6-2016

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Abstract

The relationship between non-traditional (a.k.a. non-cognitive) admissions criteria and graduation rates of radiography students was investigated. The population for this study included all radiography program directors responsible for accredited programs in the United States and Puerto Rico (N = 618). All programs are required to maintain records on retention in accordance with the Joint Review Committee on Education in Radiologic Technology (JRCERT) (n.d.). A total of 737 radiography programs are recognized by the American Registry of Radiologic Technologists (ARRT) and of the 737 programs, 618 are programmatically accredited by the JRCERT. Of the 618 programs accredited, the institutions offer either an associate's degree, a bachelor's degree, or are considered certificate programs.

Two-year programs that utilized non-traditional admissions criteria had higher graduation rates. Admission criteria such as the use of prerequisite courses were positively related to student persistence to program completion, while criteria such as departmental observations were not. These conclusions were drawn from data submitted by program directors that encompassed two- and four-year radiography programs. An ANOVA demonstrated statistically significant differences (p = .05) between two-year programs that employ non-traditional admissions criteria and programs that rely more exclusively on traditional selection criteria such as GPA, standardized tests, reference letters, and interviews. Radiography program directors should be using prerequisite course performance to reformat their current admissions process to improve graduation rates in their programs.

An abundance of research has focused on selective admissions within allied health programs, including nursing, athletic training, dental hygiene, occupational therapy, respiratory care, and midwifery (Agho, Mosley, & Williams, 1998; Baker, 1994; Ehrenfeld, Rotenberg, Sharon, & Bergman, 1997; Hughes, 2013; Johnson, Johnson, Kim, & McKee, 2009; Kenny, 2010; O'Donoghue, 2008; Standridge, Boggs, & Mugan, 1997). Despite varied and plentiful research in the allied health field, little has focused on

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admissions standards for radiography programs. The sparse literature that exists has clearly demonstrated that undergraduate diagnostic radiology education, curriculum, and pedagogy vary widely among disciplines and colleges within disciplines (Barlev, Lautin, Amis, & Lerner, 1994; Subramaniam & Gibson, 2007). Tay, Kamei, and Tan (2009) recently summarized the scarcity of literature that has addressed this issue with one concise statement: "Evidence-based radiology education and radiology education research are glaringly lacking" (p. 195).

Tay et al. (2009) noted that selective admissions within radiography relies heavily on research that has been utilized for other allied health careers. Admissions criteria used by other programs as predictors of success cannot be generalized to radiography programs, although they could have related value. In a study performed by Kavanagh (1981), cognitive factors of academic success were examined, and a high correlation was found between high school grade point average (GPA) and grades in the radiography program. Kavanagh reported that the research findings were inconsistent with other related radiography research. According to the Joint Review Committee on Education in Radiologic Technology (JRCERT), 484 certificate programs and 267 degree programs were available in 1985 for radiography. Kwan, Childs, Cherryman, Palmer, and Catton (2009) noted that far more certificate programs were available, and the programs did not require prerequisite classes prior to admission; therefore, these programs were forced to rely on high school GPA as a predictor of student success.

Clearly, the demand for radiographers and allied health professionals is directly aligned with the functions of higher education on multiple levels (admissions, retention, and financial) (Kenny, 2010). The resources to train these individuals are of high cost and limited access, yet are necessary in order to fulfill the demand for healthcare professionals to serve the communities that these institutions of higher education strive to serve. In several healthcare-related programs, the admissions process consists of two components: assessing cognitive ability and assessing non-cognitive attributes (Agho et al., 1998; Johnson & Edwards, 1991; Kwan et al., 2009; Scott et al., 1995). In order to assess these components, programs have used a variety of tools, including but not limited to standardized testing, high school GPA, math and science GPA from prerequisite classes, interviews, reference letters, observations, and first-come, first-served procedures to select students each year (Agho et al., 1998; Baker, 1994; Hughes, 2013; Kenny, 2010; Ehrenfeld et al., 1997; O'Donoghue, 2008; Standridge et al., 1997; Johnson et al., 2009).

