ENROLLMENT SNAPSHOT OF RADIOGRAPHY, RADIATION THERAPY AND NUCLEAR MEDICINE PROGRAMS

2006

Reported December 2006

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EXECUTIVE SUMMARY

In mid-September 2006, a hardcopy questionnaire and/or an invitation to complete an online questionnaire was sent via mail and e-mail when possible to each of the 972 radiography, radiation therapy and nuclear medicine programs listed by the American Registry of Radiologic Technologists. As of October 16, 2005, 718 of 972 questionnaires were returned, which represented an overall return rate of 74%. This included 523 (73%) program directors who chose to respond by e-mail or online at the ASRT Web site, and 195 (27%) who chose to mail their surveys to ASRT. Furthermore, 540 of 723 (75%) radiography programs, 81 of 118 (69%) radiation therapy programs, 94 of 131 (72%) nuclear medicine technology programs, and 15 other/unspecified programs had responded to the survey.

Summary of Data:

Of the 217 certificate-only programs, 113 (52%) indicated that they have an articulation agreement with a community college or with a four-year college or university.

Entering-class radiography and radiation therapy enrollments appear to be leveling off, while nuclear medicine entering-class enrollments have continued to rise. Information from program directors of almost three-fourths of ARRT-listed educational programs in these specialties estimates fall 2006 first-year enrollments at 17,323 radiography students, 1,295 radiation therapy students and 2,033 nuclear medicine technology students. These represent increases (1.6% for radiography, 5% for radiation therapy and 21% for nuclear medicine technology programs) relative to 2004 enrollments. However, from 2005 to 2006 estimated nationwide radiography enrollments increased by only .5% and radiation therapy programs *decreased* by 3%.

Overall, 77.4% of program directors reported full enrollment in fall 2006 compared to 76.7% in 2005, 77.5% in 2004, about 75% in 2003, 66% in 2002, and 50% in 2001.

The rate at which directors of programs at full enrollment reported turning away qualified students projects to an unmet national demand of about 37,136 students, while programs not at full enrollment reported unused capacity totaling only 1,753 students. The ratio of number of qualified students turned away to total number admitted was about 1.9 among radiography programs, 1.0 in radiation therapy, and 1.3 in nuclear medicine. About 11.6% of radiography program directors, 14.3% of radiation therapy program directors and 17.6% of nuclear medicine program directors reported that they plan to increase enrollments.

About 25% of radiography programs' associated clinical sites still employ film-screen systems while 75% are completely filmless, with a predominance of computed radiography (CR) systems over digital radiography (DR) systems. Radiation therapy and nuclear medicine technology program directors who considered this question relevant indicated that 71% of radiation therapy programs' associated clinical sites are filmless, with a predominance of DR over CR systems and about 30% still employing film-screen systems. On the other hand, only 11% of nuclear medicine programs' associated clinical sites still employ film-screen systems, while 89% are filmless and more than seven times as many nuclear medicine technology clinical sites employ DR systems as use CR.

Only about one-third (32%) of radiography program directors and about three-fifths (57% and 60%, respectively) of radiation therapy and nuclear medicine technology program directors feel that their programs "have adequate resource materials on the topic of digital imaging to adequately prepare instruction". This percentage was lower (26%) among associate-degree programs than among certificate (43.5%) and bachelor's (46%) programs. When asked what resource materials are lacking in this area, 54% of the program directors checked "textbooks" and 42%, "on-campus laboratory equipment."

Information gathered by this and previous years' enrollment snapshots was combined with information gathered from the ARRT renewal form database to generate projections as to how many additional

technologists would be added to and retained in the U.S. labor force between 2004 and 2014. These projections indicate that if all of these factors remain at their fall 2006 levels over that period, the radiography profession will fall about 6% short of the number of additional radiographers the Bureau of Labor Statistics (BLS) reports will be needed. The number of radiation therapists added to and retained in the U.S. work force will, on the other hand, exceed the BLS-estimated need by about 25%, and nuclear medicine will add and retain almost three times the number of additional nuclear medicine technologists the BLS projects will be needed.

BACKGROUND AND OBJECTIVES

This is the sixth in a series of annual reports from ASRT on entering class enrollments in educational programs for radiographers, radiation therapists and nuclear medicine technologists. Given the importance of anticipating trends in the supply of radiologic technologists and the lag between R.T. recruitment and education and students sitting for certification exams, the ASRT intends to capture an annual "snapshot" of the earliest stage of the recruitment process by surveying directors of educational programs.

The ASRT Enrollment Snapshot of Radiography, Radiation Therapy and Nuclear Medicine Programs, November 2001[1] provided the first empirical evidence that the downward trend in entering-class enrollments observed since 1994 had reversed. Snapshot 2002[2] verified that this trend continued in the 2002-2003 academic year, and combined these entering-enrollment figures with demographic data for radiologic technologists supplied by the ARRT to provide the first indications of whether current recruitment and retention rates were sufficient to meet U.S. Bureau of Labor Statistics demand estimates in these three specialties. The data indicated that, if nothing changed, the profession would meet the BLS-estimated demand for nuclear medicine technologists and radiation therapists, but would fall far short of the need for additional radiographers. Snapshot 2003[3] added a question about the percentage of each program's graduates who enter the U.S. work force. The analysis showed further increases in entering enrollments and updated the projections of numbers of new radiographers, radiation therapists and nuclear medicine technologists that would be added through 2010. Snapshot 2004[4] revealed that the number of students entering increased, though at a lower rate than in the previous four years. Overall, "the best current estimate is that radiation therapy is producing new practitioners substantially above the correct rate to meet the 2012 demand estimated by BLS, while nuclear medicine will nearly triple the estimated need and radiography is likely to come up somewhat short (by about 14%) of the projected demand unless enrollments or retention rates are increased." Snapshot 2005[5] updated those projections to a 7% shortfall for radiography (relative to the BLS 2004 – 2014 target), a 47% overshooting of the estimated need for additional radiation therapists, and about twice as many additional nuclear medicine technologists as the BLS estimates will be needed.

