Perceptions Toward Research Among Undergraduates in an Imaging Sciences Baccalaureate Program: A Secondary Analysis

THESIS

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Abstract

The need for medical imaging professionals to become more prolific in critical thinking and knowledgeable in evidence-based practice increases as innovations in the field continue to increase, both technically and in terms of advanced career options. This descriptive study explores the perceptions and attitudes among two classes of undergraduate students as they progress through a four-year baccalaureate degree program in medical imaging. It delves into the exposure to research education the participants undergo and considers 5 factors prior to admission into the program and during their graduating quarter in the program. Quantitative results (survey) reveal a significant increase in research exposure, identifying faculty as the most turned to resource and a significant change on one of five factors. Supplemental qualitative results (interviews) provide insight to perceptions and attitudes toward research among participants.
Dedication

To my daughter, Claire
Acknowledgments

I would like to thank my family and friends, especially my mother, Dee, and my husband, Corey, who always understood my determination and supported my efforts. I could not have done this without them in my corner.

I would also like to acknowledge my co-workers, who I also consider my friends. They were always so flexible in helping to make my sometimes inconvenient schedule and time constraints workable.

Most importantly, I would like to thank my advisor, Kevin, whose patience and knowledge seemed never-ending throughout this process. I am very grateful to have had his guidance every step of the way. I could not have done this without his expertise and his ability to multi-task.
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Chapter 1: Introduction

Background

Professional research is the cornerstone of advancement in technology and medicine. With the consistent growth and variety of professions within radiology, it is important for medical imaging professionals to stay current on technological advances, as well as comprehending and generating additional research in their area of practice. Radiologists have a long history of producing research, but there is a need for imaging technologists to become more involved. Imaging technologists’ clinical experience, imaging expertise, patient interaction and knowledgeable viewpoints can provide a great addition to medical imaging research and help to increase professional status, and contribute to evidence-based practice and lifelong learning.

Radiology is a significant allied health profession in the medical field with its role in providing diagnosis and improving quality of life. With all the technological change that radiology has experienced and will continue to experience, current and future medical imaging professional graduates will need to keep pace with innovations that are occurring and impacting clinical practice. Evidence-based practice (EBP) requires that health care decisions are based on the most current, best available, relevant and valid evidence.¹ The ability to access, appraise, and apply evidence-based research clinically, as well as
acquiring scholarly-writing skills is the key to continuing to increase the development of professional knowledge and status in the radiology field. ²

**Significance of the Problem**

Allied medical professions have realized a need to base clinical practice on scientific evidence since the 1990’s.³ However, barriers such as negative attitudes towards research, difficulty accessing credible research, and lack of ability to evaluate published research has limited its use by many allied medical professionals.³ These limitations are applicable to the field of medical imaging. To reach a level where clinical practice can be influenced and informed by research, the education of future practitioners needs to be examined. Students need the ability to understand and critique research that has been done, evaluate its validity and not take all research at face value.⁴

In order to increase students’ comprehension and/or conduction of professional research, it can be incorporated as part of the formal education of medical imaging. With early research education, medical imaging students will be able to incorporate these experiences and can begin to contribute to research as part of a lifelong learning process throughout their career. Medical imaging, however, currently has broadly written standards in terms of the education and/or licensure requirements, which could make consistent research exposure in formal education difficult to achieve.⁵
**Historical perspective of Medical Imaging Education**

Early medical imaging education consisted of one year hospital-based certificate programs in conjunction with on-the-job technical training. As time has passed and medical technology advances, programs with this educational route have been reduced dramatically, (although they still remain in smaller hospitals and military programs in the US) mostly due to the American Registry of Radiologic Technologists (ARRT) requiring a successful completion of a minimum of 24 months of formal education to sit for the national certification exam. Because of this requirement, among other reasons, associate/technical degree completion has become the typical medical imaging education due to its advantages of less time and expense than the baccalaureate degree option. Even with these advantages, there is still is a great deal of support for raising educational standards and promoting a more professional approach as opposed to a dominantly technical education. Associate level, two year degree programs are designed to focus their limited time with technical and clinical education as required by the ARRT, leaving little room for incorporating quality research education.

Requiring a baccalaureate degree as the standard entry level credential for medical imaging professionals could provide means for raising professionalism and increasing research experience. According to the U.S. Department of Labor, the standards of qualification for professional and scientific professions is “successful completion of a full four years of study in an accredited college or university leading towards a bachelor’s or higher degree or its equivalent…” Internationally, several advanced nations have made significant developments in the way of this requirement by requiring a baccalaureate
degree as the entry-level requirement for medical imaging.⁸ Advantages exist for baccalaureate degree holders, such as more job responsibility, career advancement and increased job satisfaction, although a 4 year degree in medical imaging is not currently mandated as the minimum standard in the United States.⁹

Providing focused research education during a 4 year baccalaureate degree program can give students a foundation to work collaboratively with physicians and other medical professionals. This collaboration could be instrumental in continuing and adding to the knowledge in the radiologic sciences. Accessing, understanding and even conducting research as a requirement for graduation could lay the groundwork, but it would be important for graduates to continue research and professional ventures as their careers progress.

Through exposure in course work and observation/assistance of faculty and graduate research, the aspiration is that students will acquire awareness and an appreciation for legitimate, evidence-based research and practice. With more students that are well-educated in aspects of research, the goal is that more will participate in research throughout their career. A lack of exposure to research limits their interest, perceptions and attitudes when it comes to research.³

**Objective**

In order to improve upon overall, long-term perceptions and attitudes toward research among students and future medical imaging technologists, there is a need to explore students’ current impression of research, especially at the undergraduate level. This
information can possibly provide a context for determining what is needed from faculty, students, and outside influences to increase understanding and appreciation of research and professionalism among students. These concepts may be extended long term into graduates’ professional careers.

Research Question

This study will explore and answer the following question:

*Given the importance of research in the medical imaging field, what are the perceptions and attitudes toward research among undergraduate students as they pursue their degree in a baccalaureate medical imaging program?*

By exploring this question, insights can be gained regarding students’ current attitudes and perceptions toward research, and also inform educational programs’ on the possible potential that curricular revisions may have for affecting any changes in those attitudes and perceptions.

Research Approach

In order to answer the above research question, a pre-experimental study using ex-post facto secondary data analysis was conducted. Data was collected in a baccalaureate level radiology program which is part of a large university that is a Research 1 University accredited by the North Central Association (NCA). The data represented attitudes and perceptions toward research by the students. The questionnaire used was approved by the
Institutional Review Board (IRB) and was adopted by the program for continued use after its role in a previous study by Evans and Kowalczyk that explored perceptions and attitudes of students who were enrolled in an introductory radiography course.10

Evans and Kowalczyk conceived their original study in 2004 to be a longitudinal study but were limited to only 9 out of 69 subjects that participated in the graduating class of 2006. Their study was therefore scaled back to a multi-level pre-test post-test design. The program in their study (the same program involved in this current study) continued to give the adopted questionnaire from 2004 to students in its introductory class each year. Data was also collected by the program on two graduating classes, 2007 and 2008, quantitatively during students’ time in the program through to graduation. Additionally, data was collected qualitatively, with interviews during the students’ final quarter of the program for supplemental descriptive information. This provided a possible option for a mixed method approach, having both quantitative and qualitative data to answer the proposed research question.

Upon inquiry to the program faculty, it was established that the data was collected as a program outcome measure. The first two data collection points for the 2007 and 2008 graduates were at the beginning and at the conclusion of the introductory course to the medical imaging profession (required for admission into the program), which had been revised within the last few years to include more of an emphasis on the role research has in the field of medical imaging. The next collection point was at the conclusion of the students’ first year in the program and the last point was at the conclusion of the students’ graduating quarter. Interviews were conducted at the conclusion of the students’ graduating quarter as well.
Ex-post Facto Pre-Experimental Design:

\[ O_1 \times O_2 - O_{\text{Int}} \]

\( O_1 \) – Questionnaire Distribution - Pre-program

\( X \) – Baccalaureate Medical Imaging Program

\( O_2 \) – Questionnaire Distribution - conclusion of the students’ graduating quarter

\( O_{\text{Int}} \) - Supplemental Qualitative Interviews graduating quarter

Glossary/Definition of Terms

Dependent variable: attitudes of students

Independent Variables: Educational experiences provided by BS Medical Imaging Program

Limitations

Unanticipated exposure to research between the times of the questionnaire administrations could present a history threat to internal validity. During the course of their undergraduate career, especially within the program, there are academic activities and outside influences that could have informed their responses. Examples include having a research minor, taking separate research courses from an elective curriculum, participating in journal clubs, writing an honors thesis, and participating in project competitions, media, clinical experiences, etc.
Interactions between participants and data collectors could present an internal validity threat and bias as well, due to the faculty and staff distributing the questionnaires to the students from the introductory class and through the program. Interacting with the faculty and staff on an almost daily basis during the program in courses and advising, and knowing they are collecting the data may cause their responses to be biased favorably or unfavorably.

