrate genomic discoveries into health promotion.

Section 3 reports on findings related to a nation-wide survey of health educators' knowledge of genomics and attitudes toward the CDC-proposed genomic competencies. A web-based survey, entitled Health Promotion and Genetics/Genomics, was developed and distributed to all members of four major health education organizations. The associations among respondents' socioeconomic status, knowledge, and attitudes were also examined.

Section 4 reports (based on the previous study's sample) health educators' likelihood of adopting genomic competencies into health promotion. Additionally, a theoretical model designed to predict health educators' likelihood of adopting genomic competencies into health promotion, was tested by using SEM analytical techniques. The model was grounded in qualitative data (collected and analyzed prior to the dissertation study) and health behavior theories.

Section 5 summarizes and discusses the three studies as a unit. Moreover, four appendices are also included in this dissertation, including Appendix A (information sheets used in the pilot test and the final study), Appendix B (the web-based instrument used in the pilot test), Appendix C (the web-based instrument used in the final study), and Appendix D (incentive drawing for the pilot test and the final study).

2. ENTERING THE PUBLIC HEALTH GENOMICS ERA: WHY MUST HEALTH EDUCATORS DEVELOP GENOMIC COMPETENCIES?*

2.1 Introduction

In 2003, the National Institutes of Health (NIH) announced the completion of the Human Genome Project (HGP). The project represents a milestone in human history, as advanced genomic technologies/information can offer insight into specific diseases and may help develop highly efficient, personalized treatment and prevention programs.[9] According to Dr. Julie L. Gerberding, Director of the Centers for Disease Control and Prevention (CDC), "[t]here are exciting things going on right now in public health. Certainly, genomics is going to have a profound impact on the public health practice of the future…"[10]

Yet in the wake of its completion, the HGP also raised new and non-trivial public health issues. These include, but are not restricted to, the general public's level of genetic literacy, the nature and challenges of informed consent for genetic testing, the intricate decision-making process associated with genetic testing, public fears about genetic discrimination, lack of access to genetic services, challenges regarding maintenance of healthy lifestyles following genomic profiling, the potential increase in health disparities, and insufficient knowledge or awareness of genomic information and

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technologies among health care providers and public health workers.[3, 11]

Many of these concerns fall under the professional purview of public health workers. Even before the completion of the HGP, scholars such as Muin J. Khoury (Director, National Office of Public Health Genomics, CDC) recommended that public health professionals 1) understand genomic factors in population health, 2) examine the clinical validity and value of genomic tests, and 3) assess individuals' family history in order to recommend genetic evaluations, intensive screening and/or lifestyle changes.[12] Once the HGP ended, Khoury and others called for a renewed commitment of the public health workforce to the incorporation of genomics into public health. Khoury and Mensah[13], for instance, postulated three immediate priorities for public health action regarding genomics: (1) investigating the relationship between genetic variants and diseases through administration of population-based surveys; (2) establishing an evidence-base for various genomic technology applications, and (3) developing capacity of the public health workforce and systems.

As members of the public health workforce, health educators also have been called upon to deal with genomic-related public health topics. In 1993, Sorenson and Cheuvront[14] authored the first paper advocating for "health behavior and health education studies to contribute to effective programs and policies" [(p.591)] due to the increasing demands for genetic services since the beginning of the HGP. These studies would examine the utilization and effectiveness of genetic services, as well as assess the consequences of genetic testing. More recently, in what may be characterized as a unique editorial decision among health education journals, *Health Education and*

Behavior devoted its entire October 2005 issue to discussing the role of, and research/practice opportunities for, health educators regarding genomics.

Despite the expectation that the public health workforce, in general, and health educators, in particular, have a significant role to play in the intersection of genomics and public health, the majority of them have never received formal training in genomics.[4] In 2003, the Association of Schools of Public Health (ASPH) surveyed representatives of 33 accredited U.S. public health schools. ASPH found that approximately half of these schools did not offer genomics in their curriculum and only 15% included the topic "genomics" in their core courses.[15] Unfortunately, similar data do not exist for programs of health education/health promotion housed outside of schools of public health. Qualitative data we collected recently (unpublished), however, indicated that most health educators interviewed have not formally been exposed to genomics-related topics during their training in health promotion.

Even as a large gap lies between the expectations for health educators in this post-genomic era and the training they receive, we believe it is important to develop the case, or establish the need for, their greater involvement in the upcoming genomics dimension of public health and health education. Therefore, in this paper we develop and put forth five arguments designed to persuade health educators to explore genomics, to incorporate genomic information and technologies (such as family histories) into their health promotion research and practice and, thus, develop their genomic competencies. These arguments may also prove useful for raising health educators' awareness of public health genomics (PHG), for diminishing perceptions of incompatibility between PHG and health educators' personal beliefs and values, and for increasing health educators' motivation for engagement in genomic-related health promotion research and practice.

2.2 Defining Key Terms

Issues of terminology are inherent in any and all sciences and fields of practice, and PHG does not differ in this regard: knowledge of, or at least familiarity with, basic terminology is an important first step in understanding PHG's scope and target. Some scholars even propose that terminology *shapes* the field of genomics (as, for instance, in the choice of particular words, images, and metaphors used to communicate genetic information to the lay public – for an in-depth discussion of genomics as a form of public health discourse see Petersen & Bunton, 2002[16]). Regardless of which philosophical perspective concerning the role of language in science one espouses, mastery of basic terminology is essential for a healthy and constructive dialogue. Nonetheless, it is important to bear in mind that given the novelty of the field, many terms are still vaguely or ambiguously defined, exhibiting small (but important) variations in meaning. For the purpose of this manuscript, and given the demographic characteristics of its readership, we will present those definitions most widely used within the U.S. and North-American contexts. Whenever appropriate, we will note alternative definitions or potential ambiguities. This basic terminology and its most commonly used/cited definitions and delimitations are presented in Table 2.1, as *pairs* (e.g., Genetics vs Genomics), for easier comparisons between newer and more familiar terms.

Table 2.1 The definitions and delimitations of key terms frequently used in Public Health Genomics in the U.S.

Key Terms	Definitions and Delimitations
Genomic Competencies	The term *Genomic Competencies* refers to a set of knowledge and professional skills related specifically to public health genomics. *Genomic competencies* were developed by a group of interdisciplinary experts in public health to ensure public health professionals can embrace up-to-date genomic knowledge and skills to promote human health and prevent diseases. Genomic competencies for public health workers – according to the CDC – include 1) "demonstrating basic knowledge of the role that genomics plays in the development of disease, 2) identifying the limits of one's genomic expertise, and 3) making appropriate referrals to those with more genomic expertise." Moreover, there are genomic competencies required for public health professionals, public health leaders/administrators, public health clinicians, epidemiologists, health educators, laboratory technicians, and environmental health workers.[7]
Genetics VS. Genomics	Although *Genetics* and *Genomics* are often used interchangeably, the definitions of these terms differ in important ways. *Genetics,* originally associated with the study of Mendelian inheritance, is the research of single genes and their structure, functions and effects. The field of Genetics encompasses basic bio-chemical research regarding specific genes and their potential association with animal or human morbidity. The field can be sub-divided into 3 major domains: Classical Genetics, Molecular Genetics, and Evolutionary Genetics.[17] More often than not, *Genetics* focuses on a single, isolated gene. Many of the most popularly known diseases (albeit more rare and severe) – including Cystic Fibrosis, Tay-Sachs Disease, Huntington's disease, and Hemophilia – are single-gene diseases.[4] Derived from the sequencing of the human genome, *Genomics* is an expansion of *Genetics*, and comprises the study of the entire human genome (albeit "genomics" may also apply to plants and animal sciences; for example, community genomics refers to "the analysis of species populations and their interactions, recognizing that both species composition and interactions change over time, and in response to environmental stimuli.[18]") Genomics encompasses – as does Genetics – the research of a single gene's structure and function, but it moves beyond to exploring interactions among multiple genes and their functions, as well as to investigating interactions between genes and their environment(s). Thus, *Genomics* is broader in scope than *Genetics.* Most diseases result from interactions among genes, environment, behavior, and access to health care. Such diseases include cardiovascular illnesses, common late-onset Alzheimer's disease, obesity, non-insulin-dependent diabetes mellitus, cancers and others. New genomic technologies have made it possible to explore genetic factors (i.e. single gene responses and gene-to-gene interactions) as well as broader interaction factors (i.e. gene-to-environment interaction) leading to disease.[4]
Old Genetics VS. New Genetics	The meaning of the term *New Genetics* varies based on different time periods and its uses. For example, in 1979 the term *New Genetics* was introduced to raise awareness of new techniques with the potential to identify genes' structure; currently such techniques are considered "old". Today, users refer to "*New" Genetics* in order to differentiate it from the "*old" Genetics*. *Old Genetics* focused on rare hereditary diseases with a single gene mutation, affecting only a small portion of populations. *New Genetics,* however, deal with nearly all diseases – since most are genetic-related – that can affect large population groups. Furthermore, in recent years the term *New Genetics* also has been utilized to differentiate genetic studies from Eugenics, since the former implies individuals' autonomy and freedom of choice while the latter suggests discrimination and prejudice.[16]
Public Health Genetics VS. Community Genetics	Both *Public Health Genetics* and *Community Genetics* are bridges between clinical genetics and public health. *Public Health Genetics* is defined as the application and utilization of advanced genetic technologies to promoting public heath and preventing diseases. *Community Genetics*, consisting of applied and scientific components, seeks to maximize the best elements of clinical genetics and public health, and to minimize the potentially harmful effects of genetics. The purpose of the applied component in *Community Genetics* is to incorporate genetic services into communities, which are, then, evaluated through scientific methods. Although *Community Genetics* is similar in meaning to *Public Health Genetics*, the latter is more commonly used in the United States, while the term *Community Genetics* is the preferred usage

Table 2.1 continued

Key Terms	Definitions and Delimitations
	in Europe.[11] Furthermore, Mackenbach[19] argues that *Public Health Genetics* stresses the overall health gains for the population, whereas *Community Genetics* focuses on the empowerment of communities and the respect for individual autonomy.
Public Health Genetics VS. Public Health Genomics	The distinction between *Public Health Genetics* and *Public Health Genomics* is similar to the one made between *Genetics* and *Genomics: Public Health Genomics* covers a wider range of issues than *Public Health Genetics.* The definition of *Public Health Genomics* varies based on different organizations and countries. For example, according to the CDC, *Public Health Genomics* is referred to as "the study and application of knowledge about the elements of the human genome and their functions, including interactions with the environment, in relation to health and disease in populations"[5] Yet, Public Health Genomics is defined by the Public Health Genomics European Network (PHGEN) as "the responsible and effective integration of genome-based knowledge and technologies into public policy and into health services for the benefit of population health."[20] Despite such slight differences due to cultural and organizational variability, the central theme of *Public Health Genomics* is an interdisciplinary field in which public health professionals should be able to integrate genomic and environmental information into public health research, practice, and policy.
Genetic Medicine VS. Genomic Medicine	The notion of *Genomic Medicine* is broader than *Genetic Medicine. Genomic Medicine* seeks to apply the knowledge and tools generated by the HGP into medical practice. Unlike *Genetic Medicine,* focusing on relatively uncommon, single gene diseases, *Genomic Medicine* targets the majority of diseases which result from complex interactions of multiple genes and their environment(s). *Genomic Medicine* manifests itself as improved understanding of the biology of diseases and health, advanced gene therapies, patient-tailored pharmacotherapy, the utilization of increased genetic testing, and personalized medical care based on individuals' genomic profiles.[3, 11]
Pharmacogenetics VS.. Pharmacogenomics	*Pharmacogenetics* and *Pharmacogenomics* are two similar disciplines which explore how individuals' genetic variations can affect their responses to drugs. The former was recognized in the 1950s, and deals with single gene response to drugs; the latter was introduced in the 1990s, and investigates multiple genes' responses to drugs with the assistance of new genomic technologies (e.g. microarrays). Based on individuals' genomic profiles, *Pharmacogenomics* can be utilized to design personalized drugs to prevent and treat diseases. These can be expected to maximize the benefits of treatments and reduce medications' harmful side effects.[21]
Nutrigenetics VS. Nutrigenomics	Both *Nutrigenetics* and *Nutrigenomics* are specific areas in Nutrition Science, which are conceptually similar, but not identical, even though they are often used interchangeably. The discipline of *Nutrigenetics* investigates how individuals' genetic variations can affect their responses to specific nutrients. In contrast, *Nutrigenomis* seeks to understand the effects of nutrients on individuals' genetic expression and regulation. The progress of *Nutrigenetics* and *Nutrigenomics* holds promise to prevent diseases by not only allowing the development of personalized nutrition plans according to individuals' genomic make-up, but also by designing specific food products for sub-populations who share similar DNA codes.[22]
Health Literacy VS. Genetic Literacy	Health Literacy is defined as "the degree to which individuals have the capacity to obtain, process, and understand basic health information and services needed to make appropriate health decisions"[23] Health literacy is determined by an individual's education, by existing health system, by culture and by society. As a component of healthy literacy*, Genetic Literacy* "focuses on the context or the environment within which individuals and communities share information about genetics, try to understand the meaning of that information in their lives, and deliberate and debate with others how the applications of genetics should be used and for what purposes."[24]

2.3 Why Must Health Educators Develop Genomic Competencies?

For a listing of the arguments presented below, see Table 2.2.

Table 2.2 Reasons why health educators must develop genomic competencies

Argument 1	*Because leading professional organizations have advocated the incorporation of genomics into health promotion practice.*
Argument 2	*Because health educators' professional competencies and responsibilities encourage and corroborate the incorporation of genomics into health promotion practice.*
Argument 3	*Because health educators' genomic competencies can significantly impact the lay public's utilization of, and satisfaction with, public health genetic/genomic services.*
Argument 4	*Because by developing their genomic competencies, health educators are better able to meet emerging health needs.*
Argument 5	*Because genomics and public health are generating unique opportunities for interdisciplinary collaboration, research funding, and employment.*

Argument 1: Because leading professional organizations have advocated the incorporation of genomics into health promotion practice.

Over the past decade, several professional groups have supported the notion that health educators should develop their genomic competencies. The CDC, for instance, has gone as far as claiming that *every* public health professional should develop his/her genomic competencies.[7] Such competencies specifically require health educators to

1. "***Translate*** health related information about social and cultural environments, (including community needs and interests and

societal value systems) for use in population-based scientifically sound genomic health education programs;

2. ***Determine the factors*** such as learning styles, literacy, learning environment, and barriers that influence learning about genomics;
3. ***Differentiate*** between genomic education and genetic counseling;
4. ***Facilitate*** genomic education for agency staff, administrators, volunteers, community groups and other interested personnel;
5. ***Utilize social marketing*** to develop a plan for incorporating genomics into health education services by working with community organizations, genomic experts, and other resource people for support and assistance in program planning;
6. ***Provide a critical analysis*** of current and future community genomic education needs; and
7. ***Advocate*** [for] genomic education programs and/or integration of genomic components into education programs."[7]

Established in 1996, the National Coalition for Health Professional Education in Genetics (NCHPEG) is another professional group which notably promotes genomic education and competencies for all health professionals. More than 140 cross-discipline organizations, such as the ASPH and the American Academy of Nursing, are members of NCHPEG. The common core competencies in genetics, developed by NCHPEG, encompass 17 knowledge sub-competencies, 17 skills sub-competencies, and 10 attitudes sub-competencies.[25] Examples of knowledge sub-competencies include basic understanding of genetics terminology and "the influence of ethnicity, culture, related health beliefs, and economics in the clients' ability to use genetic information and services."[25(p.2)] Skills sub-competencies include "educate clients about availability of genetic testing and/or treatment for conditions seen frequently in practice" and "provide appropriate information about the potential risks, benefits, and limitations of genetic testing."[25(p.2)] Among the attitudes sub-competencies, "recognizing philosophical, theological, cultural, and ethical perspectives influencing use of genetic information and services" is one example."[25(p.3)]

In similar fashion, the Institute of Medicine (IOM) – when articulating the training needs for public health professionals regarding the interaction between genomics and health behavior – has set forth *genomics* as one of eight new content areas to be added to public health training curricula. These curricula should include basic and correct genomic knowledge as well as the ethical, legal, and social implications (ELSI) of genomics to ensure public health students "think genomically."[4 (p.70)]

Argument 2: Because health educators' professional competencies and responsibilities encourage and corroborate the incorporation of genomics into health promotion practice.

Defined and established by the Role Delineation Project (1979 - 1981), the responsibilities and competencies for health educators represent fundamental capacities and skills they need for planning, implementing and evaluating disease prevention and health promotion interventions. The project delineated 7 responsibilities and 29 competencies for entry-level health educators; later, 10 responsibilities and 39 competencies were added for graduate-level professionals.[26] From 1998 to 2004, Gilmore and colleagues[26] spearheaded the National Health Education Competencies Update Project (CUP) to redefine health educators' responsibilities and competencies. This revision resulted in a more complex set of skills, comprising 7 areas of responsibilities, 35 competencies, and 163 subcompetencies, categorized as entry, advanced-1, and advanced-2 levels of practice.

Many of the professional responsibilities outlined in both the Role Delineation and the CUP projects are, implicitly, consistent with the incorporation of genomics into health education practice. In three CUP Project areas of responsibility, for instance, (Area of Responsibility I – assess individual and community needs for health education; Area of Responsibility VI – serve as a health education resource person; and Area of Responsibility VII – communicate and advocate for health and health education), it becomes clear that health educators have duties to assess communities' and individuals' needs, to respond to their needs, and to satisfy their requests regarding genomics information and education.