The 2006 Enrollment Snapshot's primary objective was to document recent trends in the number of students entering educational programs in the primary disciplines of radiologic technology: radiography, radiation therapy and nuclear medicine. Program directors were asked to report their entering class sizes during the past three years. However, entering an educational program doesn't guarantee a student's entry into the R.T. work force; therefore, the survey also asked program directors to report their programs' attrition rates in recent years. Further, graduating from an ARRT-recognized educational program does not guarantee entry into the U.S. labor pool, so program directors also were asked to indicate the country in which their program is located and the approximate percentage of their recent graduates who have taken jobs in the United States. The 2006 Snapshot, like Snapshot 2005, asked directors of certificate programs to indicate whether or not their programs have an articulation agreement with a community college. This 2006 Snapshot was the first to ask directors of nuclear medicine programs to estimate the percentage of their recent graduates who have taken the ARRT(N) exam, the NMTCB certifying exam,

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[1] American Society of Radiologic Technologists. Enrollment snapshot of radiography, radiation therapy and nuclear medicine programs, November 2001. Available at: www.asrt.org/media/pdf/enrollment_survey01.pdf. Accessed November 2006.
[2] American Society of Radiologic Technologists. Enrollment snapshot of radiography, radiation therapy and nuclear medicine programs, September 2002. Available at: www.asrt.org/media/pdf/enrollment_survey02.pdf. Accessed November 2006.
[3] American Society of Radiologic Technologists. Enrollment snapshot of radiography, radiation therapy and nuclear medicine programs, fall 2003. Available at: : www.asrt.org/media/pdf/enrollment_survey_03.pdf. Accessed November 2006.
[4] American Society of Radiologic Technologists. Enrollment snapshot of radiography, radiation therapy and nuclear medicine programs, 2004. Available at: www.asrt.org/media/pdf/enrollment_survey_04.pdf. Accessed November 2006.
[5] American Society of Radiologic Technologists. Update to ASRT Enrollment Survey 2005: Projected Additions to the Work Force, 2004-2014. Available at: www.asrt.org/media/pdf/research/EnrollmentGapUpdate.pdf, Accessed November 2006.

both exams, or neither. This information help better estimate the total number of new nuclear medicine technology certificants (whether NMTCB- or ARRT-registered or both) to expect two years from now.

Program directors were surveyed about the future of their programs, including plans for increasing or decreasing enrollments and any possibility that the program might close within the next few years. Finally, program directors were asked to indicate the state of their programs' readiness to provide instruction on digital imaging.

METHODOLOGY

In September 2006 the ASRT sent an e-mail to every radiography, radiation therapy and nuclear medicine program listed in the ARRT's list of education programs[1] for which an e-mail address was available inviting program directors to complete an online questionnaire regarding their entering-class enrollments. At the same time the ASRT mailed a two-page hardcopy version of that questionnaire to every program director. In early October, a reminder of the need for participation in the enrollment survey was e-mailed to all program directors for whom an e-mail address was available and who had not explicitly told us that they had responded to the survey.

The questionnaire asked program directors about recent entering-class enrollments, plans for increases or decreases in program capacity, whether the program might be closed within the next few years, the program's attrition rate during the past few years, and adequacy of program resources for providing instruction in digital imaging (CR and DR). (See Appendix A for the full questionnaire.)

The intent was to produce a "snapshot" of the supply side of the supply and demand balance for radiologic technology disciplines. As with the 2004 and 2005 snapshots, this year's questionnaire asked the program director in which country the program is located and what percentage of recent (past five years) graduates have taken jobs in the United States. As with the 2005 Snapshot, this year's questionnaire asked directors of certificate programs whether the program has an articulation agreement with a community college. For the first time this year's questionnaire also asked nuclear medicine program directors what percentage of their recent (past two years) graduates took the ARRT(N) examination, the NMTCB certification examination, or both.

As of Oct. 16, 2006, 540 (75%) radiography programs, 81 (69%) radiation therapy programs, 94 (72%) nuclear medicine technology programs and three unspecified types of programs had responded. The return rate – 718 of 972 questionnaires – represented an overall response rate of 74%.

A **statistical note** is in order: The high response rate (which was at least 68% for each discipline for each of the three years for which enrollment figures were provided) means that the width of confidence intervals around sample means and the likelihood that the direction of a given sample difference matches the corresponding difference in the population are affected not only by absolute sample size (number of PDs responding to the question) but also by the *proportional* sample size. In particular, confidence intervals (the range of values within which there's a 95% chance that the true population value lies) are narrower by a factor of $\sqrt{1-\frac{n-1}{N-1}} \approx \sqrt{.321} = .567$ than those that would be calculated without this *finite population adjustment*. Similarly, standard errors (estimated standard deviations of sampling distributions) are smaller by that same factor, so that *t*-ratios are larger by a factor of 1/.567 = 1.765 and F ratios are larger by a factor of $1/.567^2 = 3.115$ than they would be without the finite population adjustment. In short, having sampled a high percentage of all programs gives us greater confidence that the results are representative of the population of all radiography, radiation therapy and nuclear medicine technology educational programs.

[1] American Registry of Radiologic Technologists. ARRT-recognized educational programs. Available at: www.arrt.org/index.html?content=http://www.arrt.org/nd/listOfSchools.ndm/listSchools&iframe=yes . Accessed September 2006.

DETAILED RESULTS

Source of Data

		Frequency	Percent	Valid Percent
Valid	Online	523	72.8	72.8
	Hardcopy	195	27.2	27.2
	Total	718	100.0	100.0

Type of Programs

		Frequency	Percent	Valid Percent
Valid	Radiography only	529	73.7	74.0
	Radiation Therapy only	79	11.0	11.0
	Nuclear Medicine only	92	12.8	12.9
	Other	4	.6	.6
	Radiography and Radiation Therapy	1	.1	.1
	Radiography and Nuclear Medicine	1	.1	.1
	Radiography and Other	8	1.1	1.1
	Radiography, Radiation Therapy, Nuclear Medicine and Other	1	.1	.1
	Total	715	99.6	100.0
Missing	-9.00	3	.4	
Total		718	100.0	

Overall Number of Programs in Each Specialty (including multiple-level programs)

	Responses		Percent of Cases
	N	Percent	N
Radiography	540	74.2%	75.5%
Radiation Therapy	81	11.1%	11.3%
Nuclear Medicine	94	12.9%	13.1%
Other	13	1.8%	1.8%
Total	728	100.0%	101.8%

Note: 715 respondents indicated their program's specialty(ies).