Maturation may also present itself as a limitation because students are advancing not only in age, but in professional experience, and maturity. Another possible threat to internal validity is testing. The instrument did not change between each distribution, which could produce a sensitization to it for what to expect. However, this is a low level threat due to the long time span between when the questionnaires were given.
Theoretical Framework

The theoretical framework for this study stems from a map of experiential learning in the social practices of modernity by Usher, Bryant, and Johnston. This concept explores a postmodern quadrant image of the lifelong learner using two continuua: autonomy-adaptation/expression-application. Each quadrant, lifestyle practice (autonomy-expression), confessional practice (expression-adaptation), vocational practice (adaptation-application), and critical practice (application-autonomy), depicts life and/ or educational experience with different assumptions and possibilities. Experience can be used differently in different practices. Usher and others infer that the interrelationships of the different quadrants can create more fluid dimensions of learning practice.
This study is concerned with the shift from vocational to application to critical to autonomy. Being able to take knowledge from technical/vocational training obtained from certificate and two year degree programs to apply it to problem-based learning is significant to advancing the professionalism of the medical imaging profession. Medical imaging professionals may be able to begin vocationally in education, but they also must obtain the skills needed to continue to evolve beyond that original training in their practice as the field advances. What was taught vocationally years ago may not hold true in the future for any generation and remaining reliant on the past knowledge may not be
enough for medical imaging professionals to update their knowledge. They also should be able to mentor others in their field as changes and innovations occur. Approaching autonomy in a medical imaging career will allow personnel to keep up with not only the field’s technological advances, but also with the interdisciplinary and interpersonal demands of the future of the profession.

**Educational Needs**

Meyers and Wintch acknowledge that as the intricacy of health care increases, so do the responsibilities of medical imaging professionals, which requires more aptitude and skill in sciences, mathematics, and communication – knowledge best received from colleges or universities.\(^{14}\) It has been suggested by conferees of the first American Society of Radiologic Technologists (ASRT) Educational Consensus Conference in 1996, that revisions to educational models and curricula were needed for the medical imaging profession in order to be prepared and thrive in the 21\(^{st}\) century. A strong foundation in the required courses is necessary.\(^{15}\) Traditionally, research investigation is a requirement for graduate studies, but more baccalaureate programs throughout the United States, especially programs in the medical field have been incorporating research into the curriculum as a preparation for future graduate education. If a graduate does not pursue a graduate level degree, they can still take the education and obtained skills in research comprehension into their career and clinical practices from their undergraduate education.
Professional Status and Research Focus

Nursing has addressed the idea that attitudes toward research may be affecting future generations of researchers. If baseline education has a role in shaping an overall experience in research and in advancing the field, then this may be the place to start to improving these outcomes. Law-Harrison, Lowery and Bailey explore shifts in their program’s baccalaureate nursing students’ attitudes toward research after taking a research course within their program.\(^\text{16}\) The American Nurses’ Association (ANA) expects baccalaureate nursing students to “identify researchable problems, evaluate research reports, utilize findings from credible studies in their nursing practice, and share research findings with colleagues.”\(^\text{16}\) The nursing profession is also plagued with negative attitudes toward research and inadequate utilizations of research skills and looks to explore current perceptions about research among baccalaureate nursing students.

The Law-Harrison, Lowery and Bailey study was a pre-test post-test design and data was collected with a 19 item questionnaire before and after a research course and also longitudinally over six semesters. In the students’ final senior course, the questionnaire was given again. Of the 146 students who took the courses, 116 completed the pretest and 54 (46%) completed both post-tests. Low response rate for posttests was explained by absences the day of distribution, drop outs of the nursing program, or some students may have elected not to take the post tests.\(^\text{16}\)
The study had two hypotheses, (a) that there would be significant differences in scores on the three tests in research knowledge, the highest during the first post test and lowest during the pretest and (b) students demonstrated more positive attitudes toward research during their last semester than they did at the beginning of the research course. The first hypothesis was tested with repeated measures analysis of variance procedure using SPSS-PC + MANOVA program. Results indicated a significant effect for time (Pillais statistic = 0.65826). The first data collection point had mean of 11.9, (SD 2.4), the second had mean of 15.1, (SD 1.7), and the third had mean of 12.5, (SD 2.5). An HSD (Tukey Honestly Significant Difference) test that was performed indicated that mean differences greater than 0.88 were significantly different at the 0.05 level. Therefore, the only sets of scores that were significantly different from each other were the pretest and first post test, and also the first post test and second post test. There was no significant difference between the scores on the pretest and second posttest. 

The second hypothesis was tested using a paired t-test and was supported by the results, t = - 2.43, (f =53, P = 0.018). The first data collection point, the pretest, had mean = 58.8, (SD = 7.4), and the other data collection point analyzed here was the second post test had mean = 61.5, (SD = 7.0). These results show that they demonstrated more positive research attitudes at the end of the nursing program, which was when the second post test was given. 

The knowledge scores were significantly higher at the end of the research course than at the beginning of the course, but then drastically declined between the end of the course and the end of the nursing program, which raises suspicion about whether baccalaureate nursing students retain enough knowledge about research to be able to
carry it through and utilize their skills after graduation. It also raises questions about whether the research concepts are assimilated into the program’s curriculum, as it is unrealistic to expect a long lasting change in knowledge based on one course. Linderman and Tanner (1990) suggested research should be incorporated into clinical nursing courses and not just taught as separate course. 17

In the case of attitude scores, it is encouraging that the students had positive attitudes toward research at the end of the nursing program. But the knowledge results persuaded them to revamp the course as well as integrate a greater emphasis on research throughout the curriculum. A continuation of this study monitoring the improvements was suggested for the future as a follow up. The study also suggested further studies to evaluate the long term effects on knowledge retention of different strategies for teaching research at the undergraduate level. 17

Similarly, as an education effort specific to nurses in practice, a descriptive-correlational study, conducted by Olade, looked at the gap between nursing research findings and their translation to practice in rural areas. It described the attitudes of nurses in rural settings toward research and the relationship between these attitudes and selected variables. Researchers established that while there are several studies focused on barriers to research utilization among nurses, there are limited studies on attitudes nurses may have toward research, especially in rural settings. 18

Methods included distribution of a questionnaire to rural practice settings in six counties with assistance from undergraduate and graduate nursing students in those settings. The questionnaire had established content validity and test-retest reliability of
0.92. Participation was voluntary and confidentiality was maintained through anonymity. Analysis, both descriptive and correlational, was conducted using SPSS with a 0.05 level of significance.

Five research questions were explored concerning 1) how favorable attitudes were toward research 2) what characteristics of nurses were associated with their attitudes, 3) whether participation in research activities in practice have any significant relationships with attitudes, 4) if there is a relationship between attitudes toward research and their desire for research utilization in evidence based practice and 5) what nurses in rural settings perceive to be barriers to research utilization in their practice areas.

The response rate was 88.3% as 106 of 120 questionnaires were returned. 50% were staff nurses with a wide range of ages and 73% had more than 5 years experience. Attitude scoring was classified as unfavorable (less than 60), lukewarm (60-80), and favorable (81-100). Findings revealed that 76.4% of the nurses had unfavorable or lukewarm attitudes toward research, and only 23.6% had favorable attitudes toward research. Nurses with non-nursing master’s degrees had the most favorable attitudes with a mean score of 79.3. Two areas in attitude stood out, research curiosity and research adequacy, and while 65% of the participants were fairly curious about research, only 20% considered themselves adequate in regard to research. 18

Characteristic relationships toward research attitudes showed statistically significant relationships in education (r = 0.51, p = .01) and position held (r = .45, p = .01), but not with age, years of experience, initial source of research knowledge or practice setting. Descriptive data revealed that 65% of the study population participated in data collection, 51.4% participating in medical research activities, while 41.5% had participated in
nursing research activities within the last two years. Data collection showed no
statistically significant relationship, however, participation in research (which had lower
percentage of participants) was found to have a highly statistically significant relationship
with research attitudes ($r = 0.81$, $p = .001$).

More than 76% of the participants reported a desire for research utilization if
barriers could be minimized, which has a statistically significant relationship with
attitudes toward research ($\rho = .36$, $p = .0001$). Only 20.8% of rural nurses reported
current utilization of research findings in their areas. The remaining 79.2% had a desire
for barriers to be minimized. Barriers identified were lack of time (26%), lack of research
knowledge (20%), lack of interest or encouragement from nursing administrators
(13.2%), lack of consultative support (10%), budget constraints (6%) and other reasons
(4%).

This study went beyond nursing education and focused on how nurses already in
their careers value and utilize research. It incorporated students, as they were key to data
distribution. Valuable information from this study included discussion of professional
barriers toward research that came from careers and the workplace, so that they too may
be addressed in research education. The steps to take to overcome barriers students may
face when it comes to professional research endeavors may help to increase lifelong
learning.

Exploring attitudes toward research as a barrier in its utilization and generation has
also been explored in allied medicine as a way to help answer the call for more research
emphasis in their fields and clinical practice. Educators in occupational therapy and
physiotherapy, conducted a cross-sectional study looking at perceptions and attitudes
toward research related activities among first term and final term occupational therapy and physiotherapy students. Two hundred and twenty six first and last term OT (occupational therapy) and PT (physiotherapy) students from three universities, using either traditional or problem based learning (PBL) methods, were asked to participate. Participation rate was 93.4% (n=211), consisting of OT students (n=91) and PT (n=120). They used a questionnaire with internal consistency ranging from 0.87 - 0.81, with content validity established as well. Instructors of the participants were briefed about the study and distributed the questionnaires during class time.

Analysis consisted of comparisons between groups using the Mann-Whitney U-test with data that was of the ordinal level. For nominal data, Pearson’s chi-squared test was used. Spearman rank correlation coefficients were used for correlations between variables. OT and PT students from both terms (first and last), regarded ‘reading research literature to update knowledge’ as the most important research activity related to their professional roles and ‘applying research findings to improve practice as the second. The concept of reading research literature also received the highest ratings for what students thought to be their greatest ability in research activities in all groups. All attitude scores were on the positive side of the scale, showing the most positive toward applying research findings, followed by reading research literature.

When comparing first term and last term students, the ability to perform research-related activities was rated significantly higher by last term students, regardless of which research methods they were taught, traditional or PBL. Those students who were taught with PBL methods held more positive attitudes toward research and showed much greater
intent to become involved in future research activities than those in traditional methods of research education, regardless to area of study, OT or PT. 19

These results gave the researchers hope for future development for clinical researchers in the field of occupational therapy and physiotherapy, a need that had been established. It is also noted that given the results, PBL methods of research education may be more promising than traditional methods and conducive for fostering reflective learning in graduates, future research consumers, and an overall increase in professionalism.

Physical therapy (PT) educators also sought to evaluate research attitudes, only more specifically to a particular research activity in their curriculum. Givens-Heiss and Basso looked at a mock trial learning activity with defense and plaintiff teams within their physical therapy curriculum. In this article, they describe the activity and determine whether it positively influenced the students’ attitudes toward research and their confidence in their ability to interpret and apply research findings toward clinical practice. They stated that this study was different than other previous studies to see if exposure to research changed attitudes in undergraduate students because the methods used this time evaluate changes over time to determine if it is a lasting shift, providing a more longitudinal look at the effects of the activity. 3

The participants consisted of 48 students, most of which were traditional undergraduate students pursuing a bachelor’s degree in physical therapy. The mock trial activity was a part of their curriculum, but before the onset of this activity the students were surveyed three times anonymously during the course of their first year to determine the impact of other curricular activities and courses on attitudes toward research. This
was to gauge a baseline on attitudes before entering their second year, where there was more emphasis on learning research methods, statistics and research analysis. The students were surveyed twice more during their second year before the mock trial (4th and 5th surveys), and the final survey questionnaire (6th) was given after the mock trial. They were surveyed a total of six times during their full curriculum.

The instrument used was a well established 5 point Likert scale questionnaire set to evaluate five factors. Factor 1 is concerned with the participant’s opinion of how other allied health care professionals react to PT research. Factor 2 is concerned with the participant’s opinion on the value of PT research. Factor 3 is concerned with the participant’s perception of a PT’s ability to carry out research. Factor 4 is concerned with the participants’ belief in the competence and confidence of a physical therapist to perform research. Finally, factor 5 is concerned with the participants’ perceptions on his/her ability to interpret or apply research findings to practice.\(^3\)

Statistical analysis was conducted using the Statistical Analysis System with an alpha level of 0.05. Separate one-way ANOVA (analysis of variance) of the factor scores was used with time point as the independent variable. Tukey’s post hoc tests were used to evaluate which time points were different and to determine which items attributed to changes for the factor.

Scores < 3 indicate greater confidence levels and positive attitudes, 3 is neutral, and scores > 3 indicates a lower confidence level and negative attitudes, as Likert scale levels are (1 = strongly agree; 5 = strongly disagree). Responses indicted that students generally held positive attitudes toward research which were maintained throughout the curriculum at levels less than 3. Participation in the mock trial significantly increased
students’ confidence in their research abilities and increased positive attitudes, with score level of 2.56 before the mock trail (5th survey) and 2.13 after the trial (6th survey).

The major finding was that the mock trial seemed to have more of an effect on confidence in research skills than just research education in the classroom. This was based on the lack of significant difference in scores between the 4th and 5th survey, and then the significant difference between the 5th and 6th survey, when the activity took place. Possibly incorporating skills from that activity into the overall curriculum could keep a consistent confidence level.

Factor 1, on participants assumptions on reactions of other allied medical professions to PT research, showed a significant shift from 3.3 to 3.9 (negatively worded items 3 and 5) between the beginning and end of the first year, which indicates an increase in their belief that PT research would be implemented by other allied health care professions. This may attribute to clinical exposure and seeing the role a physical therapist can have on “best” practices clinically.

Overall, findings of this study showed an increase (p < 0.05) in students’ confidence in their ability to interpret and apply research after a research activity. The students generally held positive and optimistic attitudes toward research during the course of the program. Over time, students adopted a more neutral attitude toward physical therapists’ confidence to carry out research when compared the responses from their first year. Results also indicate that after participating in the mock trial, students were less confident in the ability of physical therapists to conduct research. Also attributing to this result is the curricular emphasis on evaluating and applying evidence, and not so much on actually conducting research.
Nursing and other allied medical profession have a long history of research production. The amount of published research by radiographers is limited and because a research base is an essential element in professional distinction, evidence-based practice, and policy issues, there is a need for increased amounts of research done in the field. One study offers the approach of qualitative research as a useful tool to provide more opportunities for radiographers to enhance their research and professional career.  

Adams and Smith presented an outline of key qualitative methods that radiographers could utilize in research development taking into account the challenges faced by radiographers when it comes to conducting research. One of these challenges is the generally negative attitude toward research within the profession and the lack of research skills among students and radiography practitioners. Promoting multi-disciplinary collaboration among other professions with a research base already established such as nursing, physical therapy, etc., can be valuable in gaining more knowledge and appreciation for research. A strategic development of radiographic research could be enhanced by using multi-methods approaches, qualitative interviews, focus groups, observational methods, document/text analysis, health social sciences, patient and health delivery issues and even diary methods. Introducing these methods as a framework could be advantageous in raising interest for potential novice researchers in the qualitative realm of research.  

Negative attitudes and perceptions toward research from the radiologic sciences profession can originate in the lack of understanding quantitative statistics. A focus in education and comprehension of qualitative methods may bring out an interest in students and imaging technologists where it may have been lacking previously. Multi-method
approaches could then evolve from there, and possibly spark more of an interest in producing quantitative research and investigation as well.

One barrier in research production by the radiologic sciences is the lack of ability to search for and understand credible research. Shanahan investigated the short and long-term impacts of Electronic Information Skills (EIS) intervention on students’ behavior in information searches and evaluations.\textsuperscript{22} This study stated that undergraduate students have a dependency on search engines such as Google and that is coupled by non-critical evaluations of the information and limits the quality of information they are able to find. The attempt was to broaden their scope of accessibility and evaluation of other information search processes. A pre-test, post-test, and 1 year post-involvement with EIS intervention survey design was done to evaluate change in ability to search effectively for valid research. The results demonstrated that a purposefully designed research intervention such as EIS, can be used to change the behavior of students searching for and evaluating information.\textsuperscript{22} This study can help substantiate that one area of research education, effective literature review, can be improved upon through careful intervention.

Another recent study conducted by Hadley, Hassan, and Khan focused on allied and complementary and alternative medicine (CAM) skills, basic knowledge, and beliefs concerning evidence-based practice (EBP) and its main principles.\textsuperscript{23} They surveyed allied medical professionals and CAM practitioners who attended one day EBP workshops prior to the beginning of instruction in order to assess their learning needs. Of the 193 that attended the classes, 121 respondents (62.7\%) were allied medical professionals and 65 respondents were CAM practitioners (37.3\%). The study found that the majority of the respondents had never attended a literature appraisal skills workshop (83.7\%) or received
any formal training in research methods (69.9%), epidemiology (91.2%), or statistics (80.8%). In addition to this, 67.1 of the respondents stated they felt that they had not had sufficient training in EBP and that they needed more training and education in EBP and its principles (86.7%). More CAM practitioners accessed educational literature via the internet than allied medical professionals. Also, practitioners with more than 11 years experience felt that original research papers were far more confusing (p=0.02) than their less experienced colleagues.\textsuperscript{23} Both groups have identified that EBP training as important which has not previously met their needs.

The conclusions of this study establish that learning needs vary based on the type of profession, time since graduation and prior research experience and exposure.\textsuperscript{23} Limitations of this study consist of being exploratory and an inability to be generalized to the general population. However, its findings can be taken into consideration when planning an EBP or research methods curriculum in order to tailor it specific needs of the students. Possibly a promotion of a form of research requirement in continuing education (CE) for medical imaging could be beneficial to keep professionals updated on EBP could be beneficial. It is not only important for new graduates to retain research and EBP skills, but for experienced clinicians to also have an appreciation.\textsuperscript{23}

One recent study with a focus on attitudes and perceptions toward research among medical imaging students was published by Kowalczyk and Evans. They originally perceived the study to be a longitudinal approach for exploring the effects of an introductory course in medical imaging prior to entry in to a baccalaureate program with an emphasis on research education. It was scaled down, however, to a pre-test post-test design of just the introductory course due to limited ability to gather longitudinal data.\textsuperscript{10}
The participants consisted of students (n=69) who completed the questionnaire before and after an introductory course given by the program. Among these perspective applicants and other major-exploring undergraduates, an original 127 were consented. The questionnaire was given to several introductory courses over time whose content included “innovations in all aspects of medical imaging, corporate research and design in medical imaging, an introduction to the health sciences library, a tour of the health sciences library, an introduction to on-line search engines/databases such MEDLINE and CINAHL, guidelines on assessing levels of research using Evidence-Based Practice, and guidelines for writing a scholarly paper. Two writing assignments were required throughout the course.”

The participants were tracked for the possibility of acquiring a third survey during the senior year prior to graduation from the radiography program. Several unsuccessful attempts were made, however, only 9 students enrolled in the program were available for a third data point, so the longitudinal project was amended to just the pre-test/post-test results.

The questionnaire used was similar to Heiss-Givens & Basso’s instrument, due to its success in evaluating the research activity longitudinally. Negatively worded item responses, however, were re-coded to reflect positive ratings prior to data analysis and 8 additional items were added for additional information on techniques the radiography students used to conduct undergraduate literature reviews and to gather student demographic information. A Cronbach’s alpha was calculated based on all the surveys that were collected at the point of consent (N= 127). The reliability was .729 (p<0.005) and the questionnaire was IRB (Institutional Review Board) approved and adopted by the
program for possible future use. The same 5 factors were explored in this study as in the Givens-Heiss & Basso study and the 7 additional questions provided background information on prior research exposure on the students surveyed.

79.5% of the students indicated that the Internet was their favorite source for finding information, with consulting a textbook as the next favorite choice (67.7%). This demonstrated how important it was to introduce students in this course to locating scientific research by using quality electronic sources such as databases and search engines. Most of the students taking this course had no experience in performing literature searches (59.8%) and had only read 1-3 research articles throughout their educational experience (43.3%).

For analysis, a paired $t$-test was used to analyze the data from the 69 students who had questionnaires from the beginning and the end of the introductory course with an alpha level set a priori at 0.05. An analysis was made of the overall students’ change in perception related to each factor represented in the survey instrument. The only factor demonstrating a significant difference was Factor 5, the student’s perception of his/her ability to interpret or apply research to practice. This indicated that the students felt that they had gained an ability to interpret and apply research at the conclusion of the course, a very important skill necessary to access and interpret information required for evidence-based practice within a medical imaging career.

Because there were nine students with longitudinal data, it allowed for the use of repeated measures ANOVA to test for change in attitudes across the 5 factors over 3 data points in time. This number is small, however, it represented 45% of the graduating radiography class for 2006. Factor 1, concerning the students’ opinion concerning the
way in which other allied health care professionals react to imaging research were analyzed with ANOVA providing an F statistic of 6.63 with a p value of 0.024 (p < 0.05), which is a statistically significant shift in attitude for Factor 1. However, there was no statistically significant change in the other 4 factors: perception of the value of imaging research, perception of the general role of a technologist to carry out research, perception of the competence and confidence in a technologist to perform research, or in attitude in regards to their ability to interpret or apply research to practice. 10

Some research questions derived from this study are what changes occurred during the two years of professional education which changed the students’ perspective? What curricular changes could be implemented to maintain and improve the students’ attitude in regards to their ability to interpret or apply research to practice? Would students’ attitudes toward research change if evidence-based practice methods were integrated into clinical courses and/or modeled by practicing radiographers? 10 Since this study had taken place and the students were questioned, there has been an increase of research emphasis within the program’s curriculum and participation in research activities such as journal clubs. There has also been an increase of staff technologists in the clinical settings where students rotate who are working towards their bachelor degree completion program and master degree completion, promoting exposure to the concept of life-long learning.
Chapter 3: Methodology

This study was designed as an ex-post facto, pre-experimental project, following a previous study (Kowalczyk and Evans) conducted by the program to explore attitudes and perceptions toward research. A questionnaire designed to measure attitudes and perceptions towards research across 5 factors among undergraduates was distributed at four points in time to students in a baccalaureate level medical imaging sciences program during their academic career and educational track. Along with the four administrations of the questionnaires, a convenient sample of students were interviewed prior to graduation.

Research Design/Data Collection

This study was a secondary data analysis of existing program data. The data was originally collected by the program to capture students’ attitudes and perceptions of research at the beginning and at the conclusion of a required introductory course. The course was redesigned to explore scientific writing and research prior to admission into the radiologic sciences program. This course's content covered medical imaging, corporate research and design in medical imaging, an introduction to the health sciences library, a tour of the health sciences library, an introduction to on-line search
engines/databases such MEDLINE and CINAHL, guidelines on assessing levels of research using Evidence-Based Practice, and guidelines for writing a scholarly paper.¹⁰

Upon completion of this introductory course, those students that were accepted into the radiologic sciences program continued to be surveyed as to their attitudes and perceptions throughout the program and were given the same instrument from the introductory course, once at the end of the first year in the program and again during their graduating quarter. The program has emphasized research by requiring a research methods course and incorporating more evidence-based practice research into pre-existing courses. Qualitative interviews were also conducted during the final quarter as a means of providing qualitative data. This secondary data analysis was a mixed method assessment of the program’s collected data.

The collected data was analyzed with SPSS and any negatively worded items were re-coded to record positive ratings before analysis. A one-way ANOVA was used for analysis of the data collected throughout the program at the different data points for questions 1-17 on the questionnaire. Chi Square was used to analyze the difference between the actual and expected frequencies and providing a p value for questions 18-22 on the questionnaire. The qualitative portion was analyzed through the identification and coding of relevant themes and patterns. As themes emerged, they were organized into coherent categories.
**Subject Selection**

The subjects for this study were enrolled in the introductory course to the radiologic sciences program which is offered twice during the academic year with each class having 35-40 student enrolled per quarter. Although the course is intended for pre-radiography majors, the students enrolled in the course are diverse including pre-majors such as health science, physical therapy, and nursing, in addition to radiography. After taking this course, some of the students applied to the program and were accepted. This study’s secondary analysis involved analyzing all the available outcomes records and data with relation those students who were surveyed before and after the introductory course as well as during the program.

**Instrumentation**

The instrument used was a 5 point (1 = strongly agree; 5 = strongly disagree) Likert summated rating scale instrument based on an instrument developed by Givens and Basso to explore attitudes-to-research among physical therapy students. The Givens and Basso instrument was adapted from an instrument originally published by Hicks which was used to document the attitudes-to-research among midwives. The Hicks instrument reliability was measured using a Spearman rank order correlation coefficient and the results were highly significant (r = +0.828, p < 0.005) suggesting that the test-re-test reliability of the instrument is high. The Givens and Basso 17 items version is
made to explore five factors of confidence and attitudes toward research and was used for summative results of physical therapy students who participated in a mock trial in the classroom.³

Seven additional questions were added to obtain additional information about the techniques the radiography students used to conduct undergraduate literature reviews and to gather student demographic information.¹⁰ The questions may be helpful in deciding what resources have been useful and how exposure to research and associated tools have changed over time for these subjects. Appendix A is the final version of the instrument that was IRB approved and adopted by the radiologic sciences program which will be used to document the students’ summative information. A Cronbach’s alpha was calculated based on all the surveys that were collected in a previous study in radiologic sciences with a reliability of 0.73 (p<0.005).¹⁰

This instrument was meant to survey participants’ perceptions and attitudes toward research in 5 different factors. “The first factor is used to capture a participant’s opinion concerning the way in which other allied health care professionals react to imaging research. The second factor is used to capture an opinion on the value of imaging research. Factor 3 is the student’s perception of a technologist’s ability to carry out research. Factor 4 collects the student’s belief in the competence and confidence of a technologist to perform research. Lastly, factor 5 captures the student’s perception of his/her ability to interpret or apply research to practice.”¹⁰
Chapter 4: Results

The integration of research education into baccalaureate programs, in the radiologic sciences, is designed to promote professional advancement. The dilemma, however, lies in keeping graduates interested and motivated in utilizing these skills, as perceptions and attitudes toward research vary among students. In associate programs, there is little time allocated to research and this can also be difficult for baccalaureate degree programs. However, the option for a research focus may be easier to incorporate during a 4 year degree because of the access to the variety of university courses.

This study looked at two graduating classes (2007 and 2008) that completed surveys at four points in time. The 1st and 2nd administrations of the questionnaire were at the beginning and the end of an introductory class provided in the curriculum, which is a prerequisite course for admission into the program. The 3rd data collection point was at the end of the first year of the program and the 4th occurred prior to graduation.

Unfortunately, surveys were not distributed consistently throughout every introductory class offered over the past several years. There were students in the program’s graduating classes 2007 and 2008 that may have taken the class years ago, before the course collected survey data. Many students could have taken this course early on in their academic career and may have entered the program two or three years later.
Therefore, the study is limited to tracking only those students in the program where there were questionnaires from the introductory course available as well as their questionnaires during the program for consistency. These missing measurements could have provided valuable information, however the data would not be considered consistent. The data available provides quantitative data for 17 students from the graduating class of 2007 and 18 students from the class of 2008 for a total (n=35). Because this study is describing changes in attitudes and perceptions toward research among undergraduates pursuing a baccalaureate degree, if the students did not complete all the questionnaires over the study period, the limited data was omitted for analysis.

**Quantitative Research**

The quantitative analysis took into consideration Time 1 and Time 4 of the data collections points to report change from the first administration of the questionnaire to the last administration, collapsing the data points in between. Time 1 represented the participant before taking the introductory course as a baseline and Time 4 represented the participant as they were in their final quarter in the radiologic sciences baccalaureate program. Response rates for all questions for Time 1 and Time 4 was 100%, excluding one blank response for questions 22 during Time 1. Questions 1-17, representing factors, were grouped as such to demonstrate response rate. (See [Appendix B: Table 7](#) for response rate table.)
The instrument used in this study collected data on participants’ perceptions and attitudes toward research with 5 different factors using 1-5 Likert Scale for Question 1-17.

**Factor 1** is represented with questions 3, 5, 10 and 12 and is used to capture a participant’s opinion concerning the way in which other allied health care professionals react to imaging research.

**Factor 2** is represented with questions 1, 7, 9, and 11 and is used to capture an opinion on the value of imaging research.

**Factor 3** is represented with questions 2, 6, and 8 and is used to capture the student’s perception of a technologist’s ability to carry out research.

**Factor 4** is represented with questions 4 and 13 and is used to collect the student’s belief in the competence and confidence of a technologist to perform research.

**Factor 5** is represented with questions 14-17 and captures the student’s perception of his/her ability to interpret or apply research to practice.”

The responses for Questions 1-17 were based on a Likert scale, and ranged from negative (1) through positive (5) choices in agreement with the statement. Response means were conducted for all factors, including Factor 2, which was used to capture an opinion on the value of imaging research. This demonstrated the greatest positive shift in mean difference from Time 1 to Time 4 at .33. Factor 5, used to capture the student’s perception of his/her ability to interpret or apply research in practice and that had the least shift (a negative shift) in mean difference from Time 1 to Time 4 at -.13. Sample
sizes are equal and the data was normally distributed. (See Appendix B: Table 8 for Q1-17 response means)

Further analysis of Q1-17 was done using one-way within-subjects ANOVA (Analysis of Variance) to evaluate the change in each factor (1-5) from the first to last administration of the instrument within the same sample. A univariate test was used instead of a multivariate test because the two classes were grouped as one for analysis as a cohesive sample of the baccalaureate students. A p value was generated for each factor and the alpha level was set $p \leq 0.05$ a priori. If the $p$ value is equal to or less than 0.05, it means the probability of the difference having happened by chance is 1 in 20, and therefore “significant” for this study. The null hypothesis being that there is no change, and if $p \leq 0.01$ it is considered highly significant.

Factor 2 was the only factor demonstrating a statistically significant positive shift in the participants opinion on the value of imaging research from Time 1 to Time 4, $F(1,68) = 4.23$, $p=0.04$. (See Table 1 below)

<table>
<thead>
<tr>
<th>Q1-17 (Factors 1-5)</th>
<th>F statistic</th>
<th>df</th>
<th>Sig. (p value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factor 1 – (Q 3,5,10,12)</td>
<td>0.99</td>
<td>1</td>
<td>0.32</td>
</tr>
<tr>
<td>Factor 2 – (Q1,7,9,11)</td>
<td>4.23</td>
<td>1</td>
<td><strong>0.04</strong></td>
</tr>
<tr>
<td>Factor 3 – (Q2,6,8)</td>
<td>0.45</td>
<td>1</td>
<td>0.50</td>
</tr>
<tr>
<td>Factor 4 – (Q4, 13)</td>
<td>2.26</td>
<td>1</td>
<td>0.14</td>
</tr>
<tr>
<td>Factor 5 – (Q14, 15, 16, 17)</td>
<td>0.51</td>
<td>1</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Table 1: ANOVA Results based on Questions 1-17.
Questions 18 and 19 were multiple response questions and were both analyzed using Chi Square to measure the difference between the expected and the actual frequencies of the responses selected. Due to the multiple response style questions, each option for both questions was run separately for frequencies, however, response means were not conducted. Crosstabs were run for Time 1 and Time 4, crossed with whether it was selected by the participant or not. The expected frequencies were that no difference existed between Time 1 and Time 4. Any significant statistic (p ≤ 0.05) represents change or increase in selection of the option from Time 1 to Time 4.

Question 18, asks “When you have a question pertinent to your area, where do you turn? Choose up to 3, that you consider most helpful”; results showed that while there were increases in the amount of resources the participants chose to turn to, the only one that had a statistically significant shift (p value =0.03, df=1) was response option 5, Faculty. There was a significant increase and change from Time 1 to Time 4, in those who responded “Faculty” to where they would turn if they had a question pertinent to their area. (See Table 2 below)

Question 19, asked “Which databases have you used so far in your academic ‘career’? Check all that apply”, results showed that while there were increases in the amount of databases used from Time 1 to Time 4, there were four that were statistically significant. CINAHL, Medline, and Pub Med, and “Other” (with handwritten examples of Google Scholar, OVID, and OhioLink) which was a choice that was highly significant (p≤0.01, df=1), from Time 1 to Time 4. (See Table 3 below)
### Table 2: Q18 Most helpful research resource identified by participants.

<table>
<thead>
<tr>
<th>Question 18</th>
<th>df</th>
<th>Exact Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q18-1 - Textbooks</td>
<td>1</td>
<td>0.31</td>
</tr>
<tr>
<td>Q18-2 – Health Sciences Library</td>
<td>1</td>
<td>0.17</td>
</tr>
<tr>
<td>Q18-3 – Health Care Professionals</td>
<td>1</td>
<td>0.11</td>
</tr>
<tr>
<td>Q18-4 – The Internet/WWW</td>
<td>1</td>
<td>0.63</td>
</tr>
<tr>
<td>Q18 – 5 Faculty</td>
<td>1</td>
<td><strong>0.03</strong></td>
</tr>
<tr>
<td>Q18 – 6 Classmates</td>
<td>1</td>
<td>0.38</td>
</tr>
<tr>
<td>Q18 -7- Other</td>
<td>1</td>
<td>No statistics computed – option never selected</td>
</tr>
</tbody>
</table>

### Table 3: Q19 Databases reported by participants as used in an academic career.

<table>
<thead>
<tr>
<th>Question 19</th>
<th>df</th>
<th>Exact Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q19-1-CINAHL</td>
<td>1</td>
<td><strong>P&lt;.01</strong></td>
</tr>
<tr>
<td>Q19-2 – Cochrane</td>
<td>1</td>
<td>0.18</td>
</tr>
<tr>
<td>Q19-3- Medline</td>
<td>1</td>
<td><strong>P&lt;.01</strong></td>
</tr>
<tr>
<td>Q19-4 –PsycInfo or ERIC</td>
<td>1</td>
<td>0.50</td>
</tr>
<tr>
<td>Q19– 5 Pub Med</td>
<td>1</td>
<td><strong>P&lt;.01</strong></td>
</tr>
<tr>
<td>Q18 – 6 Other (Written responses include Google Scholar, OVID, and OhioLink)</td>
<td>1</td>
<td><strong>0.01</strong></td>
</tr>
</tbody>
</table>
Questions 20-22 were single response questions and were all analyzed using response means and Chi Square to measure the difference between the expected and the actual frequencies of the responses selected. Crosstabs were run for Time 1 and Time 4, crossed with whether it was selected by the participant or not. The expected frequencies were that there is no difference between Time 1 and Time 4. Any significant statistic (\(p \leq .05\)) represented a change or increase in selection of the option from Time 1 to Time 4.

Question 20 asked *How successful did you feel you were in following the information you needed in the above data bases (from Question 19)?* Responses were arranged in this item from a positive response (coded as 1 - minimum response) to negative response (coded as 4- maximum response). A negative difference in this case would represent a positive shift from never having used a database (option 4 to choose), to feeling very successful in following the information needed in databases (option 1 to choose).

Response means for Question 20 showed that the maximum response mean went from 4 to 3, meaning by Time 4, all participants had at least used a database. Also the ending mean (at Time 4), was 1.43, which closely represented the option 1 choice (feeling Very Successful) and the beginning mean (at Time 1), was 3.0, which represented the option 4 choice (not successful). There was a negative difference between the means from Time 1 to Time 4 (-1.57), which represented a positive shift in feeling successful. Responses means demonstrated an increase of feeling successful when following information needed in databases used. (See **Table 9** in **Appendix B** for Question 20 response means)
Chi Square and corresponding crosstabs were ran for Question 20 for Time 1 and Time 4, crossed with whether it was selected by the participant or not. The expected frequencies were that there was no difference between Time 1 and Time 4. Any significant statistic ($p \leq .05$) represented change or increase in selection of the option form Time 1 to Time 4. If $p \leq 0.01$, it is considered highly significant and if $p \leq 0.001$ is very highly significant. This was consistent for items 20-22.

Results demonstrated that during Time 1, 57.1% of the participants had never used a database and considered this question not applicable to them and by Time 4, this was at 0%. During time 1, 14.3% of the participants considered themselves very successful in following the information needed in the databases available to them, by Time 4, this was at 62.9% (See Table 4 below). Chi square results (value=32.76, $p=0.001$, df=3) is highly significant and it for a change from Time 1 to Time 4 in feelings of success when following information needed in databases used.
Table 4: Q20 Participants feelings of success toward the databases used from Time 1 to Time 4.

<table>
<thead>
<tr>
<th></th>
<th>1- Very Successful</th>
<th>2- Just Okay</th>
<th>3- Not Successful</th>
<th>4- N/A Never used</th>
<th>Count</th>
<th>% w/in Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Time 1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>10</td>
<td>0</td>
<td>20</td>
<td>35</td>
<td>14.3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>57.1%</td>
<td>35</td>
<td>100%</td>
</tr>
<tr>
<td>Time 4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>22</td>
<td>11</td>
<td>2</td>
<td>0</td>
<td>35</td>
<td>62.9%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0%</td>
<td>35</td>
<td>100%</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>27</td>
<td>21</td>
<td>2</td>
<td>20</td>
<td>70</td>
<td>38.6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28.6%</td>
<td>70</td>
<td>100%</td>
</tr>
</tbody>
</table>

Question 21 asked “How many research articles (papers with methods, results, discussion) have you read during your undergraduate studies?” Responses ranged from option 1 (None) to option 5 (Greater than 10). The minimum response shifted from 1 (at Time 1) to 2 (at Time 4), meaning by Time 4, all participants had read at least 1-3 research articles in their undergraduate studies as a baseline. Also the ending mean, (Time 4) was 4.74, which closely represented the option 5 choice (Greater than 10 research articles), where the beginning mean (Time 1) was 2.60, which closely represented the option 3 choice (4-7 research articles). Response means demonstrated a
greater amount of exposure to research articles from Time 1 to Time 4. (See Table 10 in Appendix B for Question 21 response means)

Chi Square and corresponding crosstabs were run for question 21 for Time 1 and Time 4, crossed with whether it was selected by the participant or not. Results demonstrated that during Time 1, 14.3% of the participants had never read a research article and by Time 4, this was at 0%. During time 1, only 11.4% of the participants had read 10 or more research articles, by Time 4, this was at 85.7%. (See Table 5 below) Chi square results (value=40.932, p=0.001, df=4) is highly significant for a change from Time 1 to Time 4 in the amount of exposure to research articles.

<table>
<thead>
<tr>
<th>Time</th>
<th>Count</th>
<th>% w/in Time</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td></td>
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</tr>
<tr>
<td>2</td>
<td>14.3%</td>
<td>42.9%</td>
<td>100%</td>
</tr>
<tr>
<td>3</td>
<td>22.9%</td>
<td>8.6%</td>
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<td>4</td>
<td>8.6%</td>
<td>11.4%</td>
<td></td>
</tr>
<tr>
<td>Total</td>
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<td>3</td>
<td>5.7%</td>
<td>5.7%</td>
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<tr>
<td>4</td>
<td>85.7%</td>
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<table>
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<td>3</td>
<td>14.3%</td>
<td>7.1%</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>48.6%</td>
<td>100%</td>
<td></td>
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</tbody>
</table>

Table 5: Q21: Participants identified the amount of research articles read.
Question 22 asked “How many literature searches using computerized databases like Medline, PubMed, or CINAHL have you performed during your studies?” Responses ranged from option 1 (None) to option 5 (Greater than 10). The minimum response shifted from 1 (at Time 1) to 2 (at Time 4), meaning by Time 4, all participants had done at least 1-3 literature searches using computerized databases. Also the ending mean (Time 4), was 4.51, which closely represented the option 5 choice (Greater than 10 literature searches using computerized databases) where the beginning mean (Time 1), was 1.62, which closer to option 2 to choose (1-3 research literature searches using computerized databases). Responses demonstrated a greater amount of literature searches using computerized databases to from Time 1 to Time 4. (See Table 11 in Appendix B for Question 22 response means)

Chi Square and corresponding crosstabs were run for Question 22 for Time 1 and Time 4, crossed with whether it was selected by the participant or not. Results demonstrated that during Time 1, 58.8% of the participants had never performed literature searches on computerized databases and by Time 4, this was at 0%. During time 1, only 2.9% of the participants had performed 10 or more literature searches using computerized databases, by Time 4, this was at 71.4%. (See Table 6 below) Chi square results (value=48.35, p=.001, df=4) is highly significant for a change from Time 1 to Time 4 for an increase in the amount of literature searched conducted using computerized databases.
<table>
<thead>
<tr>
<th>Time</th>
<th>Count</th>
<th>% w/in Time</th>
<th>Count</th>
<th>% w/in Time</th>
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<th>Count</th>
<th>% w/in Time</th>
<th>Count</th>
<th>% w/in Time</th>
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<td>29.4%</td>
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<td>2.9%</td>
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<td>0%</td>
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<td>5.7%</td>
<td>3</td>
<td>8.6%</td>
<td>5</td>
<td>14.3%</td>
<td>25</td>
<td>71.4%</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>29.0%</td>
<td>12</td>
<td>17.4%</td>
<td>5</td>
<td>7.2%</td>
<td>6</td>
<td>8.7%</td>
<td>26</td>
<td>37.7%</td>
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</tbody>
</table>

Table 6: Q22: Participants identified amount of literature searches using computerized databases.

Question 23 asked “What do you think is your most likely undergraduate specialty?” and because it was fill-in-the-blank, the frequencies of when certain answers came up in time 1 and time 4 were analyzed. Results demonstrated that at Time 1, 54% for participants wrote “Radiologic Technology” and 26% at Time 4. The majority of the students in the introductory course (54%) were planning radiography as their potential major, therefore surmising the course is a critical tool for recruiting theses students and is a significant opportunity to introduce and demonstrate the importance of research in the
development of imaging professionals. The 26% in Time 4 may reflect their time in the program broadening their awareness of how diverse the field of medical imaging can be and that their career options vary greatly from what they were originally aware of, especially with a baccalaureate degree. At Time 1, 0% of the participants wrote Radiation Therapy, Informatics, Management, Mammography or Quality Assurance (QA) and by Time 4, at least one or more of the participants wrote in one of these specialties. Mammography had the largest positive shift, from 0% (Time 1) to 11% (Time 4). Nuclear medicine had the largest negative shift, from 11% (Time 1) to 0% (Time 4). (See Table 12 in Appendix B for full results on Question 23) Analysis of Q24 was simply finding the average age of the participants, keeping in mind that one participant was 53 at Time 1, average age at time one (T1=21.23) and average age at time four (T4=23.83), as previously reported in results.

From the above quantitative analysis it can be stated that between the first time this group of participants were surveyed (before the introductory class) and the last time they were surveyed (in their final quarter of their baccalaureate program), there was an increase in these participants’ exposure to research practices. Turning towards the faculty as the most helpful resource for when a question arises pertinent to the participant’s area increased significantly (p value is 0.03). There was an overall increase in databases these participants used from Time 1 to Time 4, especially in CINAHL (p value is 0.01), Medline (p value is 0.01), PubMed (p value is 0.01) , and “Other” options such as OVID and Google Scholar (p value is 0.01. These participants shifted significantly from a mean of having never used a database, to a mean of feeling “Very Successful” when following
the information needed from databases used, (p value is 0.01) The amount of research articles read during undergraduate studies among these participants increased significantly from a mean of having read 4-7, to having read greater than 10 (p value is 0.01). The mean of the number of literature searches using computerized databases shifted significantly from 1-3, to a mean of greater than 10 (p value is 0.01). Also, Factor 2 was statistically significant (p value is 0.04) and captured an increase in the opinion on the value of imaging research. Participants shifted from agreeing with such statements at “Research findings have very little impact on health sciences practices” to disagreeing with them, as an example.

Qualitative Research

Supplemental qualitative data was available from a bank of interviews conducted by the program near the end of the participants’ time in the program. The questions were geared toward experiences, perceptions, and comfort levels where undergraduate research is concerned. (See Appendix C for Interview questions) These interviews were confidential and coded in a similar manner as the quantitative data, so that matching the interviews could be easily accomplished. Eight complete interviews were transcribed and used for analysis. As stated previously, not all members of the two participating classes were subjects in this study, due to a lack of first and second questionnaires, so only those interviews from the study’s subjects were included in the results. The interviews conducted during the students’ graduating quarters were a convenient sample of the
students surveyed based on availability and willingness to participate. Field notes were available for participants recorded by a witness and were basic to included facial expressions, body language, etc.

The interview questions explored the subjects’ feelings and attitudes toward undergraduate research and how research may play a role in their future careers. Understanding and generating research can be a challenging process where one must start at the beginning and become increasingly comfortable, not unlike learning to ride a bicycle and eventually feeling comfortable to ride cross-country. Learning to ride begins with inexperience and fear, in a similar manner as becoming comfortable with the research process. A fear of a failure to understand and feel confident to produce quality research could become a barrier, eliciting a negative attitude toward research.

“I am just not a huge fan of doing research. I’m glad someone does, I am just not good at it.”

The first step of riding a bicycle is not only facing your fear and getting on, but also the use of training wheels. An academic program can start by introducing students to articles and easing them into the process. At the beginning of the program, participants’ exposure to research ranged from “very very very minimal” to taking “a sociology research class…(where the participant)….had to come up with a survey or an observation and write about it.” Even with training wheels and someone ‘holding on’ as you start to pedal, you still have trepidation and a fear of that person letting go. Studies
with several levels and areas of concentration may be overwhelming and can be a
deterrent to students even attempting research.

“I am not patient. I cannot do long term studies and long term projects. I am just not patient at all. So, I do not think I would be a good researcher. Way too much time, especially if it does not turn out good.”

“I felt like (research) was a lot to understand and felt pressure especially since I really didn’t have any practical applications to what I was learning… it was just a lot of general information and I just didn’t know what to do with it.”

“I don’t really have any (future intentions with research) right now, I don’t know if that will change or not. “

One may need to pedal slowly and look carefully to the experienced rider who is holding on. This is not unlike being in a classroom and learning the basics of the research process. Reading articles first and then dissecting them with the help of more experienced assistance (reference books and the instructor/faculty) is a modest start. Starting slow with a small amount of exposure at the beginning can be helpful to decrease the overwhelming factor of research. Fear can come from being intimidated by the unknown, not knowing what questions to ask and a thought that you may need to conduct research on your own soon and not know how. These fears can become barriers to a positive outlook on research.
“I would need more help...(conducting research on their own). A lot more help. It’s still sort of an unknown, like how to put together my own.”

“...the word research makes me think of a lot of work, time consuming, a lot of energy and reading time, searching for references and going to data bases, and I think that as a negative connotation cause you have to do so much work.”

“I think that (undergraduate research) is ok, because it is on a smaller scale and with all we have to do on top of that, maybe it is it not so much as a long research project. I think helping with data when it is already collected is fine, but for us to go out and start from scratch to get this data is just too much. But I have not had to do that. Giving us part of something that had already been worked on a little can be more beneficial because of time and we can still see how it works. You are less stressed for time and good grades.”

After some time, the hope is that with the more articles read and analyzed, the more types of research studied, and the more questions answered, the fear of research will diminish a little, allowing the student to try a few things on their own. Choosing a research topic, beginning a literature search, and trying to analyze what they have found on their own can be similar to taking off the training wheels and pedaling faster when
learning to ride a bike. You are still being helped by an experienced rider (your instructor), but are trying the process on your own.

“Much more confident now. If I had to do something with research before the program, I would not even know where to start. Now, I definitely think I could set up an experiment fairly well and try to conduct research. Not perfect obviously, I’ve never done it before, but I feel like I could start out pretty well. “

Although you may still fear that an experienced rider may ‘let go’ of the bicycle, you begin to feel more comfortable with the task at hand. As with any learning process, there will inevitably be students who will be at varied levels of comfort, some not checking behind them while others need reassurance.

“I still have trouble and am not great by any means at reading or understanding research, I think for my own purposes, I could generally get through and get out of it what I needed to.”

“Um, now that I have done a little more with (research), and testing my ideas, I feel better than I did before. I saw the process first hand and think I understand it more, although it was a concentrated project and I had a lot of guidance. Could I have done it by myself? Probably not.”
“...without the (exposure to research) I think it would have left us at the bottom of the barrel, not knowing how to analyze and understand all (the research statistics and process). “

The more a beginner rides, the faster and more comfortable they become. Although they may still only ride short distances, they may not look back as often. They may even get to a level of comfort to ride along side of the experienced rider for longer distances. Practicing bicycling increases comfort and confidence, and when it comes to research, practice can produce a similar effect.

“I actually did a research thesis in this program which was the first time I had done anything like that. That definitely got me more acquainted with the process. I really didn’t know what I was doing in the beginning, so it helped my exposure to it. “

“When I came in (the program), I was not confident at all, and now...a little more confident, but not too confident in research, just a little more comfortable reading it and knowing what is being said.”

“When I first started the program, I feel like I can read a research article and just pick out things I think are valid, or is it has a small population size, or whether there are certain things that make it invalid. I think I am better at picking out things like that especially now. So I’d say I’m pretty confident in reading research article now.”
Students ultimately have a choice to assume research’s role. Barriers to developing positive attitudes toward research and getting involved in its production can still be present. Just because someone can ride a bicycle does not mean they would not rather walk. At this point in the journey much can depend on a student’s feeling toward research, not only as an undergraduate, but generally. Both comfort levels and attitude can play an important role on whether the student is riding along faster next to the experienced rider:

“I think understanding research very important. As we go along, we are going to read journals, and we are going to get educated a little more and you want to know where all that is coming from and all the statistical data that comes with it. Even just in departmental meetings when someone mouths off statistics, you can know how to find out if that is true. Like where did you get that information?”

“I was very confused in the beginning (of the program) about what the next step (with research) was, and now having been through it, I am better with the process. You have to formulate your proposal and analyze results. I’ve never been through that before and now that I have I am more confident in describing what I did and what the results were and formulating conclusions. And then taking my conclusions and knowing how to relate them back to the topic is now something I feel like I can do.”
or just walking alongside of another rider.

“I think in terms of me actually doing research, I’m not very good at it, so I don’t think it would be that valuable. In terms of other research being done by people who know what they are doing... I think it can definitely be applied, depending on how extensive the research is. I see research as a means to improve technology, so it definitely relevant. It is definitely applied every day, but me actually doing it? No. That wouldn’t help anyone. “

“I think people get set in their ways and research is the last thing people want to do sometimes, but I definitely think someone need to do it. I definitely see its worth and value. I hope it plays a big role for someone so it gets done.”

By the end of the program, the participants have experienced a significant shift as a whole in one factor, valuing research more than in the beginning of introductory class. They have also gained experience in searching for literature, and broadened their resources when it comes to research assistance. However, individualizing participants by way of qualitative data can provide a look into how some students can come away from the program ready to riding cross country alone with confidence,
“As we come out of the program we are going to be more analytical and more critical of journals when they come out and we read it. We won’t necessarily just take it at face value. We’ll be asking questions. And also we can get connected with people who do research so if or when you go to do it yourself you will have more questions answered and you have a source to go to for help on like how should I do this. Or could you help read this, see what I wrote, see if you see any improvements I need to make.”

“Research can help guide things in the right direction so that we don’t get stuck. Like genetic research and things like that...and I think that conducting research is the right way to be going. I think that to keep our profession going that we should be as knowledgeable as possible. “

“I did an undergraduate thesis and it was a lot of work, I feel like I’m a more well-rounded student because of it. I’m a more confident writer and more comfortable with the research process. As far as if I’d do another research project like for a master’s or in my career, I’m not really sure what I would do it on, I guess wherever I am in my career or interests at the time. I haven’t really thought about it much but I guess if the opportunity presented itself, I’d be interested in doing it again.”

and some have only just taken off the training wheels,
“I had no intentions to begin with (to conduct research), but now that I have had some exposure, just a tiny, bit, I feel like I might get bored just working and research might give me something to do and stay interesting in continuing to learn. And I mean, somebody has to do it...for the future.”

and others may never want to ride a bicycle again.

“I think (research) is valuable, especially if it is something you are interested in, then you would do a better job with it and it would mean more. I think if you are forced to do something, it loses meaning on some level."

“If it is research I am interested in, I guess I’d want to know more about it. But if it is something I am not interested in, I don’t really care about it. I think nothing at all because it is boring and most of the time uninteresting.”

The point is that by having concentrated undergraduate research education, students’ have been affected by research in one way or another. The tools were given to enable them to differentiate quality research from that that can be improved upon. Whether their comfort level and desire takes them to win medals in cycling or just gives
them the opportunity to ride without training wheels, research has made an impact on some level and their research education will be a part of their medical imaging careers.
Chapter 5: Discussion

The medical imaging field has a central role in the advancements and innovations of diagnosis, treatment and research. The technology available continues to exceed its predecessors in capability, speed, accuracy and image quality. Due to the improvements and continuous remodeling of technology in medical imaging, there is a need for students’ educational requirements to evolve in order to match the pace of innovation. There is a shelf life for their baseline knowledge and the American Registry of Radiologic Technologists (ARRT) has corroborated this notion by applying means to assure ongoing learning and competency in the medical imaging field.30

Any credentials awarded by the ARRT in 2011 and after, will be time-limited certifications and those certified will be required to go beyond the continuing education requirements from past graduates in order to keep their certifications active.30 This approach promotes life-long learning and provides opportunities for medical imaging professional to become more involved in the changes occurring in their field and the current research that accompanies these changes. The issue may lie, however, in how educationally equipped graduates are to meet these new challenges. Not only that, but do their perceptions and attitudes toward life-long learning and research provide a strong foundation to remain positive and dedicated to the changes?
The objective of this study was to explore students’ current impression of research, especially at the undergraduate level. This could provide a context for clarifying what is needed from faculty, students, and outside influences to increase understanding and appreciation of research and professionalism among students. These concepts may be extended long term into graduates’ professional careers. The research question asks:

*Given the importance of research in the medical imaging field, what are the perceptions and attitudes toward research among undergraduate students as they pursue their degree in a baccalaureate medical imaging program?*

This study surveyed 35 students from a baccalaureate level medical imaging program as they progressed to graduation. The results demonstrated a statistically significant increase in these participants' exposure to research practices including access and resources, providing a basis that research was infused into their education. There was an overall increase in the use of databases from having never used one, to a feeling “very successful” when following the information needed from databases. The amount of research articles read during undergraduate studies among these participants increased significantly as well as the mean of the number of literature searches using computerized databases. There was also a significant increase in the program faculty’s identification as the most helpful resource to turn toward when a question arises pertinent to the participant’s area. This indicates that the faculty demonstrated a certain knowledge and competency in research education in order for the students to perceive them as a valued source over other options.
In terms of their attitudes and perceptions toward research, which was measured by categorical factors explored in questions 1-17, an increase toward knowing the value of imaging research was statistically significant (p value ≤ 0.04). While important in measuring students’ perceptions of research in the medical imaging profession, factors 1, 3, and 4 are geared more toward technologists and factor 5 refers to students’ comfort level understanding and conducting research, as previously mentioned, it can take time and can differ greatly on an individual basis. Understanding the value of research and maintaining a level of respect for its importance can be appreciated by a graduate, no matter the level of participation in research.

Educational programs have a potential to impact attitudes and perceptions toward research with faculty involvement, research exposure and exercises included in the curriculum. This is balanced against the requirements to produce and graduate competent medical imaging professionals. These skills will be required to reflect current competency, especially now, given the new ARRT continuing education requirements for active credentialing. Incorporating research education into a program, even if it begins with a well-executed research course infused into the curriculum, is one method to prepare graduates to enter their profession.

Accompanying the new certification requirements, medical imaging education is being reviewed to determine national standards by ARRT, effective 2015. Professionally, the careers associated with radiology mandated to access credentialing will require an Associate level degree.
“Candidates applying for certification in radiography, nuclear medicine technology, or radiation therapy, or in sonography or magnetic resonance imaging as graduated of an educational program, beginning January 1, 2015, must have earned an associate degree or higher. This requirement is consistent with ARRT’s mission of promoting higher standards of patient care and will position those graduating in 2015 and beyond for their careers in the profession.” -2010 Annual Report to Radiologic Technologists from ARRT

As a result of this mandate, educators in military and hospital based programs will be compelled to collaborate with these standards and restructure their programs to offer an Associate’s degree. This new requirement from the ARRT will require all educators to review curriculum and determine what content is needed. The hope is that more emphasis may be put on critical thinking, interpretation of research, and an increased understanding of professional writing.

The new educational standards and faculty being identified as the most helpful resource to the participants of this study, provokes the question if the medical imaging education faculty is prepared for this responsibility. Research has become an essential part of nursing education, especially in baccalaureate programs. Nursing educators have had to rethink their curricula and consider how research literacy and evidence based practice (EBP) skills can be worked into their programs. Nursing educators are also examining their own ability to find and utilize relevant research in order to produce an evidence-based nursing workforce prior to licensure as registered nurses. They have collaborated with librarians, participated in inter-institutional writing support groups and
participated in student/faculty mentoring courses for research projects at the undergraduate level. Nursing educators' efforts can provide an example for the course of action needed from medical imaging educators to ensure their preparedness for the future of research education.

Contributions to the rapidly changing advancement and innovations in medical imaging are made possible by teams of researchers, which may include radiologists, medical imaging professionals, informatics professionals, etc. There is a pressing need for radiology departments and leadership to be continuously committed to radiologists pursuing and conducting valid and ethical research to keep up with their clinical colleagues. This need could provide opportunities for medical imaging educators and their students to collaborate with researchers and their clinical sites, similar to the efforts the nursing profession has made. The medical imaging profession is continuing to grow in career options as well to include a Registered Radiologist Assistants (R.R.A.) certification program since 2005, due to a shortage of radiologists and a desire to increase clinical opportunities for medical imaging professionals. This addition to the medical imaging professional circle can add to the research collaboration possibilities, not only for educators, but also for their students to assist in research efforts.

With all these dynamic changes in the profession, what educational activities can facilitate the integration of research education and appreciation into existing programs? It may vary on the type of program in question (associates or baccalaureate), but whatever the steps taken, educators must keep in mind their role as a resource and mentor. Students begin on training wheels, assuming that the faculty member holding their bicycle while
they ride is an experienced rider who will be able to support them on their journey.

Programs not only need to educate the students in research, but make sure faculty members are ready to mentor students in a positive way. The program itself may have educators who just took the training wheels off their own bicycle. Faculty could begin by looking toward themselves and knowing what they have to offer and where they may need guidance. Setting up a mentorship between faculty members could be a start to setting up scholarly activities for the students in the program. Research courses, collaboration with graduate students, constructing abstracts, searching for case studies and literature reviews can be good exercises for students as well as faculty.

Curriculum should be infused with more research and evidence based practice. There is a call for life-long learning to master continuing innovations in the medical imaging profession. Therefore, the pursuit of this will require educators to research and master research education while maintaining a positive experience that can foster agreeable attitudes toward it. Encompassing research education into a program as an additional requirement can be difficult to fit into a packed curriculum. There is a core curriculum that needs to be achieved. The occupation relies heavily upon competency and skill set mastery. In addition, evidence based practice and the process of changing practice will need to be added. Educators are faced with the challenge of initiating educational activities that promote the acquisition of critical thinking, scholarly writing and communication skills through core didactic education and professional preparation.26

To stress the relevance of research to clinical practice will require a move to incorporate research earlier in education, for example positioning a research course as a
pre-requisite course. Perhaps the earlier students are given “guidance”, the more they will practice and sooner feel comfortable. Rethinking and reestablishing curricula is difficult for any medical imaging program, no matter the degree level, so success in incorporating research education into a program while maintaining positive attitudes should begin slowly. It could start with faculty being comfortable riding alone, so they can be well equipped to help less experienced riders. The saying "it's like riding a bike" implies that once one knows how, they always will be able to do it. This adage may not hold true for research literacy, evidence-based practice (EBP) knowledge and skill. Unlike "riding a bike", there is a shelf life to that knowledge, and likewise for core education in the medical imaging profession. Promotion of life-long learning beyond baseline education among students and educators is needed to ensure essential readiness for the future careers in medical imaging.
References


Appendix A:

Quantitative Instrument/Amended Attitudes-to-Research Questionnaire

1. Research findings have very little impact on health sciences practice.  
   Factor 2
2. One essential role of allied health & nursing professionals is to carry out research.  
   Factor 3
3. Even if allied health & nursing professionals did carry out research, doctors and health care professionals wouldn’t use the findings.  
   Factor 1
4. Most allied health & nursing professionals are competent to undertake research.  
   Factor 4
5. The attitudes of physicians and other health care professionals don’t permit the implementation of any allied health & nursing research findings.  
   Factor 1
6. All undergraduate health science students should do compulsory courses on research methodology.  
   Factor 3
7. Most allied health & nursing professionals are not interested in implementing research findings.  
   Factor 2
8. Lack of time for research is no excuse for really motivated health professionals.  
   Factor 3
9. Most health professionals don’t have any motivation to carry out any research of their own.  
   Factor 2
10. Most hospitals and clinics would adopt the results of sound allied health & nursing research.  
   Factor 1
11. Most allied health professionals just pay lip-service to the value of research…they aren’t really convinced of its worth.  
   Factor 2
12. The health care professionals have a lot of confidence in health sciences research.  
   Factor 1
13. Most allied health and nursing professionals lack confidence to carry out research.

*Factor 4*

Questionnaire and factors adapted from Hicks.\(^{24,25}\)

Rating scale: strongly agree=1; agree somewhat =2; don’t know =3; disagree somewhat = 4; strongly disagree =5.


*Factor 5*

15. I am able to distinguish between relevant and irrelevant assumptions in a research article.

*Factor 5*

16. I am unable to evaluate the accuracy and validity of a research article.

*Factor 5*

17. I am confident drawing conclusions from research articles for practice decisions.

*Factor 5*

Questionnaire and factors adapted from Heiss and Basso.\(^5\)

Rating scale: strongly agree=1; agree somewhat =2; don’t know =3; disagree somewhat = 4; strongly disagree =5.

18. When you have a question pertinent to your area, where do you turn? (Choose up to 3 that you consider most helpful)

- Textbooks
- Health Science Library
- Health Care Professional
- The Internet/World Wide Web
- Faculty
- Classmates
- Other: ________________________________

19. Which databases have used so far in your academic “career” (Check all that apply)

- CINAHL
- Cochrane
- Medline
- PsycInfor or ERIC
- Pub Med – Clinical Queries
- Other: ________________________________
20. How successful did you feel you were in following the information you 
needed in the above databases”

_______ Very successful
_______ Just okay
_______ Not successful
_______ Not applicable – I never used a database

21. How many research articles (papers with methods, results, discussion) have 
you read during you undergraduate studies?

_______ None
_______ 1-3
_______ 4-7
_______ 7-10
_______ Greater than 10

22. How many literature searches using computerized databases like Medline, 
PubMed or CINAHL have you performed during your studies?

_______ None
_______ 1-3
_______ 4-7
_______ 7-10
_______ Greater than 10

23. What do you think is your most likely undergraduate specialty?

24. What is your age?

25. Can I contact you later in the year and next year for this same kind of 
information?

Questions from Evans and Kowalczyk

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Appendix B

Tables

Table 7: Overall Response rates for all questions.

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<tr>
<td>Q18</td>
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Table 8: Response Means for Questions 1-17

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Table 9: Response Means for Question 20

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Table 10: Response Means for Question 21

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<td>Time 1</td>
<td>Time 2</td>
<td>Difference in Mean (Time 1 to Time 4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>N</td>
<td>Min</td>
<td>Max</td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>Q21</td>
<td>35</td>
<td>1</td>
<td>5</td>
<td>2.60</td>
<td>1.19</td>
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</tbody>
</table>

70
Table 11: *Response Means for Question 22*

<table>
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<tr>
<th></th>
<th>Time 1</th>
<th>Time 2</th>
<th>Difference in Mean (Time 1 to Time 4)</th>
</tr>
</thead>
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<td>Q22</td>
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<td></td>
<td></td>
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<tr>
<td>N</td>
<td>34</td>
<td>35</td>
<td></td>
</tr>
<tr>
<td>Min</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Max</td>
<td>5</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>1.62</td>
<td>4.51</td>
<td></td>
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<tr>
<td>SD</td>
<td>.95</td>
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</table>
Table 12: Frequencies of participant choices of undergraduate specialty from Time 1 to Time 4 for Question 23.

<table>
<thead>
<tr>
<th>Written Answer</th>
<th>Time 1</th>
<th>Time 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>RT-Radiologic Technology</td>
<td>54%</td>
<td>26%</td>
</tr>
<tr>
<td>US- Ultrasound</td>
<td>2%</td>
<td>6%</td>
</tr>
<tr>
<td>CT-Computed Technology</td>
<td>9%</td>
<td>2%</td>
</tr>
<tr>
<td>PT –Physical Therapy</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>Good Study Habits</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>MRI- Magnetic Resonance Imaging</td>
<td>14%</td>
<td>9%</td>
</tr>
<tr>
<td>NM-Nuclear Medicine</td>
<td>11%</td>
<td>0%</td>
</tr>
<tr>
<td>Radiation Therapy</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Informatics</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Angiography</td>
<td>2%</td>
<td>11%</td>
</tr>
<tr>
<td>Management</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Mammography</td>
<td>0%</td>
<td>11%</td>
</tr>
<tr>
<td>QA-Quality Assurance</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Math</td>
<td>6%</td>
<td>0%</td>
</tr>
<tr>
<td>Biology</td>
<td>2%</td>
<td>0%</td>
</tr>
<tr>
<td>Women’s Health</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Education</td>
<td>0%</td>
<td>2%</td>
</tr>
<tr>
<td>Unknown/Blank</td>
<td>11%</td>
<td>6%</td>
</tr>
</tbody>
</table>
Appendix C:

Qualitative Interview questions

1. What is the first thing that comes to your mind when you think about research?

2. How much exposure did you have to research before the program?

3. Do you feel like the program has given you more exposure and increased your understanding of research?

4. How confident are you in your ability to understand research that has been done?

5. How confident in your own abilities are you when it comes to conducting research?

6. How do you think research should be involved in undergraduate study and curriculum?

7. As a student, in what ways do you find research valuable to your future profession? What role does it play?

8. In what ways do you think technologists value research? How can you tell?

9. How confident do you think technologists are in their ability to distinguish well done research? (Ask for examples) Is that important?

10. If you were working as a technologist, how would you find the time, resources, and support to conduct research?

11. How well do you think a large radiology department would support you on future research endeavors? And smaller department? Differences?

12. Do you feel certain modalities favor research more than others? Of so which ones? Why do you think that?

13. What are your future intentions when it comes to research in your field? Keeping up with it? Conducting it? What are your interests?