Positive and negative correlations can be seen for the various admissions criteria when selecting students. These data provide little to no direction for program officials in selecting a cohort of students each year. The need to evaluate the admissions criteria and to review the latest research is expected of program officials. The value of an improved understanding of the selective admissions process and graduation rates for college students is of economic and societal importance. As the value is observed through economic and social sectors, the lack of research supporting radiography programs has compounded the need for this research on multiple levels. Cognitive variables appear to be sufficient for success in radiologic technology programs, yet double-digit attrition of 22% exists nationwide (American Society of Radiologic Technologists, 2000). Radiography programs are limited in the number of students that can be managed due to clinical space. Students must be afforded a quality opportunity to learn in a practical and realistic environment. The limited clinical space is viewed as a valuable resource, given only to the most qualified and most likely to persist students.

Research Questions

Specifically, this research sought to determine the nontraditional admissions criteria that best predict a higher graduation rate for radiography programs. Within the questions, the following data were collected:

Nontraditional criteria

- Department observation
  - Number of hours
  - Exams
- Prerequisite classes required for degree completion

The following research questions guided the current study:

1. Are there significant differences in the number of non-traditional admissions criteria selected between programs with high graduation rates, moderate graduation rates, and low graduation rates?
2. Are there significant differences in the number of radiography department observation hours and/or exams observed between programs with high graduation rates, moderate graduation rates, and low graduation rates?

3. Are their significant differences in the number of prerequisite classes required between programs with high graduation rates, moderate graduation rates, and low graduation rates?

Population

The population for this study included all radiography program directors responsible for accredited programs in the United States and Puerto Rico (*N* = 618). All programs are required to maintain records on retention in accordance with the JRCERT (n.d.). A total of 737 radiography programs are recognized by the ARRT. Of the 737 programs recognized by ARRT, 618 are programmatically accredited by the JRCERT. Of the 618 JRCERT accredited programs, the institutions offer either an associate's degree, a bachelor's degree, or are considered certificate programs. It should be noted that, by 2015, all certificate programs were mandated by the ARRT to convert their program to an associate's degree (ARRT, 2014).

The JRCERT was contacted to obtain a list of all accredited radiography programs in the United States and Puerto Rico. The information, with program director names and both physical and email addresses, was the most recent and updated database for accredited radiography programs and included certificate programs, associate's degree programs, and bachelor's degree programs. From the list of programs, all populations were studied, including community colleges, hospital-based programs, and universities. Program success was defined as a student who entered the program and successfully graduated in two years from the start of the original cohort.

Instrument

The sequence of defining the objectives, selecting a sample, choosing or developing a questionnaire, preparing a letter of explanation, and establishing dates and acceptable methods of gathering data followed the guidelines outlined by Creswell (2008). The value of a well-developed instrument is vital to the success of a quantitative study; therefore, tools were utilized that had been tested for key attributes such as reliability and validity. For the purpose of this research, the instrument was patterned after research studies performed by Semler (2001) and Fehrenbach (1999) in the realm of dental hygiene. The survey instrument was formatted to serve the needs of this research study. The questions were evaluated and modified to reflect common standards used in selecting students in two- and four-year radiography programs (Clark & Sharf, 1983; Cohen & Brawer, 1989; Drees, 2006; Geiser, 2008; Oja, 2012; Ramineni, 2012; Sparkman, Maulding, & Roberts, 2012). After several unsuccessful attempts to contact Semler for permission to use and adapt the survey tool, the researcher contacted Fehrenbach (1999), the original developer of the instrument modified by Semler (2001). Consent was granted from Fehrenbach for the tool to be used with modifications.

The trustworthiness of data obtained through research is dependent upon the validity and reliability of the instrument used to acquire the data. The use of the pilot-tested questionnaire of the defined sample population group reflected the validity of the questionnaire (Merriam & Simpson, 1995). The correlation coefficient of the pilot study was performed to determine whether the results measured the parameters outlined for the study. It was determined that three questions should be changed to open response, and one question was written to provide a range for the participant to choose. After a detailed discussion with a methodologist, this question was changed to fill-in-the-blank.

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The dependent variables were the three non-traditional admissions criteria assessed by the corresponding survey scales: non-traditional admissions criteria, criteria used for departmental observations, and prerequisite classes required for entry-level radiography curriculum. The independent variables were the graduation rates from the 221 programs that submitted usable data.

Data Collection

Data were collected through questionnaires distributed to radiography program directors in JRCERT accredited programs. The radiography program directors were selected from the JRCERT website, which is the only programmatic accrediting agency for radiography and radiation therapy educational programs. Following the development stage, the pilot model instrument was emailed to identified program directors with accredited programs within the state of Kentucky, which constituted a small sample of participants *(N* = 15). The data were used to assess

basic item characteristics and internal consistency for each subset and concurrent validity. The research questionnaire was refined on the basis of these outcomes to ensure the data appropriately supported the research question. Through the use of a questionnaire, the study sought to identify the most effective admissions tools in determining successful completion of a radiography program. Success was defined as not only completing the program, but also passing the American Registry of Radiologic Technologist's radiography examination.

After revisions to the research tool, the survey was launched via email nationwide to all program directors who currently lead accredited radiography programs. A time frame of three weeks was allowed, as well as a link to the survey. A reminder email was sent weekly for three weeks asking participants to complete the survey. The data were then subjected to analysis of variance. The goal of the statistical analysis was to provide a predictive research study, as well as forecast the value of the variables (admissions criteria) used by programs with high retention rates. This process reflected the value of the various admissions criteria to be used when selecting students for each cohort.

Demographics

A total of 618 surveys were sent to radiography programs accredited by the JRCERT. Of the 618 surveys sent to program directors, 410 were returned. After review of the data, it was determined that, if participants did not answer Question 4 asking about program affiliation, that data would not be used. Upon further investigation, some participants had not answered Question 37, which related to graduation data. Since this was the focus of the study, those surveys also were not utilized. Once these data were removed, the response rate was 36%, representing 78% of usable data for two-year programs and 22% representing four-year programs. Of those responding, 217 program directors completed the survey.

A total of 92 programs were affiliated with community colleges, and 32 were considered allied health departments within a university setting. The entry-level curriculum revealed that 78% awarded an associate's degree, whereas 21% awarded a bachelor's degree at the completion of the program. However, both two- and four-year programs demonstrated that they admitted students only once per year, for an overall average of 95% of programs reporting. As stated earlier, most radiography programs were housed within community colleges; therefore, a higher number of two-year programs were expected to respond to the survey. For the programs that provided usable data, two-year programs had the largest pool of applicants in 2013, with a total of 3,304, while four-year programs had the highest applicant pool in 2012, with 1,154 students. Conversely, the mean graduation rate for two-year programs was 81.40 in 2012 and 83.40 in 2013 for four-year programs.

Findings

In order to facilitate statistical analyses, the three research questions noted previously were converted to null hypotheses.

RQ1: ***No significant difference will be found in the number of non-traditional admissions criteria selected between programs with high graduation rates, moderate graduation rates, and low graduation rates.*** To address RQ1, a one-way ANOVA was performed. The results indicated a significant difference for only the two-year radiography programs, $F = 3.95$, $p = 0.0212$. **Table 1** summarizes the results for RQ1 For two-year programs, Tukey's Post Hoc test revealed a significant difference between the high and moderate graduation groups, as well as between the high and low graduation groups. The high group utilized significantly more non-traditional admissions criteria.

RQ2: ***No significant difference will be found in the number of departmental observations criteria selected between programs with high graduation rates, moderate graduation rates, and low graduation rates.*** To address RQ2 a one-way ANOVA was performed. The results indicated no significant difference between two-year radiography programs with high graduation rates and four-year radiography programs with high graduation rates. **Table 2** summarizes the results for RQ2.

RQ3: ***No significant difference will be found in the number of prerequisite classes required between programs with high graduation rates, moderate graduation rates, and low graduation rates.*** To address RQ3, a one-way ANOVA was performed. The results indicated a significant difference for two-year radiography programs, $F = 3.79$, $p = 0.0246$; and four-year programs $F = 5.31$, $p = 0.0084$, with high graduation rates. Table 3 summarizes the results for RQ3.

For two-year programs, Tukey's Post Hoc test revealed a significant difference between the high and moderate graduation groups, as well as the high and low graduation groups, and also included moderate and low graduation groups. For four-year programs, Tukey's Post Hoc test revealed a significant difference

Table 1. Number of Non-traditional Admissions Criteria Items Utilized by Two- and Four-Year Radiography Programs Affiliation, by Graduation Rate

Program Type	Graduation Group	*N*	M	SD	Post Hoc Grouping
Two-year	Low (0-77%)	56	0.73	1.19	A
	Moderate (78-87%	55	1.10	1.21	A
	High (88-100%)	57	1.35	1.12	B
Four-year	Low (0-79%)	16	0.43	1.03	n/a
	Moderate (80-89%)	16	0.75	0.85	n/a
	High (90-100%)	17	1.05	1.19	n/a