Other Programs (Verbatim Specifications)

	Response	Frequency	Percent
	Blank	677	94.3
	Certificate in diagnostic medical sonography, certificate in echocardiography	1	.1
	CT	2	.3
	HC	21	2.9
	Hos	1	.1
	Hospital-based program	1	.1
	Magnetic resonance imaging computed tomography	1	.1
	Mammography	1	.1
	MR	2	.3
	N/a	1	.1
	Radiologist assistant	1	.1
	Site1185	1	.1
	Sonography	3	.4
	Ultrasound –CT-MR-mammo	1	.1
	University based	1	.1
	We also have advanced imaging certificates (CT, MR, vascular-interventional, and cardiac interventional) programs and a B.S. completion track on our campus. [Implies those are not reported on here.]	1	.1
	We also offer postassociate certificates in: ultrasound; mammography, CT and MR, and a bachelor in science in diagnostic images. [Implies those are not reported on here.]	1	.1
	We have two articulation agreements, which allows students to obtain a B.S. degree.	1	.1
	Total	718	100.0

Educational Levels

	Frequency	Percent	Valid Percent
Certificate only	217	30.2	30.2
Associate degree only	352	49.0	49.0
Bachelor's degree only	64	8.9	8.9
Other	11	1.5	1.5
Certificate and associate degree	21	2.9	2.9
Certificate and bachelor's degree	27	3.8	3.8
Certificate and other	3	.4	.4
Associate degree and bachelor's degree	8	1.1	1.1
Associate degree and other	5	.7	.7
Bachelor's degree and other	7	1.0	1.0
Certificate, associate degree, and bachelor's degree	3	.4	.4
Total	718	100.0	100.0

Overall Number of Programs at Each Level (including multiple-level programs)

		Responses		Percent of Cases
		N	Percent	N
Educational Level of Program	Certificate	271	34.0%	37.7%
	Associate degree	391	49.0%	54.5%
	Bachelor's degree	110	13.8%	15.3%
	Other	26	3.3%	3.6%
Total		798	100.0%	111.1%

Articulation Agreements

If yours is a certificate program, do you have an articulation agreement with a community college?

Educational level combo	Articulation Agreement with Community College?	Frequency	Percent	Percent of Those Who Answered the Question
Certificate Only	Yes	105	48.4	51.0
	No; with 4-year college or university	8	3.7	3.9
	Explicit No	93	42.9	45.1
	Did not Respond	11	5.1	
	Total Certificate Only	217	100.0	
Certificate and Other Educational Level(s)	Yes	20	37.0	51.3
	No; with 4-year college or university	6	11.1	15.4
	Explicit No	13	24.1	33.3
	Did not Respond	15	27.8	
	Total Certificate & Other Level(s)	54	100.0	
Certificate Not Offered (e.g., Associate Only or Associate and Bachelor's)	Yes	11	2.5	24.4
	No; with 4-year college or university	1	.2	2.2
	Explicit No	33	7.4	73.3
	Did not Respond	402	89.9	
	Total Not Offering Certificate	447	100.0	
Total		718		

Other Educational Level of Program

	Response	Frequency	Percent
	Blank	642	89.4
	3 + 1 Bachelor's degree	1	.1
	4 year bachelor's degree program in radiologic sciences with student choosing a fourth-year "senior specialization" in the advanced modalities of MR/CT, radiation therapy or medical sonography. The student graduates as a registered radiographer and registry-eligible in his/her chosen advanced modality.	1	.1
	A.A.S.	1	.1
	A.S. level is entry level for our programs but we also offer B.S. degree in rad sciences and B.S. radiologist assistant program. [Implies reported enrollments are for A.S. program only.]	1	.1
	AAS in radiologic technology	1	.1
	Advanced diploma and bachelor's degree	1	.1

	Articulation agreement with a local college that will give 30 credits for the radiography program	1	.1
	Articulation agreement with [name] university will be giving our students an associate degree for 2 additional semesters and then the option for a B.S. degree online.	1	.1
	As you can see, I checked 2 boxes above. We collaborate with the [name]university. They offer a B.S. in radiological science. 75% of our current enrolled students are on the 4-year track. 25% are pursuing our 2-year certificate.	1	.1
	Associate of applied science	1	.1
	Below: articulation agreement is for bachelor's degree, not with *community college*	1	.1
	Both	2	.3
	Both assoc and bachelor’s	1	.1
	B.S. (rad tech) and diploma in rad tech	1	.1
	B.Sc. and diploma	3	.4
	Can also get associate through our college affiliate.	1	.1
	Certificate	1	.1
	Cesep = DEC (Diplome d'etudes colegiales)	1	.1
	College articulation agreement for associate degree.	1	.1
	Diploma	5	.7
	Honors, master’s, Ph.D., prof doc and conversion to degree programs	1	.1
	In affiliation with a community college, graduates have option of A.S. degree in radiography.	1	.1
	In the process of articulating an affiliation with a college.	1	.1
	In the process of articulating an affiliation.	1	.1
	Master's degree in radiology administration	1	.1
	Master of imaging sciences	1	.1
	Master’s degree in educational administration	1	.1
	MR is advanced certificate	1	.1
	My program is a one-year certificate and a two-year associate degree program.	1	.1
	N/A	1	.1
	[name] Community college advanced diploma	1	.1
	Other would be diploma for MR	1	.1
	Our program is affiliated with the [name] university technology program, which offers a bachelor of science degree in nuclear medicine technology.	1	.1
	Our program is community college based with clinical affiliates.	1	.1
	Our program offers both the certificate (2-year) and the B.S. (4 year). We are a senior institution offering bachelors degrees, masters degree and doctoral degrees (Ed.D., Ph.D. and M.D.)	1	.1
	Postbaccalaureate certificate	2	.3
	Post center based in medical school	1	.1
	Radiography is associate, all others are bachelor’s	1	.1
	Regarding the following question - we are a certificate program that has an agreement with a community college to provide specific courses in the first year of our 28-month diploma program. However, the students graduate from a clinic-based program.	1	.1
	See above [Other prog specified: We have two articulation agreements, which allows students to obtain a B.S. degree.]	1	.1
	See above [We also have advanced imaging certificate (CT, MR, vasc. interv. and cardiac interventional) programs and a B.S. completion track on our campus.]	1	.1
	Students can receive credit from [name]university toward a bachelor's degree if they choose	1	.1
	Students coming from an academic affiliate receive a certificate from us and a B.S./B.A. from their school. Other students must have a previous bachelor’s and then receive a certificate.	1	.1
	Students entering with an A.A. or B.A. do not have to receive the A.S. degree. They receive a certificate of completion from the program.	1	.1
	Students must be registered radiologic technologist to qualify!	1	.1
	Technical college diploma (not a degree).	1	.1
	The following stats are derived by combining three distinctly different certificate options within CT.	1	.1
	The graduate receives a certificate from the program and a B.S. degree from an affiliated state college	1	.1