Furthermore, as western societies continue to experience growth in demand for genomic services and persist on consuming biased or incomplete genomic information presented by mass media outlets[27], health educators' responsibilities come, even more sharply, into focus. Increasing demands for individual genetic testing, population screenings, gene therapy, and genetic counseling – all of which involve significant decision-making components on the part of consumers – will spotlight health educators' responsibilities to facilitate voluntary choices and to provide accurate information and education. These responsibilities also include assessing communities' needs for genomic services, responding to their questions, and conveying realistic expectations about the potential harms, limitations, and benefits of various genetic services, including the reliability and validity of genetic testing, possible psychological stress after genetic profiling, and the availability of treatments.[11, 28]

Argument 3: Because health educators' genomic competencies can significantly impact the lay public's utilization of, and satisfaction with, public health genetic/genomic services.

The Interaction Model of Client Health Behavior (IMCHB)[29] provides a theoretical rationale for why health educators need to develop their genomic competencies. The model proposes that health professionals' affective support, health information, decisional control, and professional technique/competencies can influence their clients' health outcomes. In this model, clients' health outcomes encompass utilization of health care services, clinical health status indicators, adherence to recommended care regimen, and satisfaction with care.

Likewise , health educators' affective support, genomic information, decisional control, and genomic competencies can be theoretically expected to affect 1) the lay public' utilization of genomic services, 2) individuals' health status, 3) lay people's adherence to a healthy lifestyle after being informed of their genetic testing results and genomic profile, and 4) overall satisfaction with health promotion and disease prevention programs. In tandem with their ethical responsibility to the public, it will be important that health educators maintain the vision that they have an important role to play regarding the quality of health promotion services and that, in turn, such quality will increasingly be shaped by the quality of genetics-related education being provided.

Argument 4: Because by developing their genomic competencies, health educators are better able to meet emerging health needs.

The rapid pace of genomic discoveries is dramatically increasing the amount of information and tools available for use, yet the chasm between genomic knowledge and public health practice remains. This gap results, in part, from the slow progress in understanding the impact of genomic technologies, and in translating information into effective interventions. Therefore, closing the gap between *knowing* and *doing* is a pre-eminent emerging need justifying, in part, why health educators should develop their genomic competencies. In fact, many health educators have already begun to contribute toward minimizing this rift, by incorporating family history assessments, for instance, into screening programs for high blood pressure and stroke prevention.[30]

A second emerging need is to address concerns stemming from the impact of direct-to-consumer (DTC) advertising campaigns for genetic testing. Although the American College of Medical Genetics stands against DTC genetic testing[31], increased public interests and demands for this type of testing can still lead to private genetic services marketed directly to consumers. These market pressures, coupled with limited regulation of DTC advertising for genetic testing, may generate unique problems for public health.

These problems encompass clients' lack of adequate information and knowledge for pre-test decision making and interpreting of test results, as well as inappropriate test utilization (e.g., ordering a genetic test of dubious clinical validity and utility).[31, 32]

BRCA1/ BRCA2 testing for breast and ovarian cancer was the first genetic test marketed directly to the public. Women with mutated BRCA1/ BRCA2 genes have an increased likelihood of developing breast and ovarian cancer in their lifetimes. From September 2002 to February 2003, Myriad Genetic Laboratories, Inc. carried out a pilot DTC marketing campaign to advertise a BRCA1/ BRCA2 genetic test (BRAC*Analysis*®) to both women (aged 25-54 years with breast and ovarian cancer family histories) and health care providers in Atlanta, Georgia, and Denver, Colorado. This DTC marketing strategy successfully increased both consumers' and health care providers' awareness of BRCA1/ BRCA2 testing. Yet, messages from DTC advertisements were misleading. For example, BRAC*Analysis*® was portrayed as a critical tool to detect consumers' cancer risk without informing them that only a small number of breast cancer cases are caused by mutated BRCA 1/ BRCA2 genes. Along with potentially misleading information, clients were motivated to order genetic screening tests directly from the manufacturer (to bypass potential difficulties with health insurance companies), without prior consultation with their health care providers.[32]

Despite such concerns, genetic testing for BRCA1/BRCA2 will not be the last DTC marketing effort unless the U.S. Food and Drug Administration and the Federal Trade Commission can effectively regulate DTC advertising campaigns for such tests. At present, online DNA tests for breast/ovarian cancer, colon cancer, cystic fibrosis, and infertility are advertised and sold directly to consumers.[33] Health educators can, therefore, play an important role in preventing or mitigating the potentially harmful effects of self-prescribed genetic testing, by raising the public's awareness and providing adequate education. Not only can health educators inform the public of the advantages, disadvantages, and limitations of on-line genetic tests, they can also engage in policy-making and client advocacy regarding regulation of genetics-related marketing efforts. Development of health educators' genomic competencies – within this context – becomes, therefore, both vital and urgent.

Alongside these emergent needs, the paucity of certified personnel to advise clients, coupled with genetic counselors' work overload, create the need for health educators to play a role in the pool of available genetic services. In the U.S., genetic counselors receive graduate degrees in the field of medical genetics and counseling from accredited universities. Genetic counselors' tasks include providing information – through a "non-directive" approach – regarding hereditary diseases and genetic tests, alongside connecting clients to community services and support systems. Presently, the National Society of Genetic Counselors estimates approximately 2,100 genetic counselors serve over 1.5 million clients each year in the U.S., and most work in major urban medical centers.[34]

Parallel to the knowledge and practice gap, an important gulf between genetic/genomic needs and services exists, which health educators could help fill. Given their ability to work with various population groups, health educators could certainly provide genetic education and promote better understanding of genetic services, thus minimizing unwarranted anxiety and fear. While health educators could directly impact the provision of genetic/genomic services to populations with specific genomics-related needs, working within communities to promote awareness and to dispel anxieties regarding genetic services might contribute indirectly to the general public's understanding of the possibilities and limitations of genetic services, and to the improvement of the informed consent process, for genetic testing. Community-based health education promoting the linkage of service providers, community agencies, and potential clients, naturally falls under the scope of health educators' professional tasks.[28]

Argument 5: Because genomics and public health are generating unique opportunities for interdisciplinary collaboration, research funding, and employment.

Advancing PHG research and practice requires collaboration and engagement of professionals across various disciplines, including health education, special education, medicine, pharmacology, nutrition, social work, physical therapy, occupational therapy, nursing, psychology, law, genetic counseling, and genetics. Collaborations among areas with different methodological traditions and professional training can foster better understanding of, and approaches to all health issues, generally, but particularly regarding the intersection of genomics and public health. Thus far, few interdisciplinary research reports have been published in the scientific literature and the need for collecting base-line and educational outcomes data, for instance, is paramount.

Availability of funding for collaborative research and intervention might seem like a less-than-noble argument to persuade health educators to develop their genomics competencies. Yet it is encouraging to learn that the integration of genomics and health promotion is generating new funding opportunities, especially given the current diminishing resources for research and interventions regarding health behavior and education.

The first director of the NIH National Center for Human Genome Research, James D. Watson, suggested that a portion of the HGP budget should be used to study the ELSI of genomic research.[35] The NIH has, therefore, consistently made research funds available for research projects addressing the ELSI of genomic discoveries. The CDC and the U.S. Department of Health Resources and Services Administration (HRSA) are examples of other federal agencies encouraging genomic-related health promotion and disease prevention research. By way of illustration, in 2005, the CDC funded The University of Michigan's School of Medicine, the Evanston Northwestern Healthcare Research Institute, and Case Western Reserve University School of Medicine to evaluate a family history tool. In 2006, the CDC funded 11 additional projects which proposed to adopt genomics into public health research and practice. Moreover, private donors such as The Robert Wood Johnson Foundation and the March of Dimes, frequently offer grants to support studies related to genomics and health promotion.

In addition, a 1998 survey of employers such as schools of public health or preventive medicine, state/municipal health offices, insurance companies and HMOs, as well as biotechnology and pharmaceutical companies, revealed approximately 40% of respondents admitting they were "planning to hire individuals with competencies in public health genetics in the next 5 years."[36 (p.143)] This unique survey, conducted by the

Genetics in Public Health Training Collaboration, revealed that employers valued specific genetics competencies such as "apply epidemiologic and statistical studies of disease with a genetic component" (considered important or very important by 78.4% of employers sampled), and "apply methods to address ethical, legal, social and financial implications of genetics in public health" (70.3% considered important/very important). Respondents who rated these competencies as important or very important planned "on hiring individuals with that competency skill in the next 5 years."[36 (p.146)]

2.4 Discussion and Implications

In this article we proposed five arguments supporting the need for health educators to develop their genomic competencies and integrate PHG into health promotion/education. These arguments touched on various dimensions of health educators' professional goals and ranged from professional responsibilities and competencies, to the availability of funding for genomic-related research or interventions and opportunities for future employment (Table 2.2). Alongside these arguments, we presented a brief listing of key PHG terms – with their most widespread definitions – in order to facilitate understanding of the issues, and to establish a common set of meanings for readers.

The impetus for outlining this structured rationale in the American Journal of Health Education originated when we began to conduct research in the area of PHG. The more we learned about the PHG "world", the more the absence of appreciable health education initiatives and of health education professionals' involvement with the topic, became apparent. Professional genetic counselors – given their drastically small numbers – are struggling to meet their clients' needs and public health organizations (as well as civic groups, worldwide[16]) are clamoring for easily accessible education and information regarding PHG. If these scenarios are valid, *where are the health educators?*

Granted, efforts to incorporate genomics into health promotion research and practice are in place at many levels, but the profession is still very far from any sort of "tipping point." Some efforts worthy of notice include, for instance, revisions made to Green and Kreuter's PRECEDE-PROCEED planning model.[37] In the most recent edition of their classic, *Health Program Planning: an Educational and Ecological Approach (2005)*, the authors included "Genetics" as a core element in the model's epidemiological assessment phase. "Genetics" now stands, alongside "Behavior" and "Environment", as a factor that bears upon individuals' and populations' health and, as such, must be considered when planning, implementing, and evaluating effective interventions. Inclusion of a genetics element in this model, undoubtedly "forces" health promoters to consider this dimension in their planning of behavior-change programs, by prompting consideration of genetic aspects of the particular health behavior being targeted for change.

Other instances where professional strides have begun include offerings of courses and/or professional development opportunities at various public health training programs, nationwide, including at the University of Michigan, the University of Washington, and the University of North Carolina at Chapel Hill schools of public health. The University of Washington, for example, has implemented (in 2003) the first doctoral program in public health genetics in the U.S. and the world. Moreover, national and international professional conferences (such as the 2006 Annual Meeting of the American Public Health Association; the 4th DNA Sampling Conference on Public Health Genomics [2006 – Canada]; and the 2006 CDC National Health Promotion Conference with the theme of genetics/genomics), have gradually increased their emphasis on PHG. Very few presenters at these meetings, however, are health educators and most topics are not presented from a health education perspective. Lastly, professional textbooks in various fields also have begun to reflect the emerging emphasis on PHG. Texts are being published on human genome epidemiology, clinical genetic and nursing practice, genomic medicine, nutritional genomics and pharmacogenetics. While proposals for PHG textbooks may be circulating among publishing houses at this moment, health educators do not – yet – have access to quality publications focusing on the role of health education in PHG.

The arguments presented in this paper were intended to provide health educators with a multi-dimensional view of the need for incorporating genetics/genomics into health promotion practice and research. It is important to recognize, however, that most of these dimensions are rooted in an *ethical mandate*. As outlined in the Code of Ethics for the Health Education Profession, health educators share important values and responsibilities regarding their practice, including responsibility to the public, and responsibility to employers. Yet, ultimately, health educators have an ethical responsibility to the profession. Public health or health education professionals who developed genomic competencies can help meet the standards established by *Healthy People 2010*[38] for high quality public health programming. Failure to incorporate genomics into public health education, however, carries with it the risk of being perceived as condoning unethical conduct, and will lead to a stagnant field and an outdated workforce.

In presenting these five arguments, we take an important step toward increasing health educators' awareness of PHG. An equally significant and rather large task remains, however: to devise the mechanisms that will allow and facilitate health educators' incorporation of PHG into their health promotion research and practice. As starting points, the IOM has suggested that efforts should be made to a) assess the impact of genomic information on the lay public's short-and long-term behavioral changes, and b) explore the ELSI of genomic information and technologies.[39] Similarly, Wang, Bowen, and Kardia[28] outlined three areas for immediate research and practice opportunities in health promotion: assessment of the public's understanding of genetics; evaluation of interventions for health behavior change (with emphasis on evaluating the impact of genomic information on individuals' lifestyle changes and clarifying the influences of family histories on individuals' health behaviors); and "public health assurance and advocacy [28(p.692)]", through reduction of the harmful effects of DTC advertising for genetic testing, and preventing potential health disparities from genetic discrimination or unequal public access to genetic/genomic services. Engaging in such tasks would sharpen health educators' perceptions of the need for genomic competencies and would provide the appropriate context for their development.

With the completion of the HGP, "the genomic era is now a reality"[9 (p.835)] and health educators are called upon to adapt and develop new competencies. Undoubtedly, much has yet to be defined (e.g., what specific genetic/genomic knowledge will health educators need to have?), and established (e.g., development of Master's-level training programs for health educators interested in PHG), but as we undertake this "road less traveled", our profession will improve and we will have made an ethical choice.

3. PUBLIC HEALTH GENOMICS: HEALTH EDUCATORS' KNOWLEDGE AND ATTITUDES

3.1 Introduction

According to the Centers for Disease Control and Prevention (CDC), Public Health Genomics (PHG) represents "the study and application of knowledge about the elements of the human genome and their functions, including interactions with the environment, in relation to health and disease in populations."[5] Due to its multidisciplinary nature, collaboration among various fields is required to advance PHG. These fields include molecular epidemiology, pathobiology, bioinformatics, pharmacogenetics, nutrition, health services, public policy, bioethics, law, health promotion and health education. The ultimate goal of PHG is to apply genomics information and technologies to improve population health and prevent diseases.[5, 11]

As one of its team players, public health educators have a unique and critical role in PHG. Because public health educators bridge the gap between health care and lay public communities, they can reflect communities' concerns to health care professionals and policy makers, and help health professionals communicate with community groups and individuals appropriately, regarding genomic information and technologies.[40] Moreover, research and practice carried out by public health educators can also increase lay communities' genetic/genomic knowledge, determine the impact of available genomic technologies on the public's health and wellbeing, affect the lay public's satisfaction with genetic/genomic services, and facilitate lifestyle changes by using family history and genetic testing results.[28, 41]

Thus, several professional organizations have advocated the need for public health educators to develop their genomic competencies in order to conduct genomics-related health promotion and disease prevention. For example, the Institute of Medicine (IOM) recommends genomics as one of eight new content areas to be covered by every school of public health.[4] The CDC also developed 7 genomic competencies for public health educators.[7] Additionally, the National Coalition for Health Professional Education in Genetics (NCHPEG) established core competencies in genetics for health professionals.[25]

To date, however, no studies have examined public health educators' attitudes toward the CDC-proposed genomic competencies nor their awareness of efforts in the health promotion field to promote/incorporate genomics. Also, little is known regarding health educators' knowledge of genomics, since the curricula of most health education programs do not include course work in that topic area. As practicing genomics competencies is a relatively new concept for public health educators (i.e., an *innovation*), we adopted Rogers' Diffusion of Innovations Theory[42] as a framework in this study. According to this theory, individuals' knowledge can impact their attitudes which, in turn, influence their decision to adopt and implement an innovation. Additionally, the theory also postulates that socioeconomic characteristics are associated with individuals' knowledge and attitudes.[42]

We conducted this study attempting to assess: 1) U.S. public health educators' attitudes toward genomic competencies; 2) their awareness of efforts in the health promotion field to promote/incorporate genomics; 3) their knowledge of basic & applied genomic principles; 4) the associations among socioeconomic characteristics and public health educators' attitudes, awareness, and basic & applied genomic knowledge; and 5) the relationship among attitudes, awareness, and basic & applied genomic knowledge.

3.2 Materials and Methods

3.2.1 Instrument

To assess health educators, nation-wide, we developed a web-based survey, entitled "Health Promotion and Genetics/Genomics (HPG)". The survey was created with the assistance of Zoomerang™ (a commercial web-based survey tool). Cognitive and retrospective interviews were performed to ensure the measures elicited valid and reliable data.[43] Content validity was assessed by a geneticist and 3 faculty members in health education/health behavior at two universities. During September 2006, to help refine and test the survey procedures, a pilot test was conducted by distributing it to a random sample of 385 public health educators (response rate = 16.1%). Lessons learned from this pilot test helped improve the survey. For instance, to reduce the large amounts of missing data encountered for the socioeconomic characteristics questions, we revised the questions and moved them from the end, to the beginning of the survey.

In the final version of the HPG survey, respondents were first asked their socioeconomic characteristics, including their age, gender, ethnicity, religious preference, education level, work settings, years of practice, training in PHG, and their Health Education Specialist certification status (CHES). Subsequently, they were asked 14 questions regarding their beliefs (n = 7) and values (n = 7) related to seven specific genomic competencies proposed by the CDC for health educators (and re-worded for this study – see Table 3.2). In the last two sections of the survey, five items asked if public health educators were familiar with efforts made in the health promotion field to promote/adopt PHG (responses were given in 5-point Likert scale, from not familiar at all to complete familiar); and six multiple-choice questions, modified from the instrument developed by Bankhead et al.[44] and Henneman et al.[45], assessed respondents' knowledge related to basic & applied genomics.