Table 2. Radiography Department Observations Scoring Utilized By Two- and Four-Year Radiography Programs Affiliation, by Graduation Rate

Program Type	Graduation Group	*N*	M	SD	Post Hoc Grouping
Two-year	Low (0-77%)	56	0.57	0.75	n/a
	Moderate (78-87%	55	0.49	0.71	n/a
	High (88-100%)	57	0.70	0.86	n/a
Four-year	Low (0-79%)	16	0.43	0.72	n/a
	Moderate (80-89%)	16	0.37	0.61	n/a
	High (90-100%)	17	0.82	0.88	n/a

Table 3. Prerequisite Classes Required by Two- and Four- Year Radiography Programs Affiliation, by Graduation Rate

Program Type	Graduation Group	*N*	M	SD	Post Hoc Grouping
Two-year	Low (0-77%)	56	3.62	2.82	A
	Moderate (78-87%	55	4.27	2.57	BA
	High (88-100%)	57	5.08	3.06	B
Four-year	Low (0-79%)	16	2.50	3.65	A
	Moderate (80-89%)	16	3.87	3.32	BA
	High (90-100%)	17	6.35	4.15	B

between the high graduation and moderate graduation groups, as well as the high and low graduation groups, and also included moderate and low groups.

Summary

Non-traditional admissions criteria (RQ1) were listed as radiography department observations and prerequisite classes required prior to entry into the program. This study verified that two-year programs with high graduation rates had a significant difference between two-year programs with moderate or low graduation rates when utilizing non-traditional criteria. Radiography department observations (78.4%) was the highest category selected from the list. However, four-year programs with high graduation rates did not show a significant difference between moderate and low graduation rate programs. They utilized radiography department observations (72.7%) more often than the other choices.

Two-year programs also demonstrated that high graduation rate programs utilized radiography depart-

ment observations approximately one-third more often than moderate to low graduation rate programs. Four-year programs with high graduation rates utilized radiography department observations nearly double that of moderate to low graduation rates programs. Previous studies have not indicated that this particular criterion has been researched. Therefore, it is unknown whether this research aligned with previous studies. However, it was noted that programs in both two- and four-year institutions with high graduation rates required the candidates to participate in a radiography department observation prior to admission. These findings were expected, as many individuals both in and out of the medical field have little understanding of the duties performed by a radiographer.

Research question 2 asked participants whether observations of a radiography department were required, and the part of the observation that was utilized in their admissions practices. The choices included number of hours observed, number of exams observed, evaluation from the radiography department personnel, or other. The hours for observation ranged from 2 to 24. Two-year programs selected other (19.2%), and four-year programs with high graduation rates also chose other (15.8%), which included an essay of their observation experience, a tour of the department, virtual shadowing link, and a question-and-answer sheet as part of the admissions criteria. This item revealed no significant difference between two- and four-year programs with high, moderate, and low graduation rates.

Aligned with a study by Kudlas (2006), no difference in graduation rates was noted between programs that required a departmental observation and those that did not require a departmental observation. Further research did not provide additional information on departmental observations. Therefore, as a result of this research and that of Kudlas (2006), departmental observations were determined to have no impact on graduation rates.

Research question 3 inquired about the number and variety of prerequisite classes required by programs that vary according to the individual institution. From the list of choices, two-year and four-year programs selected anatomy and physiology (82%), college algebra (79%), and English I (71%). This study demonstrated a significant difference in two- and four-year programs with high graduation rates relative to the requirements that were considered to be prerequisites, in comparison to two- and four-year programs with moderate to low graduation rates. Two-year programs revealed a higher graduation rate when they required social/behavioral science classes and medical terminology. In addition, graduation rates increased when English II was required. Four-year programs showed approximately double graduation rates, as compared to moderate to low rates, when candidates were required to take social/behavioral science classes, computer literacy, medical terminology, history, and humanities. Remarkably, when communication classes were required, the high graduation programs doubled that of moderate to low programs.

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One half of all programs utilized anatomy/physiology, college algebra, and English I as prerequisite courses for admissions criteria. Over one-third of the programs utilized English II, social/behavioral science, and medical terminology as prerequisites. However, at least one-third required students to take a nurse aid class, patient care class, or introduction to the profession class prior to admittance into the program. The results of this study aligned with that of Kwan et al. (2009) that revealed undergraduate grades in mathematics ($r = 0.580$, $p < 0.01$) and undergraduate biology ($r = 0.423$, $p < 0.01$), undergraduate physics ($r = 0.344$, $p < 0.01$), and overall undergraduate GPA ($r = 0.578$, $p < 0.01$) were significantly correlated with performance in the program and with graduation rates.

Graduation rates between two- and four-year programs revealed a significant difference in prerequisite classes required of the candidates that applied to their programs. These criteria have been previously studied, and this research aligned with those studies. However, other research did not specifically ask about classes that were required as prerequisites.

Limitations

An initial limitation of the study was that data were requested for the past three graduating classes. In 2015, the ARRT mandated that, in order for graduates to sit for their national certification exam, they

must graduate with an associate's degree. Programs in the past could be hospital-based, technical programs, or independent programs that did not require college classes prior to admittance into the program. This would impede the data on college GPAs, GPAs in prerequisite classes, and required prerequisite classes. Therefore, a study on admissions criteria beginning in 2015 may show a difference in graduation rates and admissions criteria from the research obtained in this study.

An additional valid study could be performed within one's own institution. Several programs, as established earlier, place a great deal of weight on prior college GPAs, either in overall or prerequisite classes or both. However, all teachers have different standards for their individual classes, whether in prerequisite or program classes. Therefore, an "A" in one class by a particular faculty member may be a "C" in the same class by a different faculty member. Therefore, it would benefit this study, as well as radiography program directors and admissions committees, to understand the criteria used to justify grades in anatomy and physiology, college algebra, and English. It also could be beneficial to examine the teachers that the unsuccessful students have had, as compared with the teachers that successful students have had in these subjects.

Conclusion

Student departure is viewed on a scale as a direct process seeking to determine predictors of affluence in order to avail individuals to prosper through to program completion within community college settings. The literature has demonstrated the complexity and multifaceted nature of student retention in higher education institutions, including allied health programs. The struggle to retain students in some states directly affects funding from federal and state government agencies, and this practice soon may occur in all states. In addition, low retention in radiography programs affects the need for licensed competent health care workers in the United States. Healthcare is important, as it is integral to the economy and health of the aging population. However, it is evident that studies in health care associate's degree programs regarding persistence are limited within the broad range of student retention, particularly within imaging science programs.

The research disclosed that radiography department observations provided a significant difference for two-year programs. Subsequent to the enactment of the Health Insurance Portability and Accountability Act (HIPAA) in 1996, medical facilities have found it much more difficult to allow students to do observations. As noted in the research, some programs rely on virtual observations, video of the radiography department, and/or a tour of the department. As stated previously, many do not understand the scope of practice of radiography on a daily basis, as with other medical health care fields.

The number of specific prerequisite classes required varied between programs. However, the difference in graduation rates related to the specific required classes was surprising. Four-year programs revealed that the requirement of communications classes showed a drastic difference in high, moderate, and low graduation rates. Two-year programs that required foreign language demonstrated a higher graduation rate, as opposed to those with moderate and low graduation rates, and did not require foreign language as a prerequisite.

However, radiography is a unique field that mandates strong people skills, excellent communication, and the ability to think critically and adapt quickly to change. Radiographers must learn many aspects of patient care, possess strong knowledge in the cutting edge of technology, in addition to adaptability and a desire to be a lifelong learner. Although these skills may not be unique to radiographers, they are essential for a candidate who applies to a radiography program, desiring to be accepted, to complete their education, and to have a successful career in the field.

However, radiography is a unique field that mandates strong people skills, excellent communication, and the ability to think critically and adapt quickly to change.

Radiography educators must assure all applicants, consumers, and interested parties that their programs' admission practices are rational, valid, reliable, fair, and humane. In addition, they must show administrators of higher education that they can successfully predict the selected students who will be successful in the program and can be gainfully employed in their field. A competent entry-level radiographer must possess excellent academic, verbal, reasonable judgment, and clinical skills in order to be successful in

a career. The current study's focus was to add to the limited research available for radiography program directors and to provide useful information in refining and strengthening current selective admissions practices. In addition, the study sought to provide criteria that admissions committees can utilize to enhance graduation rates within programs.

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