	They are all part of a bachelor's degree, articulating with the surrounding campuses.	1	.1
	This is a hospital-based program with an academic affiliation. So, we give certificates at the end of program and those who have chosen the baccalaureate option also get a B.S. degree from our affiliated academic university.	1	.1
	This program has just graduated the last class and is now permanently closed.	1	.1
	We also have diploma.	1	.1
	We are a certificate program with an articulation at a 4-year university for a B.S. in radiography. Optional for graduates of the program.	1	.1
	We are a hospital-based program that awards certificates plus we are affiliated with 2 universities that award B.S. degrees in radiologic technology.	1	.1
	We are in the process [of obtaining an articulation agreement]	1	.1
	We are planning on establishing a couple [of articulation agreements]	1	.1
	We currently have an articulation with a university. Our students may obtain a baccalaureate degree from this institution.	1	.1
	We have a certificate program for advanced placement students.	1	.1
	We have an articulation agreement with the [name]university for a bachelor of science in health arts.	1	.1
	We have an articulation with a 4 year university so they can obtain their bachelor's. We are a new program that will graduate the first class in 2006.	1	.1
	We have an articulation with a university.	1	.1
	We have an articulation with [name] university for an associate in science degree.	1	.1
	We have an articulation with two different four-year colleges, but not a community college	1	.1
	We offer a diploma for our 2.5 year program. This would be equivalent to your associate degree	1	.1
	We offer an A.A.S. in conjunction with [name].	1	.1
	We offer the certificate and bachelor's program. We are a senior institution/university.	1	.1
	When the students graduate from our program they receive a certificate. We have an affiliation with a local college. (4-year institution)The students have an option of attending the college and earning a B.S. degree.	1	.1
	Will be a B.S. in 2007	1	.1
	Total	718	100.0

Relationship between Specialty and Educational Level of Program

		Only one program				
Educational level combos		Radiography	Radiation therapy	Nuclear Medicine	Other	Total
Certificate only	Count	161	24	26	3	214
	Percent within program type	30.4%	30.4%	28.3%	75.0%	30.4%
Associate degree only	Count	307	22	20	0	349
	Percent within program type	58.0%	27.8%	21.7%	.0%	49.6%
Bachelor's degree only	Count	21	21	22	0	64
	Percent within program type	4.0%	26.6%	23.9%	.0%	9.1%
Other	Count	9	1	1	0	11
	Percent within program type	1.7%	1.3%	1.1%	.0%	1.6%
Certificate and Associate degree	Count	9	5	7	0	21
	Percent within program type	1.7%	6.3%	7.6%	.0%	3.0%
Certificate and Bachelor's	Count	11	3	12	0	26

degree	Percent within program type	2.1%	3.8%	13.0%	.0%	3.7%
Certificate and Other	Count	0	2	1	0	3
	Percent within program type	.0%	2.5%	1.1%	.0%	.4%
Associate degree and Bachelor's degree	Count	6	0	0	0	6
	Percent within program type	1.1%	.0%	.0%	.0%	.9%
Associate degree and Other	Count	1	0	1	1	3
	Percent within program type	.2%	.0%	1.1%	25.0%	.4%
Bachelor's degree & Other	Count	3	1	1	0	5
	Percent within program type	.6%	1.3%	1.1%	.0%	.7%
Certificate, Associate degree, & Bachelor's degree	Count	1	0	1	0	2
	Percent within program type	.2%	.0%	1.1%	.0%	.3%
Total	Count	529	79	92	4	704
	Percent within program type	100.0%	100.0%	100.0%	100.0%	100.0%

There are too few other specialty and combined specialty programs to meaningfully compare their educational levels with those of the single specialty programs. Similarly, programs involving a certificate and/or an associate degree in combination with a bachelor's degree were combined into a single category for analysis, and programs with an "other" educational level were not considered. Restricting analysis to three main types of programs shows that radiography programs are more likely (58.0%) than radiation therapy and nuclear medicine programs (24.6%) to offer only an associate degree ($\chi^2_1 = 57.9$, $P < .001$). Conversely, they are less likely (4.0%% vs. 25.1%) to confer only a bachelor's degree ($\chi^2_1 = 69.8$, $P < .001$) or to offer a combination of a certificate and an associate degree (1.7% vs. 7.0%; $\chi^2_1 = 12.551$, $P < .001$). Also, nuclear medicine programs are more likely (14.1%) to offer a bachelor's degree in combination with an associate and/or a bachelor's degree than are the other two types of programs (3.5%, $\chi^2_1 = 19.7$, $P < .001$).

Country in Which Program is Located

Program Type * In what country is your program located? Cross-tabulation

Program Specialty(ies)		In what country is your program located?				Total
		U.S.	Australia	Canada	Other[a]	
Radiography	Count	512	3	10	3	528
	Percent within Radiography	97.0%	.6%	1.9%	.6%	100.0%
Radiation Therapy	Count	71	1	7	0	79
	Percent within Radiation Therapy	89.9%	1.3%	8.9%	.0%	100.0%
Nuclear Medicine	Count	90	0	3	0	93
	Percent within Nuclear Medicine	96.8%	.0%	3.2%	.0%	100.0%
Other	Count	4	0	0	0	4
	Percent within Other	100.0%	.0%	.0%	.0%	100.0%
Radiography and Radiation Therapy	Count	0	0	1	0	1
	Percent within Rad and Radiation Therapy	.0%	.0%	100.0%	.0%	100.0%
Radiography and Other	Count	8	0	0	1	9
	Percent within Rad and Other	88.9%	.0%	.0%	11.1%	100.0%
Total	Count	685	4	21	4	714
	Percent of Total	95.9%	.6%	2.9%	.6%	100.0%

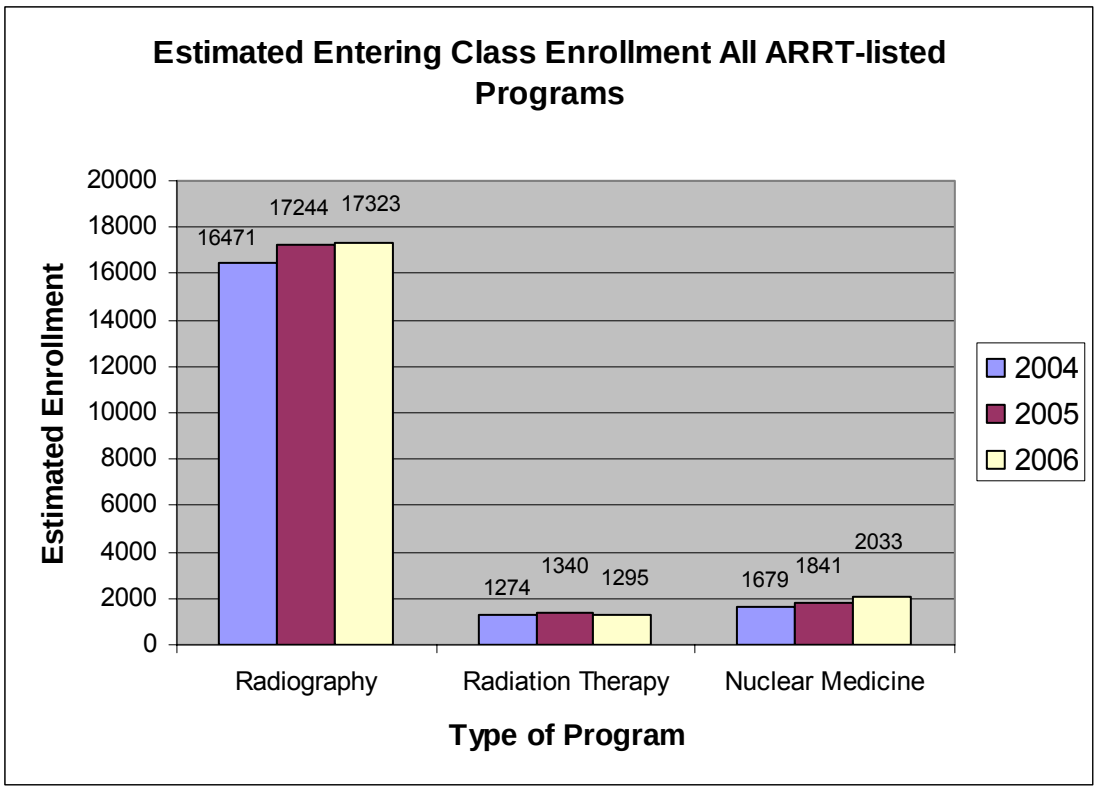
[a] Three of the four programs described as “Other” country are located in Puerto Rico. The fourth was not specified.

A significantly higher percentage of programs offering radiation therapy only (10.1%) were located outside the U.S. (all but one in Canada) than was true of those only offering nuclear medicine or only radiography (3.1%, $\chi^2_1 = 9.4$, $P < .01$).

ENROLLMENT TRENDS

Entering-Class Enrollments, All ARRT-listed Programs

All three types of radiologic technology programs experienced increased total entering-class enrollments from 2004 to 2005 (as estimated from retrospective reports of those years' enrollments), but the 2005 to 2006 increase for radiography was less than 1%, and from 2005 to 2006 radiation therapy programs *decreased* in estimated total enrollment by 3.35%.



1. What were your freshman enrollment figures for 2004, 2005 and 2006?
5. What was the attrition rate for your program over the past few years?

			1. How many students entered your program each of the following years?			5. What was the attrition rate for your program over the past few years?
Only one program			2004	2005	2006	
Radiography	N	Valid	512	522	522	513
		Missing	17	7	7	16
	Mean		24.0801	24.1159	23.9598	18.42%
	Median[a]		20.4200	20.1400	20.3478	13.5000
	Mode		20.00	20.00	20.00	10.00
	Std. Deviation		17.29154	17.17748	16.57251	18.82665
	Sum		12329.00	12588.50	12507.00	9450.62

	Percentiles[a]	5	7.5467	7.5111	6.9000	.6654
		25	14.1176	14.2364	14.1429	7.9000
		50	20.4200	20.1400	20.3478	13.5000
		75	29.3103	29.5217	29.1613	21.8500
		95	51.6000	51.0857	50.2000	69.2500
Radiation Therapy	N	Valid	74	77	78	77
		Missing	5	2	1	2
	Mean		12.1351	11.8571	10.9744	16.58%
	Median[a]		10.4000	9.7273	9.0000	9.0000
	Mode		8.00	7.00	7.00	.00
	Std. Deviation		9.06948	9.06514	9.56044	23.17275
	Sum		898.00	913.00	856.00	1276.30
	Percentiles[a]	5	2.4800	2.6750	1.5600	.1202
		25	7.2727	6.7917	5.1667	1.5000
		50	10.4000	9.7273	9.0000	9.0000
		75	14.6364	15.1000	13.8000	21.3250
		95	25.8000	23.4333	25.4000	79.5500
Nuclear Medicine	N	Valid	88	91	92	88
		Missing	4	1	0	4
	Mean		14.3523	15.0879	15.5217	10.15%
	Median[a]		10.8000	11.5714	11.7273	6.0000
	Mode		9.00	12.00	6.00	.00
	Std. Deviation		12.73247	13.06790	13.66111	15.82836
	Sum		1263.00	1373.00	1428.00	893.45
	Percentiles[a]	5	2.2667	3.0500	3.7333	.1220
		25	7.5833	7.8846	7.6667	2.0000
		50	10.8000	11.5714	11.7273	6.0000
		75	15.8333	17.5833	17.8571	11.4118
		95	40.4000	41.9000	39.8667	29.2000

[a] Calculated from grouped data.

Trends in Mean Entering-class Size as a Function of Specialty and Educational Level

A 3 (specialty) x 5 (educational level) x 3 (year) ANOVA of differences in mean entering-class size was conducted, with the third factor a repeated-measures (within program) factor. The analysis was restricted to programs that reported enrollment figures for all three years.

Averaged across disciplines and educational levels, mean reported entering-class size increased from 2004 (21.4 students per program) to 2005 (21.5 students per program – a 0.6% increase) and *decreased* from 2005 to 2006 (21.3). Neither difference is statistically significant (Bonferroni-adjusted level of .05), even when correcting to the desired general population, which is represented at a level of 68% by the survey sample.

However, some program types showed statistically significant year-to-year changes in mean entering-class size, as indicated in the following table:

Changes in Entering-class Size

Program Disicpline	Mean Number of Students in Entering Class			Increase 2004 - 2005	Increase 2005 - 2006
	2004	2005	2006		
Radiography only (N = 442)	24.04	24.13	23.92	0.09 (0.4%) *P* = .021[a]	-0.21 (-.9%) *P* = .107
Radiation therapy only (N = 60)	11.30	10.89	9.87	-0.41 (-3.7%) *P* = .052	-1.01 (-9.3%) *P* < .001
Nuclear medicine only (N = 63)	14.08	14.89	15.23	0.81 (5.7%) *P* = .089	0.33 (2.2%) *P* = .058

[a]All *P* values in this table include the finite-population adjustment.

Radiography programs showed a small but statistically significant increase in mean reported entering-class enrollments from 2004 to 2005, but the average size of radiography entering classes did not change significantly from 2005 to 2006. Radiation therapy programs' mean reported entering-class enrollment dropped a statistically nonsignificant 4% from 2004 to 2005. They dropped 2005 to 2006 by a statistically significant 9%. Nuclear medicine's entering-class sizes did not change significantly across this three-year period, though the sample mean reported class size increased nonsignificantly each year.

A couple of these trends differed significantly across educational levels. In particular, programs offering only a bachelor's degree in radiation therapy showed a slight (.21 students) increase in class size from 2005 to 2006 that was significantly different from the mean decrease for radiation therapy programs as a whole, while radiation therapy programs that offered a bachelor's degree in addition to a certificate and/or an associate degree decreased significantly more (a 5.33-student decrease in mean entering-class size) than the radiation therapy average of a 1.12-student decrease.

Within nuclear medicine technology programs, certificate programs dropped in mean entering-class size by 1.23 students from 2004 to 2005, as opposed to the overall average increase of .81 students for nuclear medicine technology programs as a whole, while associate degree nuclear medicine technology programs' increase of 3.60 students was significantly above the nuclear medicine technology average. On the other hand, nuclear medicine technology programs offering both certificate and associate programs increased by significantly more (2.86 students) from 2005 to 2006 than the nuclear medicine technology average increase in class size of .32 students, while nuclear medicine technology programs offering a certificate and/or an associate degree in addition to a bachelor's degree declined by 1.08 students, significantly below the average 2005-to-2006 change.

The analysis also showed that, within and averaging across year, radiography programs tend to have larger entering-class sizes than do nuclear medicine and radiation therapy programs and that associate-only programs and programs offering both a certificate and an associate degree tend to enroll more students than do the other three educational levels, while certificate-only programs have a significantly below-average mean entering-class size.

Number of Programs Experiencing Increase vs. Decrease in Enrollment

	Change in enrollment, 2004 to 2005				Change in enrollment, 2005 to 2006		
Program Type	Decreased	Remained the Same	Increased		Decreased	Remained the Same	Increased
Radiography	122	249	141		151	236	133
Radiation Therapy	26	26	22		36	25	15
Nuclear Medicine	20	39	29		26	31	34

Somewhat (specifically, 19) more radiography programs reported increases in entering-class enrollments than reported decreases from 2004 to 2005, but there were somewhat more (18) programs reporting decreases than increases from 2005 to 2006. Even more of a deceleration of enrollment growth was reported by radiation therapy programs: 4 more decreases than increases from 2004 to 2005 and 11 more decreases than increases from 2005 to 2006. On the other hand, more nuclear medicine programs

reported increases than decreases both from 2004 to 2005 (9 more increases than decreases) and from 2005 to 2006 (8 more increases than decreases).

Crucial Results from Previous Tables and Graph:

	Year	Total Reported Enrollment	Specialty Programs Reporting Enrollments	No. of ARRT-recognized programs	Estimated Total, All Programs	Percent Change	All Programs Reporting Enrollments*	Return Rate (% of that year's PDs who responded)*	Sent this year	No. of Programs Reporting Enrollments for 1 or more years*
Radiography	2004	12329	512	684	16471	---	522	76.3%	723	540 (74.7% overall response rate)
	2005	12589	522	715	17244	4.69%	533	74.5%		
	2006	12507	522	723	17323	0.46%	533	73.72%		
Radiation Therapy	2004	898	74	105	1274	---	76	72.4%	118	81 (68.6% overall response rate)
	2005	913	77	113	1340	5.15%	79	69.9%		
	2006	856	78	118	1295	**-3.35%**	80	67.80%		
Nuclear Medicine	2004	1263	88	117	1679	---	90	76.9%	131	94 (71.8% overall response rate)
	2005	1373	91	122	1841	9.62%	93	76.2%		
	2006	1428	92	131	2033	10.46%	94	71.76%		

Radiography's 75% return rate was significantly higher than the 70% return rate for nuclear medicine and radiation therapy programs combined ($\chi^2_1 = 5.8$, $P < .05$) after applying the finite-population adjustment.

Reports from the program directors who responded to this year's questionnaire (including their retrospective reports on 2004 and 2005 enrollments) indicate that all three program types had modest increases (by 1.1% to 7.6%) from 2004 to 2005 in total number of programs. However, average entering-class size showed very different patterns of change for these three disciplines. Radiography programs' mean class size was essentially constant across this three-year period, leading to a 5% increase in total nationwide entering-class enrollment from 2004 to 2005, followed by a very small increase (1%) from 2005 to 2006.

Radiation therapy programs' small drop in mean entering-class size from 2004 to 2005 was more than offset by the increased number of radiation therapy programs for a net gain of about 5% in nationwide entering-class enrollment. However, the 4% increase in number of programs from 2005 to 2006 was offset by a sharp (9.4%) decrease in mean class size, leading to a 3% decrease in total entering-class enrollment in radiation therapy programs. Finally, nuclear medicine experienced increases in mean entering-class size both in 2005 and in 2006. Coupled with substantial increases in number of programs, this led to increases in total nuclear medicine technology program entering-class enrollment of about 10% from 2004 to 2005 and again from 2005 to 2006.

Comparison with Enrollment Trends Reported in Snapshot 2004

The changes in total entering-class enrollments from 2004 to 2005 reported above are generally consistent with those reported in ASRT's Enrollment Snapshot 2005 for radiography (4.7% based on 2006's retrospective reports vs. 5.1% reported in Snapshot 2005) and radiation therapy (5% vs. 9%). However, the 10% 2004-to-2005 increase in total nuclear medicine entering-class enrollments computed from this year's reports seems at odds with the near-zero change (-.1%) from 2004 to 2005 reported last year.

* Includes combination programs that contained this discipline (e.g., a program that contained both radiography and radiation therapy components). Other statistics were based only on single-specialty programs for the specific discipline. Also does not include programs that returned questionnaires but did not provide enrollment data for that year.

However, this discrepancy could result from sampling fluctuation, i.e., due to chance differences between the sample of nuclear medicine technology program directors who responded to this year's questionnaire and those who responded to last year's. The 95% confidence interval around this year's estimate of the 2004 total enrollment figure for nuclear medicine technology programs is ± 241 students – i.e., the true total enrollment in the 117 nuclear medicine technology programs that were in operation in 2004 could be as low as 1,458 students. Had the figure been 1,529, an estimated 10% increase would be reported for entering-class enrollment from 2004 to 2005. Coupled with a similarly broad confidence interval around the 2004 enrollment reported in this year's snapshot, it is possible that the difference between last year's and this year's estimates of the 2004-to-2005 increase for nuclear medicine programs is simply due to sampling variation.

The growth in total enrollments in each of the three specialties has clearly occurred at a lower rate over the past three years than in the 2001 to 2003 period.

Attrition Rates by Program Type and Educational Level

5. What was the attrition rate for your program over the past few years?

Attrition as a Function of Educational Level of Program

Educational Level	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Certificate only	214	13.1437	16.85370	1.15210	10.8727	15.4147
Associate degree only	337	21.3659	20.06944	1.09325	19.2155	23.5164
Bachelor's degree only	62	11.9323	20.57149	2.61258	6.7081	17.1564
Certificate and Associate degree	20	15.2000	16.70361	3.73504	7.3825	23.0175
Certificate and/or Associate degree and Bachelor's degree	37	11.3649	10.38014	1.70648	7.9040	14.8258
Total	670	17.1304	19.06868	.73669	15.6839	18.5769

Attrition as a Function of Program Discipline

Program Type	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean	
					Lower Bound	Upper Bound
Radiography	513	18.4223	18.82665	.83122	16.7892	20.0553
Radiation Therapy	77	16.5753	23.17275	2.64078	11.3158	21.8349
Nuclear Medicine	88	10.1528	15.82836	1.68731	6.7991	13.5065
Total	678	17.1392	19.18755	.73689	15.6923	18.5861

The mean attrition rate for programs providing an estimate was 17.1%. This rate differed significantly as a function of both program type and educational level of the program, as well as their interaction. In particular, programs offering only an associate degree reported significantly higher attrition (21.4%) than the overall mean attrition rate for all educational levels. However, this difference was significantly higher within radiation therapy programs (29.7% vs. 16.6%) than within radiography (21.7% vs. 18.5%) and nuclear medicine technology programs (9.3% vs. 10.4%). And nuclear medicine programs reported a significantly lower mean attrition rate (10.2%) than did radiography (18.4%) and radiation therapy (16.6%) programs. Nuclear medicine technology programs had the lowest reported attrition rates within every educational level *except* for bachelor's programs, among which nuclear medicine technology programs had a higher mean attrition rate (18.2%) than did radiation therapy (8.0%) and radiography (9.4%) programs.

Perceived Variability in Attrition Rate

6. Has this attrition rate varied substantially over the past few years?

Responses to the above questions were combined into a single variable assessing amount and direction of change in attrition rate, with a "No" response to question 6 coded as zero (no change either direction), except that answering question 6y overrode a "No" response to question 6. "Increased" was coded as +1; "decreased" was coded as -1; and "increased some years, decreased others" was coded as +.01. A two-way ANOVA of mean differences on this combined variable yielded statistically significant effects of program specialty (finite-population-adjusted $F_{2,641} = 8.54$, $P < .001$), program educational level ($F_{4,641} = 5.33$, $P < .001$) and their interaction ($F_{2,641} = 2.34$, $P < .05$).

6y. If "yes," how has the attrition rate varied?

Direction of change (if any)		Frequency	Percent	Valid Percent
Valid	Stayed same	512	71.3	72.0
	Increased	34	4.7	4.8
	Decreased	79	11.0	11.1
	Increased some years, decreased others	86	12.0	12.1
	Total	711	99.0	100.0
Missing	System[a]	7	1.0	
Total		718	100.0	

[a]Seven directors indicated that their attrition rates had varied, but didn't indicate how they had varied.

More than two-thirds of program directors reported that their attrition rates have held steady over the past few years. Among the 16% of programs that reported a consistent trend in attrition rates, 70% reported that attrition rates had declined over the past few years. However, the predominance of declines over increases was true only of radiography programs, which were significantly more likely than nuclear medicine technology and radiation therapy programs to report decreased attrition rates (mean change score = -.068 vs. +.001 and +.035 on the -1 to +1 scale). This difference was much more pronounced in and statistically significant only for programs that combined two or more educational levels. Further, certificate-only programs were significantly more likely (mean change score = -.105) than programs offering only a bachelor's degree (+.052) to report decreased attrition rates across all three disciplines.

7. About what percent of your program's graduates over the past five years have taken jobs in the U.S. (including U.S. territories and Puerto Rico)?

Country	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
U.S.	642	98.0545	9.1862	.3625	97.3426	98.7664	.00	100.00
Canada	8	15.1750	98.0545	9.1862	.3625	97.3426	98.7664	100.00
Other[a]	4	92.7500	15.1750	34.4311	12.1732	-13.6101	43.9601	100.00
Total	654	97.0083	92.7500	6.6018	3.3009	82.2451	103.2549	100.00

[a] Three of these four programs specified Puerto Rico as the "Other" country in which their programs are located. The fourth did not name a country.

Note: Two U.S. programs reported that 0% of their graduates took jobs in the U.S; one, 3%; and a fourth, 11%. In three of these four cases there was no response to the attrition-rate question or the reported attrition rate was identical to the report percent of graduates taking U.S. jobs, so it's possible that these were actually those three programs' attrition rates. Omitting them (but not the report of 0% taking U.S. jobs that was accompanied by a reported 10% attrition rate) yields a U.S. mean of 98.3% of graduates taking U.S. jobs.

Omitting the three outliers discussed above, a factorial ANOVA yielded a statistically significant difference in mean percentage of students entering the U.S. job market as a function of specialty (finite-population-adjusted $F_{2,606} = 4.58$, $P = .011$). But educational level and interaction between program type and educational level did not significantly affect students entering the U.S. job market.

Program	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
Radiography	484	98.1550	8.5999	.3909	97.3869	98.9230	.00	100.00
Radiation Therapy	69	93.2609	23.0349	2.7731	87.7273	98.7945	.00	100.00
Nuclear Medicine	82	96.7366	14.6820	1.6214	93.5106	99.9626	.00	100.00
Total	635	97.4400	11.9645	.4748	96.5076	98.3724	.00	100.00

Radiation therapy programs had a significantly lower percent of entry into the U.S. job market (93.3%) than the other two types of program. This is attributable to the fact that a significantly higher percentage of the specialty's programs (7 of 71 – 9.9%, all Canadian) are located outside the U.S. than is true of the other two specialties (18 of 602 – 3.0%). When only U.S. located programs are considered, the percents are 98.4%, 98.9%, and 99.0% of radiography, radiation therapy, and nuclear medicine technology programs, respectively.

ARRT vs. NMTCB Certifying Exams

8. If yours is a nuclear medicine program, approximately what percent of your program's graduates over the past two years have taken the ARRT certification exam in nuclear medicine technology vs. the NMTCB certification exam?

		Percent taking ARRT (N) only	Percent taking NMTCB only	Percent taking both exams	Percent taking neither exam[a]
N	Valid	91	91	91	91
	Missing	627	627	627	627
Mean		10.1209	50.2702	35.0484	4.5604
Median[b]		.6957	58.5714	18.5000	.3000
Mode		.00	.00	.00	.00
Std. Deviation		25.3876	40.0034	37.2500	16.8597
Minimum		.00	.00	.00	.00
Maximum		100.00	100.00	100.00	98.00
Percent zeroes		73.6%	22.0%	24.2%	86.8%

[a] This category was omitted from the online version of the questionnaire; it equals 100% minus the sum of the other three percentages.
[b] Calculated from grouped data.

NOTE: This question was apparently somewhat confusing for respondents, as there were 23 program directors whose responses summed to more than 100%. Many of these respondents appear to have missed the "only" qualifier in "ARRT exam only" and/or in "ASRT exam only." The final analysis was based on the 76 respondents whose responses summed to 100% or less, plus 15 nuclear medicine technology directors whose responses seemed interpretable as follows:

Reported Percentage			Percentages as Interpreted and Used in Above Table			
ASRT only	NMTCB only	Both exams	ASRT only	NMTCB only	Both exams	Neither exam
.0	100.00	9.00	.00	91.00	9.00	.00
.0	100.00	10.00	.00	90.00	10.00	.00
.0	100.00	10.00	.00	90.00	10.00	.00
.0	100.00	12.00	.00	88.00	12.00	.00
2.0	100.00	2.00	.00	98.00	2.00	.00
10.0	100.00	.	.00	100.0	10.00	.00
17.0	100.00	100.00	.00	83.00	17.00	.00
20.0	100.00	20.00	.00	80.00	20.00	.00
33.0	100.00	100.00	.00	67.00	33.00	.00
35.0	100.00	.	.00	65.00	35.00	.00
35.0	100.00	.	.00	65.00	35.00	.00
45.0	80.00	30.00	15.00	50.00	30.00	5.00
50.0	50.00	50.00	.00	.00	50.00	50.00
71.4	71.40	.00	28.60	71.40	.00	0
99.0	1.00	99.00	.00	1.00	99.00	.00
100.0	95.00	95.00	5.00	.00	95.00	.00

One nuclear medicine technology program director responded “unsure” and another, “NA” (because that program had suffered 100% attrition in recent years and had no graduates qualifying for the exams). Finally, there were seven response patterns for which no interpretation could be determined; these were treated as missing data in the above analyses.

ASRT only	NMTCB only	Both exams
10.0	10.00	90.00
6.0	94.00	11.00
25.0	50.00	75.00
100.0	50.00	10.00
60.0	40.00	70.00
50.0	50.00	85.00
5.0	100.00	90.00

Near-term Changes

Capacity for Increase

2a. Is your program currently at full enrollment?

A significantly higher percentage (82.7%) of associate degree programs than of those offering only a certificate or bacherlor's, and combined certificate/associate programs (65.0%) reported being at full enrollment (t_{677} = 6.792, P < .001). Programs offering the bachelor's degree in combination with an associate degree and/or a certificate were least likely (50.0%) to be at full enrollment (t_{677} = 3.396, P < .001) after finite-population adjustment. The pattern of educational-level differences held within each of the three program types. However, the relationship between likelihood of being at full enrollment and program type differed significantly among the five educational levels ($F_{8,677}$ = 4.42, P < .001) as follows:

2. