# Nursing Students' Perceived Knowledge and Attitude Towards Genetics

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## Abstract:

The purpose of this study was to assess the knowledge base of nursing students regarding the topic of genetics and how this may change as a student progresses through the nursing program. A 70 item multiple-choice and dichotomous survey was given to freshman, sophomore, junior, and senior nursing students at a university school of nursing in the eastern part of the United States. Two hundred and seventy five pre-licensure nursing students, 255 females and 18 males, comprised the sample.

A one-way analysis of variance (ANOVA) was performed and the results concluded that there was a significant difference among the freshmen, sophomores, juniors, and seniors in regards to having at least a 'minimal' knowledge or better of medical genetic terminology and conditions. Seniors reported a higher number of terms which they had at least a 'minimal' knowledge level or better than freshmen or sophomores. Also the juniors reported a higher number of terms which they had at least a 'minimal' knowledge level or better than sophomores.

**Keywords:** Nursing Education | Genetics | Nursing students | Knowledge

## Article:

### Introduction

Scientific knowledge of genetics has exponentially increased in the first decade of the 21st century, but while the scientific world now understands a great deal about genetics, public understanding of genetic information has not kept pace (Bates et al., 2005 and Hietala et al.,

1995Jallinoja et al., 1998 and Williams et al., 2004. The mission of the National Coalition for Health Care Professionals Education in Genetics (NCHPEG) is to promote the integration of genetics into healthcare education and use this information to improve health throughout the nation (Maradiegue et al., 2005). Since genetic information is essential to the recognition of many disorders, nurses need to be well informed about genetics. A better understanding of genetic information and implications for practice would permit nurses to incorporate genetics into nursing care, provide more holistic care, and advocate better for their patients (Jenkins et al., 2001).

To identify studies relevant to this topic, a search of the following terms, ‘knowledge AND genetics’ from 1990 to 2010 were placed into two databases: PUBMED (National Library of Medicine) and CINAHL (Cumulative Index to Nursing and Allied Health Literature). Several studies have examined physicians' knowledge of genetics (Michie et al., 1995 and Toiviainen et al., 2003), Williams et al. (2004) found no research on the knowledge of nurses about the field of genetics. One study that looked at advanced practice nursing students' knowledge of genetics (Maradiegue et al., 2005), found that most of these students had a minimal knowledge of medical genetics. The authors concluded that there are significant gaps in the nursing curriculum in regard to medical genetics and a good deal of education is needed to improve the genetic competence of nurses. Bankhead et al. (2001) found that practicing nurses in England routinely took family histories, but needed further education on family history and genetic information.

Williams et al. (2004) noted that genetics is a necessary component of nursing in the 21st century, and the American Academy of Nursing (AAN) and the Institute of Medicine (IOM) have both addressed the need for nurses who are prepared to take part in genetic health care services. Yet Challen et al. (2005), who examined educational competencies in genetics of nongenetic health professionals in five European countries, found inconsistent training and education in genetics for these professionals.

Strategies for health professional education in genetics can be found in the Essentials of Genetic and Genomic Nursing: Competencies, Curricula Guidelines, and Outcome Indicators, established by the American Nurses Association (ANA) in 2006. In order to produce proficient nurses, the ANA notes that “Each nursing curriculum preparing registered nurses for practice (at any and all levels) should include genetic and genomic learning experiences sufficient for all registered nurses to be proficient in the essential competencies” (p. 38). However, a strategic plan needs to be formulated to incorporate these components into nursing curricula and practice (Jenkins and Calzone, 2007). As a first step, current knowledge and comfort with genetic nursing need to be assessed to identify the changes needed in nursing curricula.

Jenkins et al. (2001) provided a template for the addition of medical genetics information to nursing curricula. But only two articles have reported how medical genetics education was delivered in their nursing curriculum. Nicol (2002) reported on the integration of medical genetics in the undergraduate nursing curriculum in New Zealand; and Cragun et al.

(2005) reported on the success of genetic education for nursing and dietetic students at the University of Cincinnati. In addition, ethical, social and legal implications of genetic testing with the United States and the United Kingdom mandate the provision of genetic information in all level of nursing curricula (Williams et al., 2006).

This study therefore examined experience, knowledge, and comfort level with medical genetics among nursing students in an undergraduate program.

**Methodology**

This descriptive, cross-sectional study of undergraduate nursing students was a replication of a study done by Maradiegue et al. (2005) with graduate nursing students, and used the same survey instrument. Paper-and-pencil surveys were distributed to all students with a major in pre-nursing or nursing – freshman through senior years – registered for seven nursing classes in the spring semester of 2008. The junior and senior students had been admitted into the school of nursing, while freshman and sophomore students had only proposed an interest in the field of nursing by declaring pre-nursing as a major. The study was conducted at a university school of nursing in the eastern United States. A return envelope was provided in the classroom for students who chose to complete the survey on site, and in the student lounge for students who chose to complete the survey later.

The target population is freshman, sophomore, junior, and senior undergraduate pre-licensure students who have chosen nursing as their major. Approval to conduct the study was obtained from the institutional review board at the University. A cover letter reflecting the elements of informed consent was given to subjects before they received the survey. Potential subjects were told that their participation was voluntary, their information would be kept confidential, they would not be penalized for answering the questions incorrectly, and their standing in the nursing class would not be affected whether or not they participated. Subjects were instructed not to put their names on the survey.

The “Genetics Needs Assessment Survey” was developed by Maradiegue et al. (2005), and permission was granted for use in this study (Table 1). The survey developers established content validity by the use of a panel of people experienced in medical genetics and healthcare evaluation (Maradiegue et al.). The paper-and-pencil survey consisted of 70 multiple-choice and dichotomous items. Three items assessed demographics, 52 items evaluated the student's perceived knowledge of various genetic concepts, 9 items examined the student's comfort with genetics in the clinical setting, and 6 items assessed the way students would like educational activities to be conducted in regard to genetics.

**Table 1.** INSTRUMENT.

**Course Number:** 110 220 310 320 340 360 430

**GENETICS NEEDS ASSESSMENT SURVEY**

The **Genetics Needs Assessment** is designed to provide insight on the knowledge base, experiences, and comfort level within the field of medical genetics among undergraduate students. The information you provide on this survey will be kept confidential.

Please complete this survey with a pen or pencil. Return the survey to the provided envelope provided at the front of the classroom by the end of the class. If you are unable to complete the test by the end of the class period, you may return the completed survey to a return envelope labeled "Genetics Needs Assessment Survey" located in the student lounge (Room 422). The deadline for returning the survey is _____.

Please complete this survey without the help of others. You will not be penalized for any incorrect answers. Your survey will be kept confidential. Please do not write your name on the survey.
Thank you for your assistance!

**I. Demographics.**

**Directions:** Please fill in blank or place a check mark in the appropriate slot.

**Age:** ____

**Gender: Male** ___ **Female** ___

**Educational Background:**
**Do you have a previous degree? Yes** ____ **No** ____ **If so what in?** _____

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**II. Background Assessment.**

**Directions:** Check the box that most accurately represents your current knowledge/comfort with the following topics in genetics. Note: If you have already been formally trained in an area (e.g. course or workshop), please indicate this by marking the last column.

| Topic: | No knowledge of this topic | Minimal knowledge of this topic | Some knowledge of this topic | High level of knowledge of this topic | Extremely comfortable explaining this topic to others | Have previous formal training |
|---|---|---|---|---|---|---|
| DNA Structure/Function | | | | | | |
| RNA Structure/Functiona | | | | | | |
| DNA Replication | | | | | | |
| Mitosis | | | | | | |
| Meiosis | | | | | | |
| Transcription | | | | | | |
| Translation | | | | | | |
| Protein Synthesis | | | | | | |
| Mutations | | | | | | |
| Autosomal Dominant Inheritance Patterns | | | | | | |
| Autosomal Recessive Inheritance Patterns | | | | | | |
| X-Linked Inheritance Patterns | | | | | | |
| Mitochondrial Inheritance Patterns | | | | | | |
| Genograms | | | | | | |
| Tay Sachs | | | | | | |
| Cystic Fibrosis | | | | | | |
| Breast/Ovarian Cancer | | | | | | |
| Colon Cancer | | | | | | |
| Hemochromatosis | | | | | | |
| Sickle Cell Disease | | | | | | |
| Thalassemias | | | | | | |
| Fragile X | | | | | | |
| Phenylketonuria (PKU) | | | | | | |
| Huntington's Disease | | | | | | |

**Table 1 cont.**

| Topic: | No knowledge of this topic | Minimal knowledge of this topic | Some knowledge of this topic | High level of knowledge of this topic | Extremely comfortable explaining this topic to others | Have previous formal training |
|---|---|---|---|---|---|---|
| Gaucher Disease | | | | | | |
| Myotonic Dystrophy | | | | | | |
| Familial Hypercholesterolemia | | | | | | |
| Neurofibromatosis | | | | | | |
| Duchenne's Muscular Dystrophy | | | | | | |
| Hardy-Weinberg Equilibrium | | | | | | |
| Polymerase Chain Reaction (PCR) | | | | | | |
| Trisomy 21 | | | | | | |
| Trisomy 18 | | | | | | |
| Trisomy 13 | | | | | | |
| Turner Syndrome | | | | | | |
| Klinefelter Syndrome | | | | | | |
| Osteogenesis Imperfecta | | | | | | |
| Gene Therapy | | | | | | |
| Pharmacogenetics | | | | | | |

**Table 1 cont.**

2. Please check the box that most accurately represents your response.

| I can define the following terms: | Yes | No |
|---|---|---|
| Gene | | |
| Locus | | |
| Allele | | |
| Genotype | | |
| Phenotype | | |
| Homozygote | | |
| Heterozygote | | |
| Dominant | | |
| Recessive | | |
| Missense mutation | | |
| Nonsense mutation | | |
| Frameshift mutation | | |
| Karyotype | | |

**Table 1 cont.**

3. Please check the box that most accurately represents your response.

| I would feel comfortable: | Definitely not | Probably not | Probably yes | Definitely yes |
|---|---|---|---|---|
| Finding information on a specific genetic disease on the Internet | | | | |
| Using OMIM | | | | |
| Recommending a specific support group to a patient with a genetic disease | | | | |
| Making a specific referral for a patient with genetic questions | | | | |
| Speaking to a patient about his/her family history | | | | |
| Speaking to a family about a diagnosis of a specific genetic disease | | | | |
| Drawing a patient's pedigree | | | | |
| Given a pedigree, predicting the chances that an unborn child would have a genetic disease | | | | |
| Speaking with a family about customizing medications based on genetic make-up | | | | |

**Table 1 cont.**

4. Please check the box that most accurately represents your response.

| The following educational/conference activities would improve my knowledge/understanding of genetics: | No | Probably not | Probably yes | Definitely yes |
|---|---|---|---|---|
| Lectures | | | | |
| Small Group Discussion | | | | |
| Role Play | | | | |
| Practice with Standardized Patients | | | | |
| Readings | | | | |
| Problem Sets | | | | |

Thank you for completing this survey!

Data were coded and entered into an SPSS database. Descriptive statistics including frequencies and percentages were used to describe the students' demographics, perceived knowledge about medical genetics, comfort level with integrating medical genetics into practice, and educational activities integrating medical genetics into curriculum that were most often chosen by the students. These frequencies were compared to those reported in the original study (Maradiegue et al., 2005). Additionally, the mean numbers of students who answered the 39 multiple-choice knowledge questions with at least “minimal” knowledge at each level (freshman, sophomore, junior, senior) were compared using one-way analysis of variance (ANOVA). A significance level of $p < 0.05$ was set to indicate significant differences between levels of students.

**Results**

Two hundred and ninety nine surveys were distributed to pre-licensure nursing students. Sixteen freshman, 112 sophomores, 77 juniors, and 70 seniors completed and returned the survey, for a total of 275 surveys. Ninety-four percent of all the freshmen, 98% of sophomores, 91% of juniors, and 82% of seniors returned the surveys, for an overall return rate of 92%. The lower responses by junior and senior level participants may have been due to the fact that these classes ran later than their allotted time and many participants did not stay to complete their surveys after class or return them to the marked folder in the student lounge.

The majority of the participants were women (93%), and their mean age was 23 years. The majority of the participants were first-degree (79%) students. Table 2 gives additional demographic information on the participants.

**Table 2.** Pre-licensure nursing student demographics.

| Demographics | |
|---|---|
| Age (years) | |
| Mean | 23.36 |
| | N (%) |
| Gender | |
| Male | 18 (7) |
| Female | 255 (93) |
| Nursing school enrollment | |
| Freshman | 16 (6) |
| Sophomore | 112 (41) |
| Junior | 77 (28) |
| Senior | 70 (25) |

The mean total score for each of the 39 medical genetics knowledge questions was computed. An ANOVA was performed on these data. Because of the moderate skewness of the data (Polit, 1996), square root transformation was performed, and a more normal distributed curve was obtained.

The survey contained 39 questions that assessed participants' perceived knowledge of medical genetic conditions and terminology. Participants could choose “no,”- “minimal,”- “some,”- “high”- level of knowledge for each item. Most of the participants said that they had “some” to “high” knowledge of common genetic terms such as DNA structure, RNA structure, mitosis, translation, and transcription. However, the majority of the participants chose “no” or “minimal” knowledge of terms such as myotonic dystrophy, thalassemias, and Hardy‑Weinberg equilibrium. Eighty-eight percent of the participants said they had “no” knowledge of Gaucher Disease. Table 3 depicts the students' perceptions of their knowledge of selected genetic topics, broken down into genetic terms, genetic conditions, and other.

**Table 3.**Number and percentages of pre-licensure nursing students' knowledge of certain genetic topics.

| | Knowledge level | | | |
|---|---|---|---|---|
| Genetic topics | None | Minimal | Some | High |
| | N (%) | N (%) | N (%) | N (%) |
| Genetic terms | | | | |
| Mitosis | 0 (0) | 21 (8) | 151 (56) | 102 (36) |
| Meiosis | 1 (1) | 26 (9) | 145 (54) | 99 (36) |
| Translation | 2 (1) | 28 (9) | 150 (55) | 95 (35) |
| Transcription | 2 (1) | 28 (9) | 149 (55) | 95 (35) |
| DNA replication | 0 (0) | 21 (8) | 148 (54) | 106 (38) |
| RNA structure/function | 0 (0) | 33 (12) | 147 (53) | 95 (35) |
| DNA structure/function | 0 (0) | 16 (6) | 144 (52) | 115 (42) |
| Protein synthesis | 2 (1) | 24 (9) | 149 (54) | 100 (36) |
| Mutations | 0 (0) | 20 (7) | 145 (53) | 109 (40) |
| Autosomal dominant inheritance | 5 (2) | 30 (11) | 144 (52) | 96 (35) |
| Autosomal recessive inheritance | 6 (2) | 32 (11) | 139 (51) | 98 (36) |
| X-linked inheritance | 8 (3) | 34 (12) | 143 (52) | 89 (33) |
| Mitochondrial inheritance pattern | 14 (5) | 50 (18) | 146 (53) | 65 (24) |
| Genograms | 13 (5) | 42 (15) | 151 (56) | 68 (24) |
| Genetic conditions | | | | |
| Hemachromatosis | 140 (51) | 90 (33) | 41 (15) | 4 (1) |
| Breast cancer | 9 (3) | 71 (26) | 144 (52) | 51 (19) |
| Familial hypercholesteremia | 150 (55) | 58 (21) | 41 (15) | 26 (9) |
| Huntington's disease | 55 (20) | 125 (46) | 82 (30) | 13 (4) |
| Phenylketonuria | 84 (31) | 95 (35) | 79 (29) | 17 (5) |
| Gaucher's disease | 242 (88) | 26 (10) | 7 (2) | 0 (0) |
| Myotonic dystrophy | 216 (79) | 42 (15) | 15 (5) | 1 (1) |
| Sickle cell disease | 7 (3) | 58 (21) | 149 (54) | 61 (22) |
| Thalessemia | 181 (66) | 59 (22) | 30 (11) | 5 (1) |
| Fragile X | 118 (43) | 93 (34) | 52 (19) | 12 (4) |
| Neurofibromatosis | 203 (74) | 58 (21) | 13 (4) | 1 (1) |
| Trisomy 21 | 98 (36) | 64 (23) | 83 (30) | 30 (11) |
| Trisomy 18 | 152 (55) | 86 (31) | 29 (11) | 8 (3) |
| Trisomy 13 | 157 (57) | 83 (30) | 29 (11) | 5 (2) |
| Turner syndrome | 134 (49) | 83 (30) | 48 (18) | 10 (3) |
| Klinefelter syndrome | 160 (58) | 77 (28) | 32 (12) | 6 (2) |
| Osteogenesis imperfecta | 199 (72) | 54 (20) | 19 (7) | 3 (1) |
| Tay Sachs | 48 (18) | 112 (41) | 91 (33) | 24 (8) |
| Cystic fibrosis | 11 (4) | 88 (32) | 133 (48) | 43 (16) |
| Colon cancer | 15 (6) | 82 (30) | 138 (50) | 40 (14) |
| Duchenne muscular dystrophy | 151 (55) | 90 (33) | 28 (10) | 6 (2) |
| Other | | | | |
| PCR | 191 (70) | 50 (18) | 21 (8) | 12 (4) |

| | | | | |
|---|---|---|---|---|
| Gene therapy | 82 (30) | 103 (37) | 76 (28) | 14 (5) |
| Genogram | 18 (7) | 44 (16) | 114 (42) | 98 (35) |
| Pharmacogenetics | 106 (39) | 101 (37) | 54 (20) | 12 (4) |

The answers to these 39 multiple-choice questions were grouped into two categories: “no” knowledge or “minimal” or greater knowledge. “Minimal” or greater knowledge was coded as “1” and “no” knowledge was coded as “0.” Scores on all 39 items was computed in this way for each participant. None of the participants said they had at least “minimal” knowledge of all 39 topics. Eleven participants said they had at least “minimal” knowledge of 36 of the items.

One-way analysis of variance (ANOVA) indicated that there were significant differences between the freshmen, sophomores, juniors, and seniors on the mean number of items on which they had at least minimal perceived knowledge; the F ratio was 5.575 ($p = 0.001$); this is shown in Table 4. Since this ANOVA was significant, the differences between each class were examined, using Fisher's least significant difference (LSD) test. This test revealed a significant difference between freshman and seniors, with a $p$ value of 0.01, as well as a significant difference between sophomores and juniors, with a $p$ value of 0.032. Furthermore, a significant difference was found between sophomores and seniors, with a $p$ value of >.0001 (Table 5). Fig. 1shows the mean total scores of each class level.

**Table 4.** One-way ANOVA of the mean number of responses indicating at least “minimal” knowledge or better.

| | Sum of squares | df | Mean square | *F* value | *p* value |
|---|---|---|---|---|---|
| Between groups | 516.280 | 3 | 172.093 | 5.574 | .001 |
| Within groups | 7996.381 | 259 | 30.874 | | |
| Total | 8512.662 | 262 | | | |

**Table 5**.Multiple comparisons of dependent variable with Fisher's least significant difference (LSD) test.

| | | Mean difference (I–J) | Standard error | *p* value |
|---|---|---|---|---|
| Freshmen | Sophomore | − 1.18875 | 1.63120 | .467 |
| | Junior | − 2.99480 | 1.67097 | .074 |
| | Senior | − 4.34615 | 1.68195 | .010* |
| Sophomore | Freshmen | 1.18875 | 1.63120 | .467 |
| | Junior | − 1.80606 | .83850 | .032* |
| | Senior | − 3.15741 | .86018 | .000* |
| Junior | Freshmen | 2.99480 | 1.67097 | .074 |
| | Sophomore | 1.80606 | .83850 | .032* |

| | | | | |
|---|---|---|---|---|
| | Senior | − 1.35135 | .93341 | .149 |
| Senior | Freshmen | 4.34615 | 1.68195 | .010* |
| | Sophomore | 3.15741 | .86018 | .000* |
| | Senior | 1.35135 | .93341 | .149 |

*$p < 0.05$.

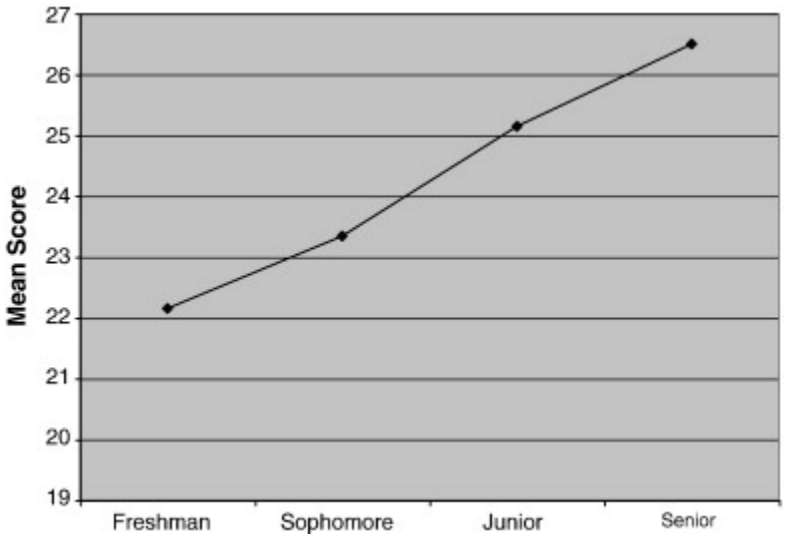


**Fig. 1.** Plot of mean scores with at least a ‘minimal’ response or better.

Finally the raw scores for each question (maximum range 0‑5 on each of the 39 items, with a maximum possible score of 195) were added up for each participant, and the distribution of scores was examined for normality. A skewness of 1.124 and a kurtosis of 2.984 were found, indicating that the scores were not normally distributed. To normalize the distribution and meet the assumptions of ANOVA, a square root transformation was performed, and ANOVA was then computed using the transformed variables. There were no significant differences between the four groups on the total score on the 39-item knowledge test (F ratio of 1.645, $p = 0.179$).

Some knowledge questions on the instrument had to do with the perceived ability to define 13 genetic terms. When asked whether or not they could define the term “dominant,” 100% of the participants said “yes,” but only 23% of the participants said they could define the term “missense mutation.” Fig. 2 shows the numbers and percentages “yes” and “no” responses to each of the 13 items.

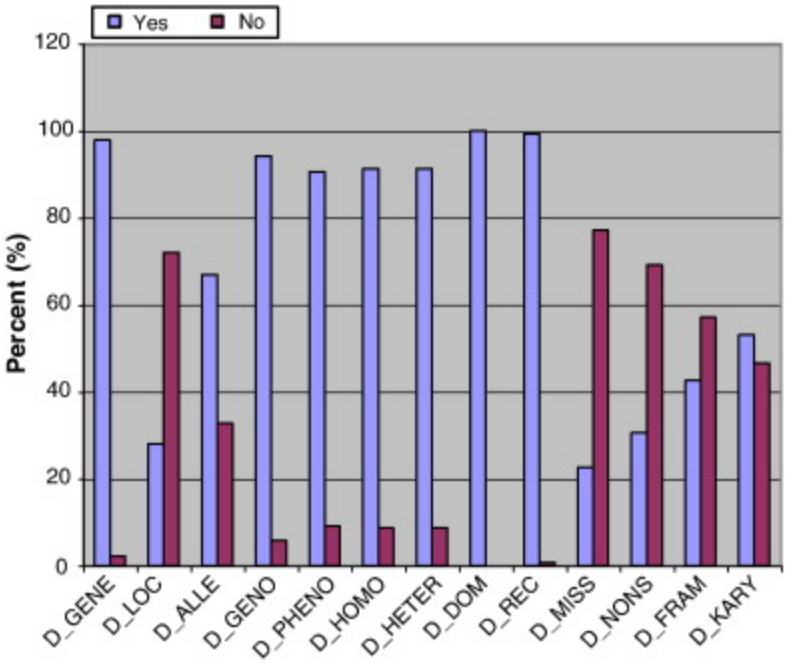


**Fig. 2.** Percent of 'Yes' or 'No' responses to definition of genetic terms by pre-licensure nursing students.

The survey also asked for participants' opinions of their clinical comfort level with medical genetics, including finding information about genetics on the Internet, drawing a pedigree, or speaking to a patient about family history. Four choices could be selected to answer the questions: "definitely not," probably not, "probably yes," or "definitely yes."

While 96% of the participants answered "probably yes" or "definitely yes" to feeling comfortable in finding information about genetics on the Internet, only 61% felt comfortable speaking to a family about a diagnosis of a specific genetic disease. Table 6 shows the data on participants' comfort level regarding medical genetics.

**Table 6.** Comfort level of pre-licensure nursing students regarding integration of genetics in clinical settings.

| Genetic topics | Definitely Not, N (%) | Probably Not, N (%) | Probably Yes, N (%) | Definitely Yes, N (%) |
|---|---|---|---|---|
| Accessing genetic information on the Internet | 0 (0) | 11 (4) | 134 (49) | 129 (47) |
| Speaking to family/patient about genetic diagnosis | 18 (7) | 88 (32) | 107 (39) | 61 (22) |
| Drawing a pedigree | 24 (9) | 64 (23) | 121 (44) | 65 (24) |
| Predicting outcomes of a pedigree | 39 (14) | 64 (23) | 134 (49) | 35 (14) |

Finally, participants were asked six multiple-choice questions regarding educational activities that would improve their knowledge of genetics. The response choices were "no," "probably

not," "probably yes," and "definitely yes." Participants were asked to indicate the effectiveness of educational activities such as lectures, small group discussions, role play, practice with standardized patients, readings, and problem sets; 93% responded "probably yes" or "definitely yes" to the effectiveness of practice with standardized patients. They also felt lectures would be effective (91%), along with small group discussions (86%), problem sets (85%), readings (74%), and role play (55%).

**Limitations**

This study was conducted in one school of nursing; therefore, results cannot be generalized to other populations. The study was a replication of a previous study, but with a different population. As such, the same instrument was used as in the previous study. This instrument focused almost exclusively on biological aspects of medical genetics. Future research should also include assessment of psychosocial knowledge and values regarding genetics and genetic testing. Content mapping of genetic information included in the curriculum was not available; future studies would be strengthened by correlating curriculum content with student knowledge.

**Discussion**

This study revealed significant differences in the perceived knowledge of medical genetics between freshmen and seniors, sophomores and juniors, and sophomores and seniors. The seniors had a greater perceived knowledge of genetic terms than either freshman or sophomores, and the junior class had greater perceived knowledge than the sophomore class. The majority of the participants felt comfortable defining common genetic terms; however, most of the participants were not comfortable in speaking with patients about genetic diseases.

When the total scores on the 39-item knowledge portion of the tool were compared, there were no significant differences between the groups. Maradiegue et al. (2005) obtained 46 surveys from advanced practice nursing students, while in this study 275 surveys were collected from pre-licensure students. The majority of the participants in the Maradiegue et al. (2005) study were women (70%), comparable to this study in which 93% of the participants were women. However, the participants in the two studies differed in age. The mean age of the pre-licensure students was 23 years, while the most frequently chosen age category of the advanced practice nursing students was 30‑39.

Both advanced practice nursing students and the pre-licensure students said they had "no" or "minimal" knowledge of genetic disorders such as Gaucher's Disease (92% and 98% respectively). Both groups had "some" to "high" knowledge of basic genetic terms such as DNA structure/function (60% and 94% respectively). However, the pre-licensure students (37%) on average chose more "high" level knowledge on basic genetic terms than advanced practice nursing students (5%). Both studies found that students perceived more knowledge of basic genetic terms than of more specific conditions.

All of the advanced practice nursing students as well as the pre-licensure students said that they could define the genetic term “dominant.” Only one advanced practice nursing student said that she could define missense mutation, nonsense mutation, or frameshift mutation, whereas 117 (43%) pre-licensure students said they could define at least one of these genetic terms.

In addition, the advanced practice nursing students felt less comfortable that the undergraduate students integrating genetics into the clinical setting. More pre-licensure nursing students (68%) chose “probably yes” or “definitely yes” to the question about their ability to draw a pedigree than advanced practice nursing students (22%). Also, 61% of the pre-licensure students said “probably yes” or “definitely yes” in answer to a question about speaking with a family about a diagnosed genetic disease, but only 34% of the advanced practice nursing students.

Furthermore, the advanced practice nursing students believed that the utilization of problem sets and selected readings were the best educational activities to help facilitate learning. However, the pre-licensure nursing students felt that practice with standardized patients and lectures were the most effective educational activities. Finally, both studies found that nursing students agreed that role play was the least effective educational intervention. Therefore, educators should use several teaching strategies to engage students with varying learning styles (Bradshaw & Lowenstein, 2007). Simulation can be used in conjunction with teaching strategies such as lecture and discussion to allow students to practice skills such as speaking to patients about genetics-related topics.

The studies indicate that both pre-licensure and advanced practice nursing students lack knowledge of medical genetics. However, pre-licensure nursing students perceive that they have more knowledge of genetic terms and the ability to define more technical genetic terms than advanced practice nursing students. This may be due to the fact that more genetic information is integrated in undergraduate nursing curricula than when advanced practice nursing students went through their pre-licensure nursing program. However, pre-licensure students may have been less willing to admit lack of knowledge or inability to define genetic terms because they felt they should be able to do so at this stage of nursing school. The undergraduate students in this study did not have a stand-alone genetics course in their curriculum, but basic genetic content was covered in the freshman biology class, and then integrated into some of the nursing classes in the junior and senior year.

The studies revealed a lack of comfort in integrating medical genetics into practice. However, the pre-licensure students felt more comfortable than licensed nurses in doing so. Although this replication study was unable to directly assess the reasons for these differences, it is possible that pre-licensure students have a better understanding of genetics because more medical genetics is integrated in their curriculum today than was the case for the advanced practice nurses in their undergraduate programs. However, the pre-licensure students may overestimate their comfort in integrating genetics into practice because they have not cared for such patients except as a

student nurses, whereas the advanced practice nurses may have a more realistic view of their ability and comfort level.

## Conclusion

The need for genetic knowledge and understanding has increased since the completion of the Human Genome Project. However, the integration of genetics into nursing curricula throughout the United States and Europe has been sporadic at best. This may be related to the differences in health policies between Europe and the U.S. (Challen, et al., 2005). Nevertheless, the American Association of Colleges of Nursing (2008) has integrated genetic information into the Essentials of Baccalaureate Education for Professional Nursing Practice, which serves as an important benchmark for American schools of nursing.

In the school of nursing where this study was conducted, knowledge of medical genetics improved as the students progressed toward graduation. These results support the general assumption that knowledge about health topics increases as students progress in the nursing program. Nevertheless, additional research needs to assess the curriculum in order to determine where genetics information is covered. This study did not look at the placement of genetic information in the curriculum; it would be interesting to see how placement of genetic content in the curriculum influences the knowledge of medical genetics among students.

In summary, this study revealed that pre-licensure nursing students have increased perceived level of knowledge as they advance in the nursing program. Future research should examine the actual knowledge of genetics among nursing students, since this survey assessed only the perceived knowledge of nursing students. Also, nursing curricula should be examined to identify gaps in information on medical genetics and identify the areas where genetic education is lacking.

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