To reduce the phenomenon of social desirability in respondents' answers, we did not inform them the genomic competencies listed in the beliefs and values (or attitudes) questions were proposed by the CDC. Additionally, the awareness and basic & applied genomic knowledge questions were placed at the end of the survey, in order to avoid potential feelings of intimidation. The estimated time for completing the survey was 15-20 minutes. Participants could receive incentives for participating in the survey, by entering a drawing for four $50 money order certificates. To take advantage of the learning opportunity this survey represented, all participants were provided access to five PHG continuing education links to learn more about PHG. The final version of the HPG survey is available upon request to the main author.

3.2.2 Study Sample

We requested approval from 5 major public health education and health promotion organizations, to access members' e-mails, and obtained permission from 3 organizations: the National Commission for Health Education Credentialing (NCHEC), the Society for Public Health Education (SOPHE), and the School Health Education and

Services (SHES) Section of the American Public Health Association (APHA). Furthermore, we were granted permission to use e-mail addresses of members of the Health Education E-mail Directory (HEDIR), a major health education electronic communication listeserv, serving most members of the American Association of Health Education (AAHE). In total, 9,391 e-mail addresses were collected.

3.2.3 Procedures

All study procedures were approved by the Institutional Review Board of (AUTHORS' UNIVERSITY). We sought to survey the entire sampling frame of 9,391 names, by sending three personalized e-mails (one notice and two follow-ups), containing the link to the HPG web-based survey and to invite their participation. In addition, the American School Health Association (ASHA) and the HEDIR also advertised the study by distributing two separate survey links to their members. In both the personalized e-mails (sent by the main author) and the advertisements sent by the two listservs, we mentioned our inclusion criteria: to be eligible to participate, respondents should self-identify as a health educator/health promoter and currently work as a health educator/health promoter.

While we sent 9,391 e-mail invitations to health educators across the nation, 1,333 were found to be invalid (i.e., 1,267 were undeliverable, duplicated, or incorrect; and 66 respondents, during the data collection period, informed us that they did not match our inclusion criteria). Among the remaining 8,058 valid e-mails, a total of 1,862 public health educators completed the survey (estimated response rate = 23.1%). Because of the anonymity of the HPG survey, we could not assess potential bias in the response rate by examining whether respondents differed from non-respondents in any systematic manner.

3.2.4 Statistical Analyses

We performed all statistical analyses of survey data using SPSS® version 14.0 (SPSS Inc., Chicago, IL). We also assessed the data for missingness and frequency distributions. As 17% of the data for the attitudes scaled variable were missing, we imputed the mean for the overall attitude score, to estimate missing values.[46] Various multiple regression models assessed the associations among socioeconomic characteristics, attitudes, awareness, and basic & applied genomic knowledge. Probabilities $< .05$ were considered statistically significant, when testing null hypotheses.

This study also tested the data's validity and reliability, through exploratory factor analysis, and Cronbach's alpha. The construct validity of the basic & applied knowledge data was also assessed through confirmatory factor analysis, with the assistance of Analysis of Moment Structures (AMOS), version 7.0. Validity and reliability testing indicated the data were psychometrically sound[47] (further details of psychometric testing are available from the main author).

3.3 Results

3.3.1 Socioeconomic Characteristics of the Sample

Among the 1,863 returned surveys, those containing items exhibiting more than 50% missing data were deleted; therefore, the final sample consisted of 1,607 valid questionnaires. Table 3.1 lists the socioeconomic characteristics of the sample. The average age was 40.1 years (SD = 12.0) and the average years of practice in health education was 11.2 (SD = 9.3). Respondents were predominantly White (76.8%), female (83.9%), and CHES certified (81.1%). Most identified themselves as Christian (70.5%). As respondents were allowed to choose multiple work settings, 51.7% said they worked in a community setting, 44.4% in a college/university setting, 37.3% in a government setting, and 35.8% in a health care setting. The majority of respondents (71.4%) had never received any training in genetics, genomics, or PHG, whilst 15.6% had taken courses and 13.1% had received other types of training in PHG (e.g., obtaining continuing education units, attending conferences, receiving job training, and conducting research.)

3.3.2 Attitudes toward Genomic Competencies

Table 3.2 displays the frequency of respondents' agreement with each of the genomic competencies presented to them. As our measure of attitudes comprised two dimensions (beliefs and values), respondents were first asked whether they agreed/disagreed with the 7 statements related to specific genomic tasks. In general, most health educators surveyed (88.6%) strongly agreed/agreed with the genomic competencies being proposed. The highest frequency of agreement was found for the competency, "conducting a needs assessment for community-based genomic education programs (90.8%)", whereas "advocating for community-based genomic education programs" had the fewest respondents agreeing (86.6%).

Table 3.1 Characteristics of participating public health educators

Characteristic	N	%
Mean age	40.1 years ± 12.0	
Gender		
Male	257	16.1
Female	1344	83.9
Ethnicity		
White	1217	76.8
Non-white	368	23.2
Black/African American	164	10.3
Hispanic/Latino	86	5.4
Asian/Pacific Islander	77	4.9
Alaskan Native/American (Native) Indian	8	0.5
Other	33	2.1
Religious Preference		
Christian[a]	1095	70.5
Non-Christian[b]	460	29.6
Degree		
Bachelor's degree or less	293	18.3
Master's degree	973	60.7
Doctoral degree	337	21.0
CHES Certified		
Yes	1303	81.1
No	303	18.9
Work Settings[a]		
Community setting	831	51.7
College/University setting	714	44.4
Local/County/State/Federal Government Setting	600	37.3
Health care setting	576	35.8
K-12 school setting	366	22.8
Business/Industry Setting	232	14.4
College/University Health Services Setting	147	9.1
Training in genetics/genomics or public health genomics		
No training	1143	71.4
Took Courses	249	15.6
Other training[b]	209	13.1

[a.] Respondents were allowed to choose multiple work settings.
[b.] Other training included Continuing Education Units, conferences, job training, research, self-study, etc.

Table 3.2 Percentage distribution of public health educators' responses to questions regarding their attitudes toward the modified CDC genomic competencies (N = 1,607)

Health educators' genomic competencies	**Attitudes toward public health genomics**			
	Beliefs		**Values**	
	Agree (%)	**Disagree (%)**	**Important (%)**	**Not Important (%)**
Translating complex genomic information for use in community-based health education programs	87.8%	12.2 %	48.9%	51.1%
Facilitating genomic education for agency staff, administrators, volunteers, community groups, and other interested personnel	87.6 %	12.4 %	45.5%	54.6 %
Developing a plan for incorporating genomics into health education services by working with community organizations, genomic experts, and other stakeholders	88.6 %	11.4 %	47.4%	52.6 %
Conducting a needs assessment for community-based genomic education programs	90.8 %	9.1 %	52.0%	48.0 %
Advocating for community-based genomic education programs	86.6 %	13.3 %	49.5%	50.5 %
Integrating genomic components into community-based genomic education programs	88.6 %	11.4 %	52.3%	47.8 %
Evaluating the effectiveness of community-based genomic education programs	89.9 %	10.1 %	49.4%	50.5 %

Nearly half of the sample (49.3%) believed that it was somewhat or extremely important for them to practice genomic competencies, ranging from 52.3% saying that it was important for them to integrate genomic components into community-based genomic education programs to 45.5% stating that it was important for them to facilitate genomic education for agency staff, administrators, volunteers, community groups, and other interested personnel.

3.3.3 Awareness

Participants were asked whether they were familiar with the efforts made in the health promotion field to promote/incorporate PHG (Table 3.3). Overall, public health educators had little awareness of key events, or elements, related to PHG. A total of 26.4% of public health educators were familiar with the fact that "Genetics" has been added to Phase 2 (Epidemiological Assessment) of the PRECEDE-PROCEED Model, a widely-adopted health intervention planning mode.[37] Similarly, most public health educators in our sample were unaware that the Institute of Medicine has recommended

Table 3.3 Percentage distribution of public health educators' responses to questions regarding the awareness of effort in health promotion field to promote/incorporate public health genomics (awareness)

Please rate your familiarity with...	Familiar	Not Familiar	Neutral
"Genetics" has been added to phase 2 (Epidemiological Assessment) of the PRECEDE-PROCEED Model?	26.4	61.1[b]	12.5
The Institute of Medicine has recommended genomics as one of eight new content areas for public health education programs.	5.7	84.8	9.5
The CDC has recommended 7 genomic competencies for health educators.	3.9	87.5	8.6
The National Coalition for Health Professional Education in Genetics (NCHPEG) has established the *core competencies in genetics* for health professionals.	3.5	89.6	6.9
The CDC and 3 Universities[a], have developed the web-based training tool, *E-Facts on Public Health Genomics* (formerly *Genomics for Public Health Practitioners*).	3.4	90.6	6.0

[a] University of Michigan, University of North Carolina, and University of Washington
[b] This percentage was also added by the percentage of the answer, "I am not familiar with the PRECEDE-PROCEED Model".

genomics as one of eight new content areas for public health education programs (84.8%). They were also unaware – in large numbers – that the CDC has recommended 7 genomic competencies for public health educators (87.5%) and that the NCHPEG has established core competencies in genetics for health professionals (89.6%). Nearly the entire sample ignored the fact that the CDC, the University of Michigan, the University of North Carolina, and the University of Washington have developed a web-based training tool, "E-Facts on Public Health Genomics" to train public health workers in PHG (90.6%).

3.3.4 Basic and Applied Genomic Knowledge

Six multiple-choice items were developed to measure respondents' basic & applied genomic knowledge. For each question, six answer options were provided to the respondents and only one answer was correct. On average, 51.1% of the answers to the six items regarding basic & applied genomic knowledge were correct (equivalent to an "F" grade, in most university settings). The majority of participants (89.0%) answered correctly that "taking folic acid before and during the early stages of pregnancy could reduce a fetus' risk of neural tube defects." While most (85.5%) knew that positive genetic testing results indicated a higher-than-average risk for a specific disorder, approximately 70% did not recognize that genetic testing was utilized both to detect individuals' genotype, and to calculate the offspring's chance of developing an autosomal recessive disorder if both parents are carriers. Additionally, almost half stated they could not make appropriate public health recommendations based on the findings from their clients' family histories. The question regarding the Human Genome Project had the lowest correct response rate: Only one-fifth of the respondents answered correctly that 99.9% of nucleotide bases were exactly the same in all people.

Table 3.4 Multiple regression analyses of predictors of public health educators' attitudes toward genomic competencies, awareness of efforts in the health promotion field to promote/incorporate PHG, and basic & applied genomic knowledge.

Predictors	**Model 1 Attitudes** (*Adjusted R^2 = 0.11*)			**Model 2 Awareness** (*Adjusted R^2 = 0.05*)			**Model 3 Basic and Applied Knowledge** (*Adjusted R^2 = 0.06*)		
	ß	SE	*p*-value	ß	SE	*p*-value	ß	SE	*p*-value
Age	-0.002	0.064	0.952	-0.049	0.013	0.227	-0.019	0.005	0.645
Gender	-0.012	1.418	0.672	-0.064	0.278	0.020	0.080	0.103	0.004
Ethnicity	-0.078	1.196	0.004	-0.060	0.239	0.027	0.076	0.087	0.005
Religious Preference	-0.008	1.092	0.752	0.016	0.217	0.558	-0.072	0.080	0.008
Degree Bachelor's Degree or Less vs. Master's Degree	-0.053	1.335	0.127	-0.041	0.269	0.250	0.048	0.097	0.179
Degree Bachelor's Degree or Less vs. Doctoral Degree	-0.024	1.777	0.530	0.113	0.355	0.004	0.123	0.128	0.001
CHES Certified	0.050	2.969	0.528	0.177	0.583	0.025	0.142	0.215	0.076
Work Setting Non-Health Care Setting vs. Health Care Setting[a]	0.002	2.549	0.980	-0.162	0.498	0.040	-0.098	0.185	0.222
Years of Professional Practice	-0.042	0.084	0.303	0.037	0.017	0.381	-0.092	0.006	0.026
Training in Genetics/Genomics or PHG No Training vs. Took Courses	0.032	1.429	0.248	0.156	0.276	0.000	0.171	0.102	0.000
Training in Genetics/Genomics or PHG No Training vs. Other Training[b]	0.066	2.299	0.014	0.063	0.464	0.020	0.058	0.166	0.033
Awareness	0.279	0.137	0.000	—	—	—	—	—	—
Basic & Applied Genomic Knowledge	0.071	0.380	0.010	—	—	—	—	—	—

[a]: Health care setting also included College/University health services setting
[b]: Other training included Continuing Education Units, conferences, job training, and research , self-study, etc.

3.3.5 Socioeconomic Factors Associated With Attitudes, Awareness, and Basic and Applied Genomic Knowledge

To assess if select socioeconomic factors were associated with attitudes, awareness, and basic & applied genomic knowledge in our sample, we ran a series of regression analyses. The analyses consisted of developing various regression models, beginning with a demographic-characteristics-only model, and systematically adding a single variable to the previous models. These additions of variables to each subsequent model were done manually, and are not the same as the step-wise regression analysis procedure. Table 3.4 presents only the last models in each series, containing all variables, as these models comprise the maximum amount of statistical controlling. Testing of the data also indicated the absence of a multicollinearity problem for the models (Table 3.4).

In Model 1, ethnicity (being non-white) and training in PHG, such as attending continuing education/conferences activities, were the only two socioeconomic factors positively associated with respondents' attitudes toward genomic competencies. An attitude scaled variable was computed by linearly combining belief and value items. Yet, their regression coefficients were quite small (ß = - 0.078 for ethnicity and ß = 0.066 for training)

The dependent variable in Model 2 was respondents' awareness of the efforts made in the health promotion field to promote/incorporate PHG. An overall awareness score was calculated by summing respondents scored on five relevant items. Seven socioeconomic factors were positively related to respondents' level of awareness: gender (male), ethnicity (non-white), doctoral degree, CHES certification, working in non-health care setting, taking courses related to genetics/genomics or other training related to PHG. Among these factors, the strongest predictor of awareness was whether respondents were certified as health education specialist (ß = 0.177).

Model 3 examined respondents' socioeconomic characteristics and their relationship with basic & applied genomic knowledge. The basic & applied genomic knowledge index was computed as the sum of respondents' answers to 6 knowledge items. Model 3 indicates that males, whites, non-Christians, those with doctoral degrees, with fewer years of work in health education/promotion, and those who have had training in genetics/genomics were more likely to score higher in the basic & applied genomics items. Moreover, training (in the form of taking courses related to genetics, genomics, and/or PHG) had the strongest association with basic & applied genomic knowledge (ß = 0.171).

3.3.6 Associations among Attitudes, Awareness, and Basic and Applied Genomic Knowledge

In Table 3.4, Model 1 also showed that, after controlling for the variance of the socioeconomic factors, both awareness and basic & applied genomic knowledge were significantly associated with respondents' attitudes toward genomic competencies. Stronger awareness of efforts in the field to incorporate PHG was significantly associated (ß = 0.279) with better attitudes toward PHG competencies for public health educators.

3.4 Discussion

While several studies have surveyed various health professionals' attitudes and/or knowledge regarding genetics/genomics[8, 48-60], to the best of our knowledge this is the first study which seeks to assess public health educators' attitudes, awareness, and genomic knowledge related to PHG. Responding to the first question proposed in this study, our findings indicated that the majority of public health educators (88.6%) in our sample agreed with the CDC-proposed genomic competencies. Yet, fewer respondents (49.3%) appeared to value the practice of each genomic-related task. When attitudes are conceptualized as the linear combination of these two dimensions (beliefs and values), our sample's overall attitude toward the competencies was not very positive (mean = 53.2 points ± 20.7, median = 54.0 points; the theoretical mid-point of the scale was 59.5 points [range: 7-112 points]), with a higher score indicating more positive attitudes.

The second question in this study sought to assess public health educators' awareness of efforts in the health promotion field to promote/incorporate genomics. Overall, public health educators in our sample were unaware that professional organizations such as the CDC, IOM, and NCHPEG, have called for public health educators to engage in genomics-related research and practice. This finding is in line with that of another study conducted by Irwin et al. which found that only a minority of North Carolina public health nurses were familiar with the CDC's genomic competencies.[57]

Conversely, over one-forth of respondents were familiar with the fact that the PRECEDE-PROCEED Model, one of the most popular health education program planning and evaluation models ever developed and adopted by these professionals, had added "genetic factors" to the original model in 2005. This suggests that respondents were more aware of changes made in their own professional field (health education/promotion) than they were of broader changes being implemented in related professional organizations. This finding suggests that professional health education organizations should take note: As of February 2007, for instance, none of the major public health education organizations was a member of NCHPEG.[61] Joining NCHPEG may increase these organizations' willingness to promote PHG and further increase public health educators' awareness of their professional responsibilities as team-players in PHG.

In response to our third research question, we found a significant deficiency in knowledge of genomics within our sample. Given the possibility that participants with a higher level of genomics knowledge were over-represented in this study due to the survey's character, public health educators' genomic knowledge may, in reality, be lower than what was found in this study. In general, respondents had deficient knowledge in genomics, albeit they fared better in the "applied" knowledge questions, than in the "basic" ones. The simplest and immediate explanation is that the majority of training programs in health education and public health do not include either genetics or genomics in their curriculum.[62] Fortunately, incorporating genomics into the public health curriculum is beginning to be promoted by scholars in public health and genomic medicine.[63]

Because public health education is an applied professional field, it makes sense that basic genomics may not be valued as highly as applied genomics. Yet, according to the

Diffusion of Innovations Theory, "it is usually possible to adopt an innovation [PHG] without principles-knowledge [basic knowledge], but the danger of misusing a new idea is greater and discontinuance may result."[42 (p173)] To avoid public health educators' misrepresenting genomic information to the public and, therefore, hindering the practice of genomics-related health promotion, training in essential genomics concepts and methods for public health educators should be carefully considered.

The fourth question proposed by this study regarded the associations among socioeconomic factors, attitudes, and basic & applied genomic knowledge. Findings from the multiple regression models raise many important issues. First, albeit Non-White survey respondents exhibited less basic genomic knowledge than Whites, Non-Whites had higher awareness regarding, and more favorable attitudes toward, the CDC genomic competencies' statements. This finding is consistent with Singer et al.'s study[64], indicating that ethnical minorities had more positive attitudes toward utilizing genetic testing than whites, even though minorities had less knowledge regarding genetic testing. Laskey et al[54] also found the ethnic minority pre-med students had positive attitudes toward using genetic testing to carry out disease prevention and interventions. As public health educators serve as a communication channel between health care systems and their own communities, their positive attitudes may encourage ethnic minorities to accept genomics-related health promotion and intervention programs in the future. Ethnic diversity in attitudes toward PHG may, in fact, carry positive outcomes for PHG. This should be systematically examined in future research of the public health workforce.

As expected, the findings regarding training and education levels, within our sample, echo previous studies which surveyed other health professionals: Exposure to genetics/genomics or PHG training[60, 65] and higher levels of education[66] were associated with better genomic knowledge and awareness, whereas years of professional practice exhibited a negatively correlation.[60] An interesting result was also found that respondents with CHES certification were more aware of efforts made in health promotion areas regarding PHG. Nevertheless, it remains unclear why male participants in our sample were more familiar with efforts in the health promotion field to promote/incorporate PHG, but had less genomic knowledge than females.

Respondents who worked in non-health care settings were also more familiar with efforts made in health promotion regarding PHG. As PHG is a new innovation, primarily advocated by researchers and practitioners from academia and the federal/state governments, respondents in a health care setting may not have started to integrate genomic discoveries into their practice. As changing health behavior is often the subsequent step after clients learn about a positive genetic testing result, increasing referrals of clients to public health educators is anticipated to happen. Thus, it is importance for public health educators who practice in a health care setting to understand their roles in PHG.

Among our findings, only training in genomics/PHG is amenable to intervention and change. This finding is supported by Guttmacher et al.[67] which highlight the importance of continuing education for health care professionals. Thus, relevant training should also be developed and advocated. Continuing education tools, focusing on PHG-content, might be an important venue for delivery of PHG information and for the development of favorable professional attitudes.

Lastly, according to the Diffusion of Innovations Theory[42], this study proposed to examine whether awareness, basic & applied genomic knowledge, and attitudes were associated. We found both awareness and knowledge had positive relationships with respondents' attitudes toward genomic competencies. Since the innovation-decision process contains five steps, namely, *knowledge, persuasion*, *decision*, i*mplementation*, and *confirmation process*[42], it is important for public health educators to know about the existence of PHG, to learn how to conduct genomics-related health promotion, and to espouse positive attitudes (the *persuasion stage)*. Only then will they be equipped to choose to adopt genomics-related health promotion (the *decision stage)* and subsequently implement (the *implementation stage*) and seek reinforcement for their previous commitments (the *confirmation stage*).

3.4.1 Study Limitations

There are two limitations in this study, which researchers and practitioners should consider before applying our findings. While this study assessed public health educators' attitudes, awareness, and knowledge related to PHG, the inability to generalize, due to potential sample bias, is its major drawback. Three factors may have contributed to sample bias. First, due to lack of information regarding the "true" population of health educators in the U.S., we had to survey members of major health education professional organizations. Yet, not every health educator in the U.S. belongs to these selected organizations. Second, a potential self-selection bias may have occurred, as public health educators completing the survey may have stronger beliefs of their role in PHG, may have more genomic knowledge, or may have greater interest in this emerging topic. Third, we utilized a non-traditional survey approach (web-based) to obtain more honest responses and recruit more participants, but this could have resulted in non-response bias due to respondents' inability or unwillingness to complete the survey in this format. Because of the anonymity of the survey, we could not assess these potential biases in the response rate by examining whether respondents differed from non-respondents in any systematic manner.

Another limitation is that only a small amount of the variance in genomic knowledge and attitudes (5% - 11%) was accounted for by the socioeconomic factors we measured. Other factors, such as perceived compatibility between genomic principles and health educators' professional/personal role and HEs' exposure to various mass media channels (according to the Diffusion of Innovations Theory[42]), may also be important to consider. The purpose of this study, however, was not to search for a model to explain genomic knowledge, awareness, and attitudes. Rather, we were interested in exploring their associations, as a first step in understanding public health educators' views of PHG.

4. HEALTH EDUCATORS' LIKELIHOOD OF ADOPTING GENOMIC COMPETENCIES INTO HEALTH PROMOTION: A STRUCTURAL EQUATION MODELING ANALYSIS

4.1 Introduction

With the completion of the Human Genome Project, establishing genomic competencies becomes vital for Health Educators (HEs), as advocated by the Institute of Medicine[4] and the Centers for Disease Control and Prevention (CDC)[7]. Researchers in the field of health education and health behavior also highlight the importance of HEs developing their genomic competencies. Chen and Goodson[41], for example, proposed five arguments to justify why HEs must develop their genomic competencies. These included professional organizations' advocacy, professional competencies and responsibilities' requirements, the impact of the public's utilization of genetic/genomic services, emerging health needs, and employment and research funding opportunities. Multiple authors[2, 28, 68-75] who published their studies in the issue of the journal *Health Education and Behavior* entitled "Implications of Genomics for Health Behavior and Health Education", also emphasized health behavior studies in public health genetics/genomics (PHG), even though they did not directly use the wording "genomic competencies".

The term "Genomic competencies" refers to specific skills and knowledge in PHG. The CDC defines PHG as "the study and application of knowledge about the elements of the human genome and their functions, including interactions with the environment, in relation to health and disease in populations."[5] According to the CDC, health educators should develop seven specific genomic competencies. These include 1) "translate health-related information about social and cultural environments, (including community needs and interests and societal value systems) for use in population-based scientifically sound genomic health education programs; 2) determine the factors such as learning styles, literacy, learning environment, and barriers that influence learning about genomics; 3) differentiate between genomic education and genetic counseling; 4) facilitate genomic education for agency staff, administrators, volunteers, community groups and other interested personnel; 5) utilize social marketing to develop a plan for incorporating genomics into health education services by working with community organizations, genomic experts, and other resource people for support and assistance in program planning; 6) provide a critical analysis of current and future community genomic education needs; and 7) advocate [for] genomic education programs and/or integration of genomic components into education programs."[7]

To the best of our knowledge, however, no studies have examined if HEs are ready to adopt these competencies into health promotion. In this study, we proposed and tested a theoretical model (see Figure 1) regarding health educators' likelihood of adopting genomic competencies into health promotion research and practice. Structural Equation Modeling (SEM) was chosen as the most appropriate technique for testing the proposed model, because SEM handles missing data efficiently, reduces type I error, calculates the measurement errors of all variables in the model, simultaneously assessed all variables and their interactions as proposed in the theoretical model, and, most importantly, examines the difference between a hypothetical model and actual empirical survey results.[76, 77]

4.2 Theoretical Model and Framework

Given the future eminent need for the public health workforce to incorporate genomics into their research and practice, understanding the factors theoretically associated with incorporating this innovation, becomes both urgent and important. As Godin et al.[78] and Armitage et al.[79] have indicated, multi-theoretical, comprehensive models can better predict behavior than single-theory modes. Therefore, to explore and interpret health educators' likelihood to adopt genomic competencies into health promotion, we relied on various behavior change theories. To develop the conceptual model, we also utilized data obtained from qualitative in-depth interviews with 24 health educators (not published). We selected, therefore, theories that explained those qualitative findings, and had also been previously utilized in research assessing health professionals' attitudes toward various innovations. Three frameworks, the Diffusion of Innovations Theory (DOI)[42], the Theory of Planned Behavior(TPB)[80], and the Health Belief Model[81] fit this selection criteria.

As practicing specific genomics competencies is a relatively new notion for HEs, it was conceptualized as an innovation in this study, based on Rogers' DOI ("the innovation is an idea, practice, or object that is perceived as new by an individual or other unit of adoption"[42 (p12)]). Additionally, diffusion of a new concept or technology is a process encompassing four main elements: the innovation, communication channels,

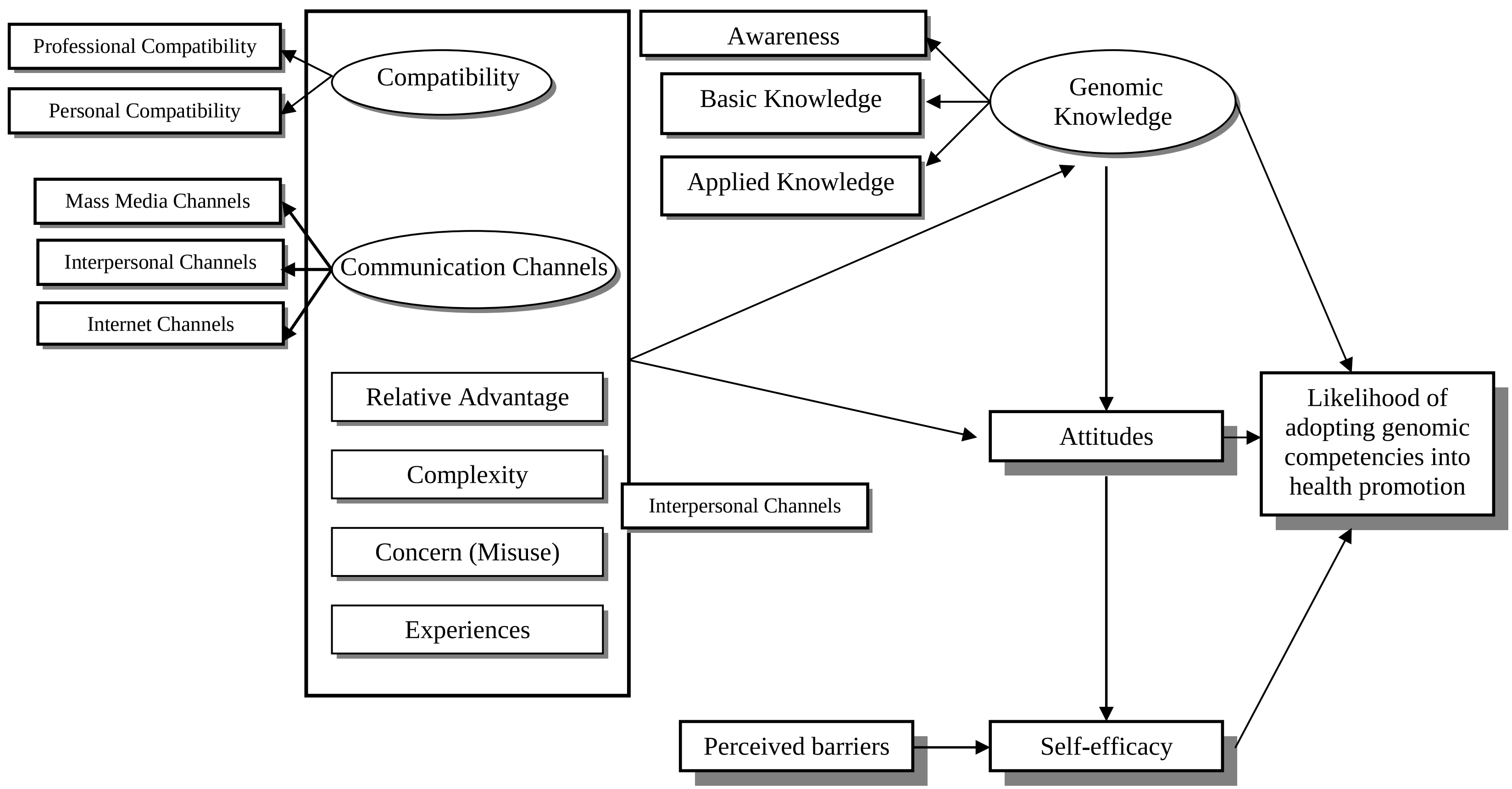

Figure 4.1 Theoretical model of health educators' likelihood of adopting genomic competencies into health promotion research and practice

time, and a social system. Several factors can influence the diffusion process, including the characteristics of the innovation (e.g., its relative advantage, complexity, and compatibility with professional/personal roles), individuals' knowledge or awareness of the innovation, and communication channels through which adopters learn about the innovation (e.g., mass media or interpersonal discussions).[42]

Moreover, in accordance with the TPB[80], attitudes and perceived behavior control can potentially affect health educators' behavior intention (likelihood) for adopting genomic competencies into health promotion. While perceived behavior control is analogous to self-efficacy (Social Cognitive Theory[82]), self-efficacy is a more powerful construct.[83] Thus, self-efficacy, in place of perceived behavior control, was added to the theoretical framework in this study. Our qualitative data also indicated that perceived barriers (Health Belief Model[81]) could influence health educators' confidence in incorporating genomic competencies into health promotion research and practice. Therefore, the model hypothesizes an effect of perceived barriers upon health educators' self-efficacy.

Two constructs in our theoretical model, however, were unique to this study and could not be explained by relevant theories. They were kept in the model nevertheless, due to their importance in the qualitative interviews with HEs. These constructs were personal experience regarding the use of genomic information and technologies and concern regarding the misuse of genomic information and technologies. The latter construct (concern) was also found to be a factor affecting public's attitudes toward the utilization of genetic testing.[84]

Therefore, based on the proposed model, this study sought to answer four specific questions, using a nation-wide sample of HEs: (1) How likely are HEs to adopt genomic competencies into health promotion research and practice? (2) Does the proposed theoretical model adequately explain health educators' actual likelihood of adopting genomic competencies into health promotion research and practice? (3) How much variance in the likelihood variable is accounted for by the predictor variables in this proposed theoretical model? (4) Which variable, in the theoretical model, is the best predictor of health educators' likelihood of adopting genomic competencies into health promotion research and practice? Is this variable significantly different from other variables?

4.3 Method

4.3.1 Design

All research procedures for this study were approved by the Institutional Review Board at Texas A&M University. For the study, we developed the on-line survey, titled "Health Promotion and Genetics/Genomics (HPG)", with the assistance of the commercial on-line survey product Zoomerang™. While survey data gathered by postal mail and on-line are similar[85], compared to the postal mail survey method, on-line surveys have a shorter response and data entry times, generate fewer incomplete responses, reduce research costs, and obtain more honest answers.[86-88]

The initial HPG survey consisted of 75 questions assessing demographic information and measuring the constructs in the proposed theoretical model. To improve the initial draft of the HPG survey, we followed Dillman's suggestion[43] to perform cognitive interviews with a convenience sample of 4 HEs and retrospective interviews with 5 HEs. The survey was revised base on the interviewees' suggestions and was later sent to a panel of experts (3 faculty in the health behavior and health education fields and one geneticist) to evaluate its content validity.

Following the completion of the survey, participants also had the opportunity to link to a separate page that allowed them to enter their preferred mail address to participate in a drawing for one of four $50 money order certificates, as an incentive. To ensure the anonymity of the survey responses, this information was recorded separately from participants' previous survey responses and could not be traced back to the respondents' answers. Furthermore, five useful resources (references regarding PHG and health promotion, such as the website links for E-Facts on Public Health Genomics and Six Weeks to Genomics Awareness) were provided in the end of the survey so participants had the opportunity to learn more about their role in PHG. The estimated time to complete the HPG survey was 15-20 minutes.

4.3.2 Participants

As a comprehensive sampling frame for the population of U.S. health educators is not currently available, we opted to survey members of major health education professional organizations. During September 2006, a pilot test was conducted by distributing the HPG survey to 385 HEs, randomly selected from the membership directories of the main health education organizations, including the Society for Public Health Education

(SOPHE), the Health Education E-mail Directory (HEDIR), and the School Health Education and Services (SHES) Section of the American Public Health Association (APHA). A total of 62 HEs completed the test (response rate = 16.1%). The pilot data were analyzed to help finalize the HPG survey. For example, to reduce the large amounts of missing data found in the last final sections of the survey during the pilot test, demographic questions were revised and moved to the beginning of the survey and "I don't know" options were added to the knowledge items. The final version of the HPG survey consisted of 72 (instead of the original 75) items (the HPG survey is available upon request from the main author).

From October to December 2006, SmartSerialMail software was utilized to send three personalized e-mails (with a link to the anonymous HPG survey), to 9,391 HEs nationwide inviting participation in the study. The sampling frame was obtained from the National Commission for Health Education Credentialing (NCHEC), SOPHE, the SHES Section of the APHA, and HEDIR. In addition, the American School Health Association (ASHA) and the HEDIR were utilized to advertise this study by providing separate survey links to their listserv subscribers. In the personalized e-mails and the advertisements from ASHA and HEDIR, we addressed our study by informing receivers that, in order to participate in this survey, they should meet our inclusion criteria by identifying themselves as a health educator/health promoter and currently working as a health educator/health promoter. In addition, the first two questions in our HPG survey were designed to screen respondents who did not meet our inclusion criteria (i.e., do you identify yourself as a health educator or health promoter? Have you ever worked as a health educator or promoter?)

Counting the 1,267 undelivered, duplicated, and inaccurate e-mails, and the 66 participants who, during the data collection period, informed us they did not view themselves a health educator or health promoter, there were 8,058 valid e-mails. A total of 1,862 HEs completed the HPG survey (an adjusted response rate of 23.1%). After deleting questionnaires containing over 50% missing data, 1,607 respondents became the final sample.

4.3.3 Measures

Likelihood of Adopting Genomic Competencies into Health Promotion

This variable, also defined as *behavioral intention* in the TPB ("the perceived likelihood of performing the behavior" [89(p69)]), comprised 7 items assessing health educators' perceived likelihood to adopt 7 genomic competencies into health promotion (table 1). These competencies were adapted from the ones proposed by the CDC. Specially, respondents were asked how likely they were to perform 7 tasks. Answers ranged from not likely at all (1), to extremely likely (4). By summing the likelihood scores from these 7 tasks, individuals could achieve a total score ranging between 7 and 28 points. The higher the score, the higher the likelihood that HEs will adopt genomic competencies into health promotion practice or research.

Table 4.1 Frequency of health educators' likelihood to adopt each Genomic Competency into health promotion

Genomic competencies*	Detail of each competency	Not likely at all (%)	Not Likely (%)	Somewhat likely (%)	Extremely likely (%)
Genomic Competency 1	Translating complex genomic information for use in community-based health education programs	40.3	36.6	20.7	2.4
Genomic Competency 2	Facilitating genomic education for agency staff, administrators, volunteers, community groups, and other interested personnel	36.7	39.4	21.2	2.6
Genomic Competency 3	Developing a plan for incorporating genomics into health education services by working with community organizations, genomic experts, and other stakeholders	32.2	39.4	23.1	5.2
Genomic Competency 4	Conducting a needs assessment for community-based genomic education programs	29.0	37.0	26.6	7.4
Genomic Competency 5	Advocating for community-based genomic education programs	28.0	41.0	26.6	4.5
Genomic Competency 6	Integrating genomic components into community-based genomic education programs	27.0	38.1	30.3	4.5
Genomic Competency 7 [a]	Evaluating the effectiveness of community-based genomic education programs	29.5	40.6	24.5	5.4

Competencies 1 – 6 were adapted from the CDC-proposed Genomic Competencies
[a] Created by the authors

Genomic Knowledge (Latent Variable)

According to the DOI, there are three types of knowledge regarding an innovation. The awareness-knowledge answers the question, “What is the innovation?” The how-to knowledge answers the question: “How does the innovation work? The third type of knowledge, the principles-knowledge, is the fundamental, basic knowledge required to understand how an innovation works.[42] Instead of asking respondents a single question to measure awareness knowledge, “Have you ever heard of PHG?” we developed 5 items to gauge their awareness of various efforts in the health promotion field to promote/incorporate PHG. The responses were scaled from “not familiar at all” (1) to “completely familiar”(5). A higher score meant that HEs were more aware of these efforts made in the health promotion field.

Three how-to knowledge items were also developed, adapted from instruments created by Bankhead et al.[44] and Henneman et al.[45] to assess health educators’ knowledge regarding how to apply genomic discoveries into health promotion *(applied knowledge)*. Additionally, to measure principles-knowledge, 3 items were developed to assess respondents’ basic knowledge in genomics *(basic knowledge)*. Scores for both the applied knowledge items and basic knowledge items were calculated by adding the number of correct responses. A higher score indicated more fundamental and applied knowledge regarding genomics and PHG.

Attitudes toward Genomic Competencies

Based on the *Theory of Planned Behavior*[80], this 14-item scale was designed to measure health educators' attitudes (defined as a linear combination of beliefs and values) toward adopting 7 genomic competencies into health promotion. Both belief-type and value-type items were scored on a 4-point Likert scale (belief-type items: 1 [strongly disagree] - 4 [strongly agree]; value-type items: 1[not important at all] - 4 [extremely important]). Given that the attitude score was calculated by summing the scores on each belief item multiplied by its respective value item, a higher attitude score represents more positive attitudes toward adopting the 7 genomic competencies into health promotion.

Self-Efficacy

An essential construct in Social Cognitive Theory, self-efficacy assesses respondents level of confidence when performing a given behavior (in this case, adopting genomic competencies into health promotion practice/research).[90] Seven items were created to evaluate health educators' confidence in incorporating the 7 outlined genomic competencies. While self-efficacy is ideally measured on a 0-100-point psychometric scale[91], because of the restricted format of the web-based software, we could only design a10-point scale to evaluate respondents' confidence to adopt the competencies. A higher score on this viable means more confidence.

Compatibility between Health Educators' Personal/ Professional Beliefs and PHG (Latent Variable)

In accordance with the DOI[42], compatibility, along with communication channels, relative advantage, and complexity, can influence health educators' adoption of genomic competencies. *Compatibility* indicates "the degree to which an innovation is perceived as being consistent with the existing values, beliefs, past experiences, and needs of potential adopters"[42(p240)]. For the purpose of this study, eight items, rated on a 4-point Likert scale, were created to measure health educators' perception of the consistency between PHG and their *personal* beliefs/values (*personal compatibility*) as well as between PHG and their *professional* beliefs/values (*professional compatibility*). The higher the score on the compatibility latent variable, the higher the "match" between health educators' personal/professional beliefs and PHG.

Communication Channels (Latent Variable)

Based on the DOI, "A communication channel is the means by which messages get from one individual to another.[42(p36)]" Communication channels, consisting of mass media channels, interpersonal channels, and internet channels, can influence the rate of adoption.[42] Eight items assessed this variable. Three questions were designed to measure *mass media channels*, 4 questions to measure *interpersonal channels* and 1 question to measure *internet channel* (interactive communication via the internet). Specifically, these 8 items measured "how often" (5-point scale, anchored from "1 = never" to "5 = very often") and "from which source" (e.g., TV, radio, colleagues, professional conferences, or internet) HEs have learned about PHG. A higher score on this scale, therefore, indicates that HEs are more likely to acquire PHG messages from multiple communication channels.

Relative Advantage

Relative advantage is “the degree to which an innovation is perceived as better than the idea it supersedes.”[42 (p15)] Whether HEs believe incorporating genomic discoveries can improve current health promotion practice and research was measured with 6 items (3 belief-type items and 3 value-type items). A higher score, from a linear combination of both belief and values-related questions, indicates respondents perceive more advantages in the incorporation of PHG into their practice.

Complexity

The DOI defines *complexity* as “the degree to which an innovation is perceived as difficult to understand and use.[42 (p16)]” Six items were designed to assess 1) health educators’ perception of the *difficulty in understanding basic genetics*, 2) health educators’ perception of the *difficulty in understanding PHG*, and 3) health educators’ perception of the *difficulty in applying genomic competencies* into health promotion. A higher complexity score indicated a stronger perception of PHG as a difficult or complex innovation.

Concern with Misuse of Genomic Information and Technologies

Our preliminary qualitative interviews with 24 HEs, indicated participants’ concerns and fear about the misuse of genomic information and technologies influenced their knowledge and attitudes toward PHG. Therefore, eight items were developed to evaluate health educators' concerns with the misuse of genomic discoveries (e.g., increased health disparities, cloning of human beings, and discrimination by health insurance companies). If a respondent scored high on the sum of these items, this indicated a strong concern over the possibility of genomic information and technologies being improperly applied.

Experiences Regarding the Use of Genomic Technologies or Information

Based on our qualitative data, health educators' personal experiences regarding the use of genetic technologies or information could affect their knowledge and attitudes toward genomics and PHG. Two sets of questions were designed to ask about their personal experience. Respondents were first asked if they, or someone they knew, had ever used genomic information or technologies. If so, they were further asked to rate their experiences. A higher score indicated more positive experiences with using genomic information or technologies.

Perceived Barriers to Adopting Genomic Competencies into Health Promotion

Six items assessed health educators' perceived barriers to adopting the 7 genomic competencies we outlined (e.g., lack of knowledge, lack of time, and having to deal with the public's mistrust of genomic information/technologies). Responses were rated on a 4-point Likert-type scale (4 = a strong barrier). A higher score indicated a perception of more obstacles to adopting genomic competencies.

In summary, in our proposed theoretical model, there were 11 endogenous variables (awareness, basic genomic knowledge, applied genomic knowledge, likelihood of adopting genomic competencies, attitudes, self-efficacy, mass media channels, interpersonal channels, internet channels, personal compatibility, and professional compatibility), 5 observed exogenous variable (perceived barriers, complexity, concern [misuse], relative advantage, and experiences), and 3 latent exogenous variables (genomic knowledge, communication channels, and compatibility).

4.3.4 Analysis

Data were downloaded from Zoomerang™ and were further assessed for missing data.[46] Multivariate normality assumption[92], internal consistency (Cronbach's alpha) and construct validity of the scales (using exploratory factor analysis with principal components analysis and Varimax rotation) were tested by using SPSS®, version 14.0. Employing Analysis of Moment Structures (AMOS), version 7.0, construct validity of the latent variables was examined through confirmatory factor analysis, and the proposed theoretical model was assessed through SEM techniques.

Similar to the notion of effect sizes in regression models to evaluate how well the model fit the empirical data, the model fit between the proposed theoretical model and the survey data was assessed, initially, with the chi-square goodness of fit test (χ^2 statistics). As the χ^2 statistics is sensitive to sample size[93], three additional fit indices, the Root Mean Square Error of Approximation (RMSEA), the Standardized Root Mean Square Residual (SRMR), and the Comparative Fit Index (CFI), were also utilized to evaluate the adequacy of the model. In general, an RMSEA ≤ 0.06, an SRMR of < 0.10, and a CFI > 0.95, indicate a good fit.[77, 94, 95]

4.4 Results

4.4.1 Sample Characteristics

Among the final sample of 1,607 health educators, most were Caucasian (76.8%) and female (83.6%), with a mean age of 40.1 years (SD = 12.0). Approximately 40% of participants identified themselves as Protestants, 22.4% as Catholics, and 15.1% with no religious preference. The majority was CHES eligible (95.5%) and CHES certified (81.1%). Over half of respondents had a master's degree (60.7%) and worked in a community setting (51.7%). More than two-thirds (71.1%) of the participants had never received any training in genetics or PHG.

4.4.2 Research Questions

Research Question 1: *How likely are HEs to adopt genomic competencies into health promotion research and practice?*

Table 1 lists health educators' likelihood to adopt genomics into health promotion. In general, health educators' likelihood to adopt genomic competencies into their practice was low. Approximately 23 % of respondents indicated they were somewhat likely or extremely likely to translate complex genomic information for use in community-based health education programs and to facilitate genomic education for agency staff, administrators, volunteers, community groups, and other interested personnel. An estimated 28.3 %, 29.9 %, and 31.3 % of respondents said they were likely to adopt genomic competencies 3, 7, and 5, respectively. For genomic competency 4, conducting a needs assessment for community-based genomic education programs, 34% of respondents were somewhat or extremely likely to adopt it in their practice. Among the 7 tasks, integrating genomic components into community-based genomic education programs had the highest likelihood (nearly 35% of respondents said they were somewhat or extremely likely to do so).

Research Question 2: Does the proposed theoretical model adequately explain health educators' actual likelihood of adopting genomic competencies into health promotion research and practice?

The variable "Experiences Regarding the Use of Genomic Technologies or Information" was dropped from the initial theoretical model because only 251 participants (15.5 %) had any personal experience or had heard of other people's use of genomic information or technologies. Furthermore, a three-factor model for genomic knowledge was examined using confirmatory factor analysis and results indicated a strong correlation between applied and basic knowledge (r = 0.83), but no correlation between awareness and each of these two knowledge factors. An alternative two-factor model was then examined with *awareness (as factor 1)* and combined *basic & applied knowledge* (as factor 2),. Results showed that this two-factor model fit the data adequately ([χ^2 (21) = 88.435, p < 0.001; CFI = 0.958 and RMSEA = 0.046) although the correlation between the two factors was low (r = 0.10). Therefore, *both basic &*

applied genomic knowledge and *awareness* were included into the final SEM model as two independent observed variables.

For the communication channels latent variable, only one question assessed use of the internet as a channel, and in the exploratory factor analysis, this item loaded on the interpersonal channels factor, yielding a two-factor model (instead of three): 1) interpersonal *and* internet channels and 2) mass media channels. Confirmatory factor analysis results also established that the recursive models for communication channels (consisting of interpersonal/internet channels and mass media channels variables) and for compatibility (consisting of professional compatibility and personal compatibility variables) fit the data perfectly ([$\chi^2(2) = 1.203$, $p = 0.548$; CFI = 1.000 and RMSEA < 0.001; loadings ranged from 0.66 to 0.94).

Data validity and reliability for all other model variables were psychometrically sound. Internal consistency of scaled variables (assessed with Cronbach's alpha) ranged from 0.72 to 0.98 (mean = 0.90). Except for the variables discussed above, factor analyses findings for all other scaled variables indicated optimal factorial structure and loadings. Additional details on factor analyses results are available upon request from the main author.

Figure 2 shows the final structural model regarding study participants' health educators' likelihood to adopt genomic competencies into health promotion The structural model encompassed 9 endogenous variables (awareness, basic & applied genomic knowledge, likelihood, attitudes, self-efficacy, mass media channels,

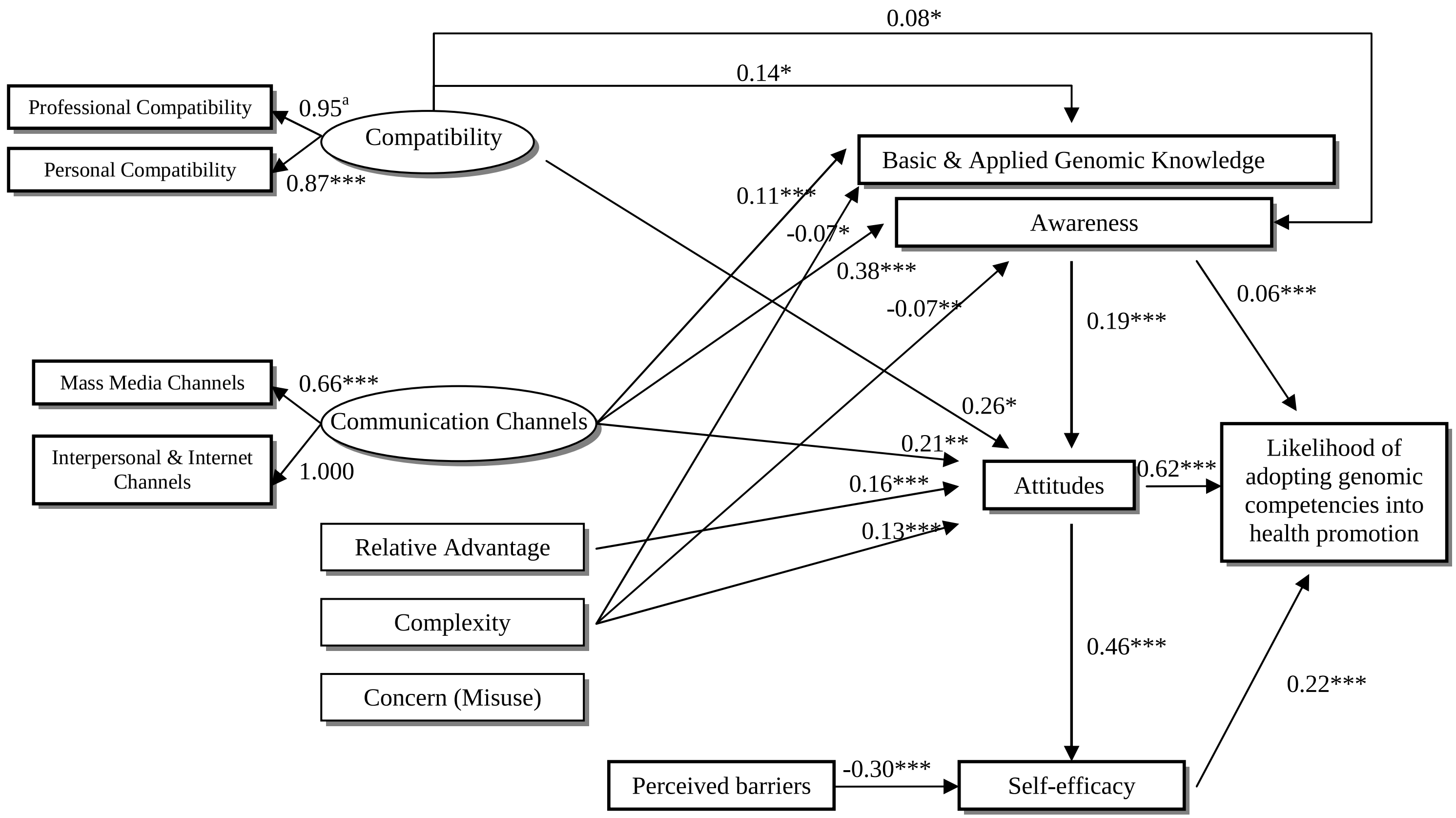

Figure 4.2 Structural model of health educators' likelihood of adopting genomic competencies into health promotion research and practice
Note: Standardized estimates of the path coefficients (standardized regression weight) were identified with asterisks for statistical significance (* $p < 0.05$, ** $p < 0.01$, and *** $p < 0.001$).

interpersonal and internet channels, personal compatibility, and professional compatibility), 4 observed exogenous variables (perceived barriers, complexity, and misuse, and relative advantage), and 2 exogenous latent variables (communication channels and compatibility).

To assess if our proposed theoretical model adequately explained the survey findings, various fit indexes associated with SEM testing techniques were examined. As expected, the χ^2 statistics was significantly rejected in the structural model [χ^2 (37) = 260.304, $p <$ 0.001] due the study's large sample size. The other fit statistics, however, indicated that the final model fit the observed data well (CFI = 0.966, RMSEA = 0.061, and SRMR = 0.037). Thus, the proposed theoretical model appears appropriate for explaining this sample of health educators' likelihood of adopting genomic competencies into health promotion.

The final model also indicated that participants' likelihood to adopt genomic competencies into health promotion was significantly affected by their awareness (β = 0.06, $p < 0.001$), their attitudes (β = 0.62, $p <0.001$), and self-efficacy (β = 0.22, $p <$ 0.001).

Compatibility between PHG and personal/professional beliefs (β = 0.08, $p = 0.01$), more exposure to PHG through various communication channels (such as hearing about genomics from the mass media or discussing PHG with colleagues -- β = 0.38, $p <$ 0.001), and perceptions of PHG as not very complex (β = -0.07, $p = 0.008$) significantly affected respondents' awareness of efforts made in the health promotion field to promote/incorporate PHG. Nevertheless, perceived relative advantage of PHG (β = -0.01,

$p = 0.811$) and concern about the misuse of genomic information and technologies ($\beta = 0.04$, $p = 0.108$) were not associated with participants' awareness.

Similarly, basic & applied genomic knowledge was only affected by the degree of compatibility between respondents' professional/personal values and PHG ($\beta = 0.14$, $p < 0.001$), their exposure to various communication channels ($\beta = 0.11$, $p < 0.001$), and their perceptions of the complexity of PHG ($\beta = -0.07$, $p = 0.012$).

HEs participating in our study had a more positive attitude toward PHG if they believed that genomics and PHG was complex ($\beta = 0.13$, $p < 0.001$); if they saw that PHG had an advantage over traditional forms of health promotion intervention ($\beta = 16$, $p < 0.001$); if they perceived consistency between the notion of PHG and their personal/professional beliefs ($\beta = 0.26$, $p < 0.001$); if they were more exposed to PHG through various communication channels ($\beta = 0.20$, $p < 0.001$), and if they were more aware of efforts made in the health promotion field regarding PHG. ($\beta = 0.19$, $p < 0.001$). Yet, their concerns regarding the misuse of genomic discoveries ($\beta = 0.01$, $p = 0.816$) and basic & applied genomic knowledge ($\beta = 0.03$, $p = 0.265$) did not significantly influence their attitude.

Weaker perceptions of obstacles to adopt genomic competencies into practice ($\beta = -0.30$, $p < 0.001$) and favorable attitudes toward genomic competencies ($\beta = 0.46$, $p < 0.001$) had, both, a significant impact on respondents' confidence (self-efficacy) to adopt genomic-related tasks into health promotion.

Research Question 3: How much variance in the likelihood variable is accounted for by the predictor variables in this proposed theoretical model?

Altogether, knowledge, attitudes, and self-efficacy explained 60.3 % of the variance in health educators' likelihood of adopting genomic competencies into health promotion research and practice. This finding also supports our previous statement that the proposed model was appropriate for explaining health educators' likelihood of adopting genomic competencies into their practice and research.

Research Question 4: Which variable, in the theoretical model, is the best predictor of health educators' likelihood of adopting genomic competencies into health promotion research and practice? Is this variable significantly different from other variables?

Figure 2 highlights that health educators' likelihood of adopting genomic competencies into health promotion research and practice (likelihood variable) was significantly predicted by awareness ($\beta = 0.06$), attitudes ($\beta = 0.62$), and self-efficacy ($\beta = 0.22$). Among these three, attitudes was the strongest predictor as it exhibited the strongest standardized regression weight ($\beta = 0.62$). We also examined the difference in the regression weights of the three significant predictors (i.e., awareness, attitudes, and self-efficacy) using χ^2 difference tests. Results indicated that attitude had a significantly stronger association with likelihood (for the comparison between awareness and attitudes: χ^2 difference (1) = 5.90; $p < 0.05$; and for the comparison between attitudes and self-efficacy: χ^2 difference (1) = 85.89; $p < 0.05$).

4.5 Discussion

Our study makes significant contributions to the field of health behavior and health education. This study is the first, for instance, to examine a national (albeit not representative) sample of HEs and their likelihood to adopt the genomic competencies recommended by the CDC for the public health workforce (and adapted for this study). Another contribution is the proposal of a theoretical model to explore the potential mechanisms underlying such adoption. The SEM analysis confirmed that this theoretical model was supported by the empirical data, and was able to explain at least 60% of the variance in likelihood of adoption. Lastly, this study attempted to survey all members from the major health education professional organizations. We successfully recruited a large number of HEs to complete the survey, and the repose rate (23.1 %) was higher than the previous study, which utilized the same commercial web-based product to survey HEs (10 %).[96] While not a statistical representation of the entire population of HEs in the U.S., the large sample provides stability for the statistical testing of the model, and confidence in the data's validity and reliability.

The findings suggest that, presently, health educators in our sample are not very willing to adopt genomic competencies into their practice. Among the seven genomic competencies presented to study participants, translating complex genomic information for use in community-based health education programs) and facilitating genomic education for agency staff, administrators, volunteers, community groups, and other interested personnel, were the two competencies that HEs would be least likely to adopt.

Conversely, integrating genomic components into community-based genomic education programs, had the highest likelihood rate. Such differences might be related to unclear meanings and practice strategies proposed in the wording of these competencies. For instance, how should the term “translate” be interpreted? How does one “facilitate” genomic education? On the other hand, integrating genomic components into community-based genomic education programs not only is easy to understand and perform, it has already been implemented by other health educators. Theisen et al.[30], for instance, have successfully incorporated a family history worksheet into a blood pressure and stroke screening program in Detroit.

Health educators’ likelihood of adopting genomic competencies into health promotion was significantly influenced by awareness, attitudes, and self-efficacy; whereas basic & applied genomic knowledge failed to affect likelihood. These findings confirm the theoretical propositions in the DOI and TPB, as knowledge, attitudes, and perceived behavior control (self-efficacy) can affect individuals’ behavioral intention.[42, 80] Yet, it is interesting to note that respondents’ knowledge of genomics neither influenced their attitudes toward genomic competencies nor their likelihood to adopt the competencies. A potential speculation is that, according to the DOI, “it is usually possible to adopt an innovation without principles-knowledge[42 (p173)]” Future studies, however, need to further explore this phenomenon, as it may have important implications for development of training programs.

The original theoretical model proposed that five factors (communication channels, complexity, compatibility, relative advantage, and concern) could affect health educators' genomic knowledge and attitudes toward adopting genomic competencies; yet only three factors, communication channels, complexity, and compatibility, were found to significantly influence health educators' attitude and knowledge in our sample. Health educators' concerns regarding misuse of genomic information and technologies did not affect their attitudes and knowledge, even if in the qualitative interviews, this concern was systematically raised. Our findings appear to contradict those from a study by Henneman et al.[84], indicating that the lay public who believed "genetic testing is tampering with nature" [(p144)] had more negative attitudes toward using genetic tests. Perhaps because participants in our study are health professionals, most of them are able to separate their personal concerns regarding the misuse of genomic achievements from their professional attitudes. Yet, this assumption should be validated by future studies, and further qualitative examination of this particular finding, might prove useful.

Moreover, even if perceived relative advantage of PHG contributed to health educators' attitudes toward genomic competencies, it failed to influence their genomic knowledge. That perception of relative advantage may affect attitudes has been supported by a previous study[8], showing that physicians who perceived more benefits of genomic medicine for their practice had a more positive attitude toward adopting genomic medicine. Yet, due to the lack of studies specifically aimed at examining the association between perceptions of the advantages of genomics and knowledge in genomics, we have no basis for further comparing our findings.

It is interesting to notice that while perceptions of PHG as a complex topic affected both knowledge and attitudes, the direction of the associations varied: perceived complexity was negatively associated with genomic knowledge and positively related to health educators' attitudes. As anticipated, if HEs believed it to be difficult to keep up with genomics and PHG, they scored lower on the genomic knowledge scale. Despite DOI's suggestion that complexity is a barrier affecting the rate of adopting a new idea[42], it is unclear, in this sample, why a strong perception of PHG as complex, resulted in *more positive attitudes* toward incorporating genomic discoveries into health promotion. A possible explanation may be that the more difficult it is for HEs to stay updated on genomics and PHG, the stronger their belief that they have met their professional responsibility towards their clients, or even, exceeded their role as educators. Future researchers, however, should investigate the mechanism behind the interaction among complexity, genomic knowledge, and attitudes, among health education professionals.

4.5.1 Limitations of This Study

Researchers should be careful when applying our findings by considering two limitations of our study. Lack of generalization is its major drawback. Even though every attempt was made to survey the population of HEs, nationwide, the sample does not represent the entire population of HEs in the United States. Because no centralized registry of HEs practicing in the U.S. exists, our only option was to survey all members of major health education professional organizations. Not every health educator, however, belongs to the professional organizations selected for this study. In addition, the Public Health Education and Health Promotion Section of the American Public Health Association declined our request for members' e-mail addresses, while the

American Association of Health Education (AAHE) did not respond to any of our requests. The absence of members from these two prominent professional groups represents an important gap in the delimitation of our study's population. Yet, we were able to obtain the HEDIR membership list which generally overlaps with AAHE's membership roster. In order to reach the HEs' population, we tried our best to survey members from the other four major health education professional organizations.

Furthermore, as this study utilized an on-line survey format to obtain more honest responses and larger response rates, this could have led to non-response bias for three important reasons: first, individuals may have been unable (not have access to a computer, at that moment) or unwilling (not familiar with on-line questionnaires) to complete the survey.[97] Second, through the course of data collection we learned that many well-intended participants forwarded their invitation e-mails to other health educators (to enlist potentially interested participants) without informing us, thus potentially altering the original sampling frame.

The inability to include the experiences variable in the final model also became a limitation. Because only few participants (n = 251) had any personal experience with, or knew someone who had been involved with genetics/genomics services, the variable was not included in the last iteration of the theoretical model. Yet, based on our qualitative study, it seems important not to ignore this factor since health educators affirm that their personal experiences regarding genetic/genomic technologies do influence their perspectives regarding genomics and public health. According to one of our interviewees,

> "…it is wonderful that we have the research and that we are discovering these, um, diseases of sort…I have a friend that is pregnant, and she just had the latest genetic testing that you can do. She is 38, and so she just had some genetic testing to make sure that the baby was going to be healthy, and I think that is wonderful that you can determine, I mean, she was 12 weeks maybe…and I think that is marvelous that that early in the pregnancy that you can do genetic studies, and it was basically a blood test to do the studies, and then they did an ultrasound and a couple of different fetal-type tests, and I think that is marvelous.." (Female, Caucasian, Catholic, University setting)

4.6 Implications for Research

Follow-up studies are required to explore three issues raised in this study. The first issue relates to why health educators' knowledge of genomics as well as their concerns regarding misuse of genomic information and technologies neither influence their attitudes, nor affect their likelihood to adopt genomic competencies into health promotion. The second issue is related to why health educators' perceived relative advantage of PHG does not influence their genomic knowledge regardless of its impacts on their attitudes toward the genomic competencies. Lastly, future research should explore why a stronger perception of PHG as complex, can result in *more positive attitudes* toward genomic competencies. While these relationships have been proposed theoretically, they were not empirically supported by our data. Further examinations of these associations, and the mechanisms underlying them, are warranted.

4.7 Implications for Practice

Findings from this study revealed that, in general, HEs in our sample were not very likely to adopt genomic competencies into their practice. Similar to other health professionals, HEs appear not to be ready for their professional role in genomics. Suther and Goodson[8], for example, surveyed 400 Texas physicians and found that only 54% were likely to adopt genomic medicine in primary care practice. Irwin et al.[57] also uncovered that North Carolina public health nurses had a low awareness of CDC's genomic competencies (only 9% were aware of them), and approximately half believed these competencies were not applicable to their current practice.

Lack of academic training in PHG may explain why HEs in our sample have weak intentions to integrate genomic competencies into health promotion. According to our qualitative interviews with HEs, when hearing about genetics or genomics, the first reaction of most participants was "I don't know anything about genetics or genomics!" or "I have never had any training in genetic or genomics." Furthermore, during the survey data collection period, a few HEs wrote us e-mails or wrote their comments in the questionnaire stating, "this is a bogus survey, as genomics is not health education"; "I am not involved in either genetics or genomics," or "I do not work in the area of genetics/genomics."

Nevertheless, it is anticipated that genomics will have a significant impact in the field of health behavior and health education, making the incorporation of genomic issues into health education and health promotion training, an imperative. Kardia and Wang[2], for instance, projected a four-dimensional framework to illustrate how health behavior and health education issues could fit into the PHG domain. The first dimension focused on individualized medicine and practice, such as conducting genetic education and incorporating genetic information to change clients' behavior. For the second dimension, the authors highlighted the various research studies in individualized medicine, including the exploration of clients' perceptionsregarding their own genetic risk and the improvement of informed consent procedures. In the intersection of practice and population health (the third dimension), for instance, HEs should be able to adopt family history tools in disease prevention and programs. Lastly, investigating genetic literacy and conducting genetics-related needs assessment among the lay public were two examples illustrating the forth dimension (i.e., carrying out research in population health).

Chen and Goodson[41] also discussed the upcoming impact of PHG in the health promotion field, and offered five arguments to justify why HEs must develop their genomic competencies. These included "1) leading professional organizations have advocated the incorporation of genomics into health promotion practice; 2) health educators' professional competencies and responsibilities encourage and corroborate the incorporation of genomics into health promotion practice; 3) health educators' genomic competencies can significantly impact the lay public's utilization of, and satisfaction with, public health genetic/genomic services; 4) by developing their genomic competencies, HEs are better able to meet emerging health needs; 5) genomics and public health are generating unique opportunities for interdisciplinary collaboration, research funding, and employment"[41 (p.24).]

Additionally, various professional organizations are presently addressing the importance of training in genomics, by developing genetic/genomic competencies and training curricula and tools. The National Coalition for Health Professional Education in Genetics (NCHPEG) has already developed the *core competencies in genetics* for health professionals.[25] The CDC, the University of Michigan, the University of North Carolina, and the University of Washington also have established two web-based training tools to educate public health workers: "E-Facts on Public Health Genomics" (formerly Genomics for Public Health Practitioners) and "Six Weeks to Genomic Awareness.[98]

We strongly believe that developing health educator-oriented curricula and training that incorporates genomic components is a pressing issue in the field of health behavior and health education, today. This study is the first step seeking to explore health educators' intention to develop their genomic competencies. At the end of our survey, we provided several key PHG sources to participants. This, along with the 5 awareness questions included in the survey (e.g., "Genetics" has been added to phase 2 [Epidemiological Assessment] of the PRECEDE-PROCEED Model) can also help HEs who took part in this study learn more about genetics/genomic competencies and increase their awareness of their role in PHG. The next step is to invite a variety of health promotion and health education leaders, alongside federal government representatives (e.g., from the CDC and the National Institutes of Health), and other professionals (e.g., geneticists, genetic counselors, physicians, and nurses) to collaboratively develop curricula and training programs tailored for the public health education workforce.

5. CONCLUSION

The purpose of this dissertation study was three-fold: 1) to provide a theoretical and evidence-based rationale justifying why health educators should invest in developing genomic competencies; 2) to assess health educators' basic and applied knowledge of genomics, and their attitudes toward genomic competencies, and 3) to examine these professionals' likelihood of adopting genomic competencies into health promotion research and practice.

Taken together, findings from the 3 studies presented in this dissertation indicated that health educators in our sample had deficient genomic knowledge, negative attitudes toward the CDC-proposed genomic competencies, and low likelihood of adopting genomic competencies into health promotion.

Nevertheless, genomics is anticipated to dramatically affect public health.[3] For example, newborn screening for various diseases and subsequent genetic evaluation are currently promoted by the government and medical professional organizations, raising many ethical, legal, and social issues.[3, 99] In addition, despite the potential for ever-increasing numbers of genetic tests (especially after the completion of the Human Genome Project), it is still unclear if the lay pubic will utilize these genetic tests, following screening recommendations, and change its lifestyle, when warranted.[3]

Thus, relevant training for health educators specifically, and the public health workforce, in general, should be advocated. The need to focus on training is supported in a previous study[67] as well as in this dissertation's findings. To steer future training direction, a theoretical model regarding health educators' likelihood to adopt genomic competencies into health promotion was proposed in this dissertation study. The structural equation modeling analyses showed that this model was supported by the data obtained from 1,607 U.S. health educators across the nation. Based on this theoretical model, health educators' likelihood of adopting genomic competencies into health promotion was significantly influenced by their awareness of efforts in health promotion field to promote/integrate PHG, attitudes toward genomic competencies, and self-efficacy. Thus, future researchers should take into account health educators' genomic knowledge, attitudes, and self-efficacy regarding integrating genomic discoveries into health promotion. As attitude is the strongest predictor, fostering appropriate attitudes among the health education workforce should be a leading priority.

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APPENDIX A

INFORMATION SHEETS:

THE PILOT TEST AND THE FINAL STUDY

Health Promotion and Genetics/Genomics

INFORMATION SHEET

You are invited to participate in a study surveying health educators'/promoters' likelihood of adopting genomic competencies for heath promotion research and practice. Your name, along with approximately 8000 other health educators, were selected because you belong to the APHA, ASHA, HEDIR, NCHEC, or SOPHE.

Lei-Shih Chen is conducting this study. She is a Ph.D. candidate in health education at Texas A&M University. This study is her dissertation research.

In this survey, you will be asked demographic information and your attitudes/knowledge of genetics/genomics and public health genomics. This survey will take approximately 15-20 minutes. Benefits include the chance to express your views regarding health educators' role in genetics/genomics, learn more about genetic/genomic competencies and health promotion, and be eligible to win one of four $50 money orders. Risk associated with this study is emotional discomfort with some questions if you are unsure about the answer.

This study is voluntary and anonymous. You will NOT provide your name in this survey. If you choose to enter the drawing to be eligible to win $50, you will be directed to a separate web link where you may enter your preferred e-mail address. As this will be done through a separate link, there will be no way to trace your responses. Data will be stored securely and only be accessed by the researcher and her dissertation committee. Your decision whether to participate will not affect your relations with Texas A&M University. You may refuse to answer questions that make you uncomfortable and withdraw from the study at any time.

This research study has been approved by the Institutional Review Board-Human Subjects in Research, Texas A&M University. For research-related problems or questions regarding subjects' rights, you may contact the Institutional Review Board through Ms. Angelina Raines, Director of Research Compliance, Office of Vice President for Research (979-845-4067; araines@vprmail.tamu.edu). If you have questions about this study or need further information, you may contact Lei-Shih Chen (979-862-8574; lace@hlkn.tamu.edu) or her advisor, Dr. Patricia Goodson (979-845-1756; pgoodson@hlkn.tamu.edu) at TAMU 4243, College Station, TX 77843.

By proceeding with this survey, you agree that you have read the above information and consent to participate. Please print this page for your records.

START SURVEY!

APPENDIX B

THE WEB-BASED INSTRUMENT: THE PILOT TEST

Health Promotion and Genomics

Thank you for participating in my dissertation research!!!
For the purpose of this study...

Genomics is *"the study of the functions and interactions of all the genetic material in the genome, including interactions with environmental factors."*

Public Health Genomics is *"the study and application of knowledge about the elements of the human genome and their functions, including interactions with the environment, in relation to health and disease in populations."*

Please click on the submit button to continue with the survey...

SUBMIT

Survey Page 1

Health Promotion and Genomics

1

Do you identify yourself as a health educator or health promoter?

YES NO

If you have filled out this survey before, please stop now!

Thank you for your attention.

SUBMIT

Survey Page 2

Health Promotion and Genomics

The questions below are designed to assess your attitudes toward 7 different tasks for health educators/promoters:

Task 1: Translating complex genomic information for use in community-based health education programs

2

Have you ever done this task (**Translating complex genomic information...**)?

YES NO

3

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

4

How much do you agree with this task?

- Strongly Disagree

- Disagree
- Agree
- Strongly Agree

5

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

6

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

Survey Page 3

Health Promotion and Genomics

Task 2: Facilitating genomic education for agency staff, administrators, volunteers, community groups and other interested personnel

---

7

Have you ever done this task (**Facilitating genomic education...)?**

YES NO

8

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

9

How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

10

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

11

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

Survey Page 4

Health Promotion and Genomics

Task 3: Developing a plan for incorporating genomics into health education services by working with community organizations, genomic experts, and other stakeholders

12

Have you ever done this task (**Developing a plan...**)?

YES NO

13

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

14

How much do you agree with this task?

- Strongly Disagree

- Disagree
- Agree
- Strongly Agree

15

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

16

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

Survey Page 5

Health Promotion and Genomics

Task 4: Conducting a needs assessment for community-based genomic education programs

17

Have you ever done this task (**Conducting a needs assessment...**)?

YES NO

18
How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

19
How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

20
How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

21
How confident do you feel that you can do this task?

0% confident — 100% confident

1 2 3 4 5 6 7 8 9 10

SUBMIT

Survey Page 6

Health Promotion and Genomics

Task 5: Advocating for community-based genomic education programs

22
Have you ever done this task (**Advocating for community-based...**)?

YES NO

23
How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

24
How much do you agree with this task?

- Strongly Disagree
- Disagree

Agree

Strongly Agree

25

How important is it for you to be involved in this task?

Not Important At All

Not Important

Somewhat Important

Extremely Important

26

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

Survey Page 7

Health Promotion and Genomics

Task 6: Integrating genomic components into community-based education programs

27

Have you ever done this task (**Integrating genomic components...**)?

YES NO

28

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

29

How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

30

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

31

How confident do you feel that you can do this task?

0% confident — 100% confident

1 2 3 4 5 6 7 8 9 10

SUBMIT

Survey Page 8

Health Promotion and Genomics

Task 7: Evaluating the effectiveness of community-based genomics education programs

32
Have you ever done this task (**Evaluating the effectiveness...**)?

YES NO

33
How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

34
How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree

Strongly Agree

35

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

36

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

Survey Page 9

Health Promotion and Genomics

37

Which of the following items are potential barriers/obstacles for you to adopt public health genomics into your practice?

	1 Not A Barrier At All	2 Not A Barrier	3 Somewhat A Barrier	4 A Strong Barrier
Incompatibility between genomics and my religious beliefs	1	2	3	4

Lack of knowledge about genomics

1 2 3 4

Lack of knowledge about how to incorporate genomics into health promotion

1 2 3 4

Lack of time to add something new to my work

1 2 3 4

Public health genomics is not a priority in my current work

1 2 3 4

Having to deal with the public's mistrust of genomic information or technologies

1 2 3 4

SUBMIT

Survey Page 10

Health Promotion and Genomics

The next set of questions will focus on your beliefs/values regarding the advantages of public health genomics...

38

I believe one of the advantages of public health genomics is to...

1 Strongly Disagree	2 Disagree	3 Agree	4 Strongly Agree

Make individuals more aware of their family histories

1 2 3 4

Conduct more effective prevention programs

1 2 3 4

Conduct more personalized prevention programs

1 2 3 4

39

How important is it for you to...

1 Not Important At All	2 Not Important	3 Somewhat Important	4 Extremely Important

Make individuals more aware of their family histories

1 2 3 4

Conduct more effective prevention programs

1 2 3 4

Conduct more personalized prevention programs

1 2 3 4

SUBMIT

Survey Page 11

Health Promotion and Genomics

The next set of questions will focus on the consistency of public health genomics with your professional and personal beliefs/values ...

40

Please indicate your agreement with each statement...

1 Strongly Disagree	2 Disagree	3 Agree	4 Strongly Agree

Adopting public health genomics into health education is consistent with my **professional** beliefs/values.

1 2 3 4

Analyzing current and future community genomic education needs is consistent with my **professional** beliefs/values.

1 2 3 4

Advocating for genomic education programs is consistent with my **professional** beliefs/values.

1 2 3 4

Adopting public health genomics into health education is consistent with my **personal** beliefs/values.

1 2 3 4

Analyzing current and future community genomic education needs is consistent with my **personal** beliefs/values.

1 2 3 4

Advocating for genomic education programs is consistent with my **personal** beliefs/values.

1 2 3 4

41

How important is it for you...

1 Not Important At All	2 Not Important	3 Somewhat Important	4 Extremely Important

Public heath genomics is consistent with your **professional** beliefs/values?

1 2 3 4

Public heath genomics is consistent with your **personal** beliefs/values?

1 2 3 4

SUBMIT

Health Promotion and Genomics

The next set of questions will focus on your beliefs/values regarding the complexity of public health genomics...

42

How easy or difficult is it for you to...

	1 Extremely Easy	2 Somewhat Easy	3 Not Easy	4 Not Easy at all
Stay updated on public health genomics-related knowledge?	1	2	3	4
Stay updated on basic genomics knowledge?	1	2	3	4
Apply genomic information or technologies to health promotion?	1	2	3	4

43

How important is it for you to…

	1 Not Important At All	2 Not Important	3 Somewhat Important	4 Extremely Important
Stay updated on public health genomics-related knowledge?	1	2	3	4
Stay updated on basic genomics knowledge?	1	2	3	4
Apply genomic information or technologies to health promotion?	1	2	3	4

SUBMIT

Survey Page 13

Health Promotion and Genomics

44

How often have you...

1 Never	2 Not Very Often	3 Not Often	4 Often	5 Very Often
Heard about public health genomics on TV?				
1	2	3	4	5
Heard about public health genomics on the radio?				
1	2	3	4	5
Head about public health genomics in the newspaper?				
1	2	3	4	5
Talked about public health genomics with your colleagues?				
1	2	3	4	5
Discussed public health genomics at professional conferences?				
1	2	3	4	5
Talked about public health genomics with those whom you educate (e.g., communities, students, and/or patients)?				
1	2	3	4	5
Talked about public health genomics with your relatives and/or families?				
1	2	3	4	5
Read about public health genomics on the internet?				
1	2	3	4	5

SUBMIT

Survey Page 14

Health Promotion and Genomics

45

I have personally used genomic information or technologies (e.g., carrier testing, prenatal testing, or cancer genetic testing).

YES NO

46

If yes, the experience(s) I had was(were) positive.

- Strongly disagree
- Disagree
- Agree
- Strongly agree

47

Someone I know has personally used genomic information or technologies (e.g., carrier testing, prenatal testing, cancer genetic testing).

YES NO

48

If yes, the experience(s) of someone I know was(were) positive.

- Strongly disagree
- Disagree
- Agree
- Strongly agree

SUBMIT

Survey Page 15

Health Promotion and Genomics

49

Tell us about what you believe regarding the use of genomic technologies/information...

1 Strongly Disagree	2 Disagree	3 Agree	4 Strongly Agree

I believe the use of genomic technologies or information can reinforce existing discrimination (e.g., discrimination by health insurance companies).

1	2	3	4

I believe the use of genomic technologies or information can increase health disparities.

1	2	3	4

I believe the advances of genomic technologies or information can lead to the cloning of human beings.

1	2	3	4

I believe the advances of genomic technologies or information can lead to the increasing use of human embryonic cells to conduct stem cell research.

1	2	3	4

50

How concerned are you that...

1 Not Concerned At All	2 Not Concerned	3 Somewhat Concerned	4 Extremely Concerned

The use of genomic technologies or information can reinforce existing discrimination (e.g., discrimination by health insurance companies).

1 2 3 4

The use of genomic technologies or information can increase health disparities.

1 2 3 4

The advances of genomic technologies or information can lead to the cloning of human beings.

1 2 3 4

The advances of genomic technologies or information can lead to the use of human embryonic cells to conduct stem cell research.

1 2 3 4

SUBMIT

Survey Page 16

Health Promotion and Genomics

The next set of questions will focus on your knowledge regarding public health genomics...

51

Please rate your familiarity with...

1 Not familiar At All	2	3	4	5 Completely Familiar

The CDC has recommended 7 genomic competencies for health educators.

1 2 3 4 5

The National Coalition for Health Professional Education in Genetics (NCHPEG) has established the *core competencies in genetics* for health professionals.

1 2 3 4 5

The Institute of Medicine has recommended genomics as one of eight new content areas for public health education programs.

1 2 3 4 5

The CDC and 3 Universities*, have developed the web-based training tool, *E-Facts on Public Health Genomics* (formerly *Genomics for Public Health Practitioners*). (*University of Michigan, University of North Carolina, and University of Washington)

1 2 3 4 5

SUBMIT

Survey Page 17

Health Promotion and Genomics

52

Please rate your familiarity with...

"Genetics" has been added to phase 2 (Epidemiological Assessment) of the PRECEDE-PROCEED Model?

I am not familiar with the PRECEDE-PROCEED Model	Not familiar At All				Completely Familiar
1	2	3	4	5	6

Case Study

You are conducting a breast cancer awareness health promotion program in a community. Judy, a woman in the community, tells you that she has a family history and a positive genetic testing result of breast cancer.

53

Which of the following regarding genetic testing is correct?

- Cancer genetic testing can detect cancer.
- Genetic testing can treat diseases.
- Genetic testing is utilized to detect individuals' genotype.
- Genetic testing is utilized to detect individuals' phenotype.
- Genetic testing is utilized to detect individuals' both genotype and phenotype.

54

What is Judy's risk of developing breast cancer?

- No lifetime risk
- Lower than the general population risk
- Similar to the general population risk
- Higher than the general population risk
- Definitely will develop breast cancer

SUBMIT

Survey Page 18

Health Promotion and Genomics

55

If a woman takes 400 mg/day of _______ before and during the early stages of pregnancy, she can reduce her fetus risk of neural tube defects (NTDs).

- Thiamin
- Folic acid
- Niacin

- Vitamin D
- Iron

56

A husband and wife are both carriers of an autosomal recessive disease. Their child will have a ________ chance of developing this recessive disease.

- 0%
- 25%
- 50%
- 75%
- 100%

57

According to the Human Genome Project, ________ nucleotide bases are exactly the same in all people.

- 91.9%
- 93.9%
- 95.9%
- 97.9%
- 99.9%

58

You are using a family history tool to classify people into 3 risk groups (average, moderate, and high). What would you recommend for people of moderate risk?

- Standard public health recommendations for maintaining good health
- Personalized prevention recommendations such as lifestyle changes or early detection strategies

A consultation with a geneticist or other appropriate specialists

Standard public health recommendations and a consultation with a geneticist or other appropriate specialists

Personalized public health recommendations and a consultation with a geneticist or other appropriate specialists

SUBMIT

Survey Page 19

Health Promotion and Genomics

Please tell us about yourself...

59

From where have you received training in genetics/genomics or public heath genetics/genomics? (Please mark all that apply)

I have never had any training in genetics/genomics or public heath genetics/genomics.

Courseswork

Continuing Education Units (CEU)

Job training

Other, Please Specify

60

Are you CHES eligible*?

*A bachelor's, master's or doctoral degree from an accredited institution of higher education; and one of the following:
1. An official transcript (including course titles) that clearly shows a major in health education, including Health Education, Community Health Education, Public Health Education, School

Health Education.
2. An official transcript that reflects at least 25 semester hours or 37 quarter hours of course work with specific preparation addressing the Area of Responsibility for Health Educator

- Yes
- No
- I don't know what CHES is.

SUBMIT

Survey Page 20

Health Promotion and Genomics

61

Are you CHES certified?

- Yes
- No

SUBMIT

Survey Page 21

Health Promotion and Genomics

62

What is the highest level of education you have completed?

- High school degree or below
- Bachelor's degree
- Master's degree
- Doctorate degree

- Other, Please Specify

[ ]

63

If you have a bachelor's degree, what was your major?
(Otherwise, please skip this question)

- Health Education
- Community Health Education
- Public Health Education
- School Health Education
- Health Promotion
- Health Education & Promotion
- Health Behavior
- Health Education & Behavior
- Other, Please Specify

[ ]

64

If you have a master's degree, what was your major?
(Otherwise, please skip this question)

- Health Education
- Community Health Education
- Public Health Education
- School Health Education
- Health Promotion
- Health Education & Promotion
- Health Behavior

- Health Education & Behavior
- Other, Please Specify

65

If you have a doctoral degree, what was your major?
(Otherwise, please skip this question)

- Health Education
- Community Health Education
- Public Health Education
- School Health Education
- Health Promotion
- Health Education & Promotion
- Health Behavior
- Health Education & Behavior
- Other, Please Specify

66

If you specified other degree, what was your major?

SUBMIT

Survey Page 22

Health Promotion and Genomics

67

Have you ever worked as a health educator or health promotor?

YES NO

SUBMIT

Survey Page 23

Health Promotion and Genomics

68

How many years have you worked as a health educator or health promotor?
(if less than 1 year, please mark **"0"**)

69

In which setting(s)?
(Please mark all that apply)

- Community Setting
- School (K12) Setting
- Health Care Setting
- Business/Industry Setting
- College/University Setting
- University Health Services Setting
- State/Federal Government Setting
- Other, Please Specify

70

Currently, in which state of the U.S.?

SUBMIT

Survey Page 24

Health Promotion and Genomics

71

What is your age (in years)?

72

What is your gender?

- Female
- Male

73

How do you describe yourself?
(Please mark all that apply)

- White
- Black/African American
- Asian/Pacific Islander
- Alaskan Native/American (Native) Indian
- Hispanic/Latino

Other, Please Specify

74

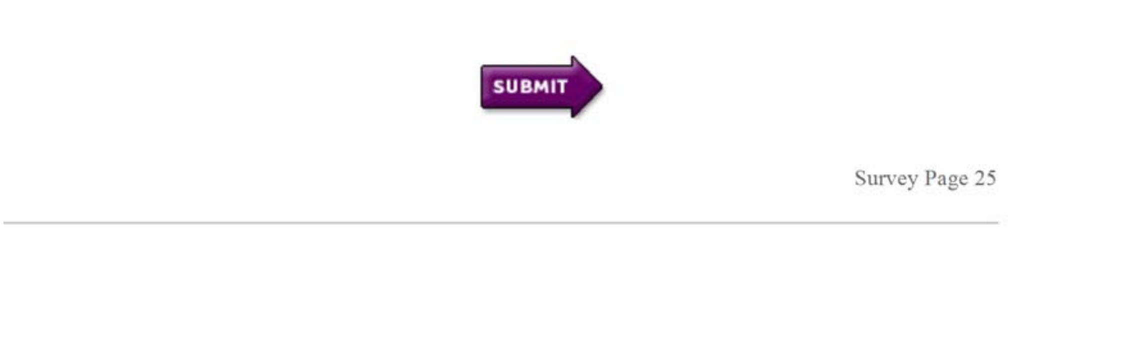
What is your religious preference? Is it Protestant, Catholic, Jewish, some other religion, or no religion?

- Protestant
- Catholic
- Jewish
- None
- Buddhism
- Hinduism
- Mormon
- Moslem/Islam
- Orthodox-Christian
- Native American
- Other, Please Specify

75

To what extent do you consider yourself a religious person?

- Very religious
- Moderately religious
- Slightly religious
- Not religious at all


SUBMIT
Survey Page 25

APPENDIX C

THE WEB-BASED INSTRUMENT: THE FORMAL STUDY

Health Promotion and Genetics/Genomics

Thank you for participating in my dissertation research!!!
For the purpose of this study...

Genomics is *"the study of the functions and interactions of all the genetic material in the genome, including interactions with environmental factors."*

Public Health Genomics is *"the study and application of knowledge about the elements of the human genome and their functions, including interactions with the environment, in relation to health and disease in populations."*

Please click on the submit button to continue with the survey...

SUBMIT

Survey Page 1

Health Promotion and Genetics/Genomics

1

Do you identify yourself as a health educator or health promoter?

YES NO

If you have filled out this survey before, please stop now!

Thank you for your attention.

129

SUBMIT

Survey Page 2

Health Promotion and Genetics/Genomics

2

Have you ever worked as a health educator or health promoter?

YES NO

SUBMIT

Survey Page 3

Health Promotion and Genetics/Genomics

3

How many years have you worked as a health educator or health promotor?
(if less than 1 year, please mark **"0"**)

4

In which setting(s)?
(Please mark all that apply)

- Community Setting
- School (K12) Setting
- Health Care Setting
- Business/Industry Setting

- College/University Setting
- University Health Services Setting
- State/Federal Government Setting
- Other, Please Specify

5

Currently, in which state of the U.S.?

SUBMIT

Survey Page 4

Health Promotion and Genetics/Genomics

Please tell us about yourself...

6

What is your age (in years)?

7

What is your gender?

- Female
- Male

8

How do you describe yourself?
(Please mark all that apply)

- White
- Black/African American
- Asian/Pacific Islander
- Alaskan Native/American (Native) Indian
- Hispanic/Latino
- Other, Please Specify

9

What is your religious preference? Is it Protestant, Catholic, Jewish, some other religion, or no religion?

- Protestant
- Catholic
- Jewish
- None
- Buddhism
- Hinduism
- Mormon
- Moslem/Islam
- Orthodox-Christian
- Native American

Other, Please Specify

10

To what extent do you consider yourself a religious person?

- Not Religious At All
- Slightly Religious
- Moderately Religious
- Very Religious

SUBMIT

Survey Page 5

Health Promotion and Genetics/Genomics

11

Are you CHES eligible*?

*A bachelor's, master's or doctoral degree from an accredited institution of higher education; and one of the following:
1. An official transcript (including course titles) that clearly shows a major in health education, including Health Education, Community Health Education, Public Health Education, School Health Education.
2. An official transcript that reflects at least 25 semester hours or 37 quarter hours of course work with specific preparation addressing the Area of Responsibility for Health Educator

- Yes
- No
- I don't know what CHES is.

SUBMIT

Survey Page 6

Health Promotion and Genetics/Genomics

12

Are you CHES certified?

- Yes
- No

SUBMIT

Survey Page 7

Health Promotion and Genetics/Genomics

13

What is the highest level of education you have completed?

- High school degree or below
- Bachelor's degree
- Master's degree
- Doctoral degree
- Other, Please Specify

14

Which of your degee(s) is in Health Education*?

*Health Education, Community Health Education, Public Health Education, School Health Education, Health Promotion, Health Education & Promotion, Health Behavior, Health Education & Behavior

	1 Yes	2 No	N/A
Bachelor's Degree	1	2	

Master's Degree

1 2

Doctoral Degree

1 2

Other Degree(s)

1 2

15

From where have you received training in genetics/genomics or public heath genetics/genomics? (Please mark all that apply)

- I have never had any training in genetics/genomics or public heath genetics/genomics.
- Coursework
- Continuing Education Units (CEU)
- Job training
- Other, Please Specify

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Health Promotion and Genetics/Genomics

The questions below are designed to assess your attitudes toward 7 different tasks for health educators/promoters:

Task 1: Translating complex genomic information for use in community-based health education programs

16

Have you ever done this task (**Translating complex genomic information...**)?

YES NO

17

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

18

How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

19

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

20

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

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Health Promotion and Genetics/Genomics

Task 2: Facilitating genomic education for agency staff, administrators, volunteers, community groups and other interested personnel

21

Have you ever done this task (**Facilitating genomic education...)?**

YES NO

22

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

23

How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

24

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

25

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

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Health Promotion and Genetics/Genomics

Task 3: Developing a plan for incorporating genomics into health education services by working with community organizations, genomic experts, and other stakeholders

26

Have you ever done this task (**Developing a plan...**)?

YES NO

27

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

28

How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

29

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

30

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

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Health Promotion and Genetics/Genomics

Task 4: Conducting a needs assessment for community-based genomic education programs

31

Have you ever done this task (**Conducting a needs assessment...**)?

YES NO

32

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

33

How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

34

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

35

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

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Health Promotion and Genetics/Genomics

Task 5: Advocating for community-based genomic education programs

36

Have you ever done this task (**Advocating for community-based...**)?

YES NO

37

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

38

How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

39

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

40

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

SUBMIT

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Health Promotion and Genetics/Genomics

Task 6: Integrating genomic components into community-based education programs

41

Have you ever done this task (**Integrating genomic components...**)?

YES NO

42

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

43

How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

44

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

45

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

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Health Promotion and Genetics/Genomics

Task 7: Evaluating the effectiveness of community-based genomics education programs

46

Have you ever done this task (**Evaluating the effectiveness...**)?

YES NO

47

How likely are you to do this task?

- Not Likely At All
- Not Likely
- Somewhat Likely
- Extremely Likely

48

How much do you agree with this task?

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

49

How important is it for you to be involved in this task?

- Not Important At All
- Not Important
- Somewhat Important
- Extremely Important

50

How confident do you feel that you can do this task?

0% confident									100% confident
1	2	3	4	5	6	7	8	9	10

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Health Promotion and Genetics/Genomics

51

Which of the following items are potential barriers/obstacles for you to adopt public health genomics into your practice?

	1 **Not A Barrier At All**	2 **Not A Barrier**	3 **Somewhat A Barrier**	4 **A Strong Barrier**
Incompatibility between genomics and my religious beliefs	1	2	3	4
Lack of knowledge about genomics	1	2	3	4
Lack of knowledge about how to incorporate genomics into health promotion	1	2	3	4
Lack of time to add something new to my work	1	2	3	4
Public health genomics is not a priority in my current work	1	2	3	4

Having to deal with the public's mistrust of genomic information or technologies

1 2 3 4

SUBMIT

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Health Promotion and Genetics/Genomics

The next set of questions will focus on your beliefs/values regarding the advantages of public health genomics...

52

I believe one of the advantages of public health genomics is to...

1 Strongly Disagree	2 Disagree	3 Agree	4 Strongly Agree

Make individuals more aware of their family histories

1 2 3 4

Conduct more effective prevention programs

1 2 3 4

Conduct more personalized prevention programs

1 2 3 4

53

How important is it for you to…

1 Not Important At All	2 Not Important	3 Somewhat Important	4 Extremely Important

Make individuals more aware of their family histories

1 2 3 4

Conduct more effective prevention programs

1 2 3 4

Conduct more personalized prevention programs

1 2 3 4

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Health Promotion and Genetics/Genomics

The next set of questions will focus on the consistency of public health genomics with your professional and personal beliefs/values ...

54

Please indicate your agreement with each statement...

1 Strongly Disagree	2 Disagree	3 Agree	4 Strongly Agree

Adopting public health genomics into health education is consistent with my **professional** beliefs/values.

1 2 3 4

Analyzing current and future community genomic education needs is consistent with my **professional** beliefs/values.

1 2 3 4

Advocating for genomic education programs is consistent with my **professional** beliefs/values.

1 2 3 4

Adopting public health genomics into health education is consistent with my **personal** beliefs/values.

1 2 3 4

Analyzing current and future community genomic education needs is consistent with my **personal** beliefs/values.

1 2 3 4

Advocating for genomic education programs is consistent with my **personal** beliefs/values.

1 2 3 4

55

How important is it for you...

1 Not Important At All	2 Not Important	3 Somewhat Important	4 Extremely Important

Public heath genomics is consistent with your **professional** beliefs/values?

1 2 3 4

Public heath genomics is consistent with your **personal** beliefs/values?

1 2 3 4

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Health Promotion and Genetics/Genomics

The next set of questions will focus on your beliefs/values regarding the complexity of public health genomics...

56

How easy or difficult is it for you to...

1 2 3 4

Extremely Easy	Somewhat Easy	Not Easy	Not Easy at all

Stay updated on public health genomics-related knowledge?

1 2 3 4

Stay updated on basic genomics knowledge?

1 2 3 4

Apply genomic information or technologies to health promotion?

1 2 3 4

57

How important is it for you to…

1 Not Important At All	2 Not Important	3 Somewhat Important	4 Extremely Important

Stay updated on public health genomics-related knowledge?

1 2 3 4

Stay updated on basic genomics knowledge?

1 2 3 4

Apply genomic information or technologies to health promotion?

1 2 3 4

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Health Promotion and Genetics/Genomics

58

How often have you...

1 Never	2 Not Very Often	3 Not Often	4 Often	5 Very Often

Heard about public health genomics on TV?

1 2 3 4 5

Heard about public health genomics on the radio?

1 2 3 4 5

Head about public health genomics in the newspaper?

1 2 3 4 5

Talked about public health genomics with your colleagues?

1 2 3 4 5

Discussed public health genomics at professional conferences?

1 2 3 4 5

Talked about public health genomics with those whom you educate (e.g., communities, students, and/or patients)?

1 2 3 4 5

Talked about public health genomics with your relatives and/or families?

1 2 3 4 5

Read about public health genomics on the internet?

1 2 3 4 5

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Health Promotion and Genetics/Genomics

59

I have personally used genomic information or technologies (e.g., carrier testing, prenatal testing, or cancer genetic testing).

YES NO

60

If yes, the experience(s) I had was(were) positive.

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

61

Someone I know has personally used genomic information or technologies (e.g., carrier testing, prenatal testing, cancer genetic testing).

YES NO

62

If yes, the experience(s) of someone I know was(were) positive.

- Strongly Disagree
- Disagree
- Agree
- Strongly Agree

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Health Promotion and Genetics/Genomics

63

Tell us about what you believe regarding the use of genomic technologies/information...

1 Strongly Disagree	2 Disagree	3 Agree	4 Strongly Agree

I believe the use of genomic technologies or information can reinforce existing discrimination (e.g., discrimination by health insurance companies).

1 2 3 4

I believe the use of genomic technologies or information can increase health disparities.

1 2 3 4

I believe the advances of genomic technologies or information can lead to the cloning of human beings.

1 2 3 4

I believe the advances of genomic technologies or information can lead to the increasing use of human embryonic cells to conduct stem cell research.

1 2 3 4

64

How concerned are you that...

1 Not Concerned At All	2 Not Concerned	3 Somewhat Concerned	4 Extremely Concerned

The use of genomic technologies or information can reinforce existing discrimination (e.g., discrimination by health insurance companies).

1 2 3 4

The use of genomic technologies or information can increase health disparities.

1 2 3 4

The advances of genomic technologies or information can lead to the cloning of human beings.

1 2 3 4

The advances of genomic technologies or information can lead to the use of human embryonic cells to conduct stem cell research.

1 2 3 4

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Health Promotion and Genetics/Genomics

The next set of questions will focus on your knowledge regarding public health genomics...

65

Please rate your familiarity with...

1 Not familiar At All	2	3	4	5 Completely Familiar

The CDC has recommended 7 genomic competencies for health educators.

1 2 3 4 5

The National Coalition for Health Professional Education in Genetics (NCHPEG) has established the *core competencies in genetics* for health professionals.

1 2 3 4 5

The Institute of Medicine has recommended genomics as one of eight new content areas for public health education programs.

1 2 3 4 5

The CDC and 3 Universities*, have developed the web-based training tool, *E-Facts on Public Health Genomics* (formerly *Genomics for Public Health Practitioners*). (*University of Michigan, University of North Carolina, and University of Washington)

1 2 3 4 5

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Health Promotion and Genetics/Genomics

66

Please rate your familiarity with...

"Genetics" has been added to phase 2 (Epidemiological Assessment) of the PRECEDE-PROCEED Model?

I am not familiar with the PRECEDE-PROCEED Model	Not familiar At All				Completely Familiar
1	2	3	4	5	6

Case Study

You are conducting a breast cancer awareness health promotion program in a community. Judy, a woman in the community, tells you that she has a family history and a positive genetic testing result of breast cancer.

67

Which of the following regarding genetic testing is correct?

- Cancer genetic testing can detect cancer.
- Genetic testing can treat diseases.
- Genetic testing is utilized to detect individuals' genotype.
- Genetic testing is utilized to detect individuals' phenotype.
- Genetic testing is utilized to detect individuals' both genotype and phenotype.
- I don't know

68

What is Judy's risk of developing breast cancer?

- No lifetime risk
- Lower than the general population risk
- Similar to the general population risk
- Higher than the general population risk
- Definitely will develop breast cancer
- I don't know

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Health Promotion and Genetics/Genomics

69

If a woman takes 400 mcg/day of _______ before and during the early stages of pregnancy, she can reduce her fetus risk of neural tube defects (NTDs).

- Thiamin
- Folic acid
- Niacin
- Vitamin D
- Iron
- I don't know

70

A husband and wife are both carriers of an autosomal recessive disease. Their child will have a ________ chance of developing this recessive disease.

- 0%
- 25%
- 50%
- 75%
- 100%
- I don't know

71

According to the Human Genome Project, ________ nucleotide bases are exactly the same in all people.

- 91.9%
- 93.9%
- 95.9%
- 97.9%
- 99.9%
- I don't know

72

You are using a family history tool to classify people into 3 risk groups (average, moderate, and high). What would you recommend for people of moderate risk?

- Standard public health recommendations for maintaining good health
- Personalized prevention recommendations such as lifestyle changes or early detection strategies
- A consultation with a geneticist or other appropriate specialists
- Standard public health recommendations and a consultation with a geneticist or other appropriate specialists

- Personalized public health recommendations and a consultation with a geneticist or other appropriate specialists
- I don't know

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APPENDIX D

INCENTIVE DRAWING:

THE PILOT TEST AND FINAL STUDY

Drawing to Win $50

Thank you for participating in my dissertation research. Your feedback is important and valuable.

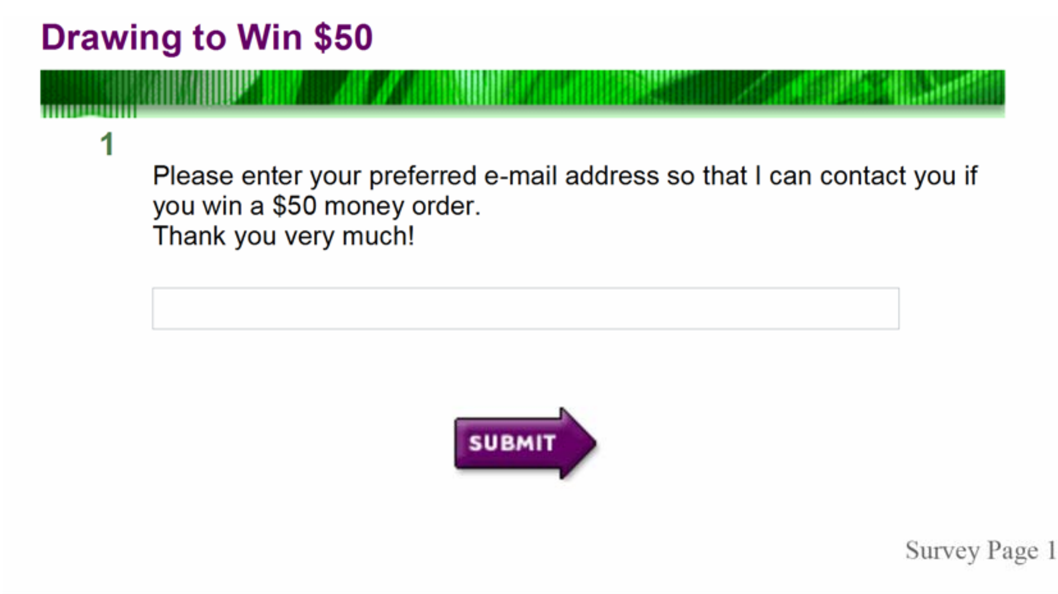
This study is anonymous. If you choose to enter the drawing to be eligible to win $50, you will be redirected to a separate web link where you may enter your preferred e-mail address. As this will be done through a separate link, there will be no way to trace your responses.

If you choose to enter the drawing, please click on **START SURVEY!** to enter your preferred e-mail address.

If you win one of the $50 money orders, I will contact you as soon as possible.

Good Luck!

START SURVEY!


Drawing to Win $50

1

Please enter your preferred e-mail address so that I can contact you if you win a $50 money order.
Thank you very much!

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Thank you very much for helping with this important study!!!

For further information regarding public health genomics and health promotion, please refer to:

1. E-Facts on Public Health Genomics (http://www.cdc.gov/genomics/public/eFactSheet/menu_ani.html)
2. Six Weeks to Genomics Awareness (http://www.cdc.gov/genomics/training/sixwks.htm)
3. Workforce Genomics Competencies (http://www.cdc.gov/genomics/training/competencies/default.htm)
4. Green LW, Kreuter MW. Health program planning: an educational and ecological approach. New York: McGraw-Hill; 2005.
5. Institute of Medicine. Who will keep the public healthy? Washington D.C: National Academics Press; 2002.

Please feel free to contact me if you have any questions regarding this survey or need further information on public health genomics and health promotion.

Lei-Shih Chen, M.S., P.T., CHES
Texas A&M University
Department of Health and Kinesiology
4243 TAMU, College Station, Texas 77843
Phone: 979-862-8574
Fax: 979-847-8987
E-mail: lace@hlkn.tamu.edu

VITA

Name: Lei-Shih Chen

Address: Lei-Shih Chen may be contacted through Dr. Patricia Goodson at the Health and Kinesiology Department, Texas A&M University, College Station, TX, 77843-4243

Email Address: lace@hlkn.tamu.edu

Education: B.S., Physical Therapy, National Taiwan University, Taiwan, 1999
M.S., Occupational Medicine and Industrial Hygiene, National Taiwan University, Taiwan, 2001
Ph.D., Health Education, Texas A&M University, 2007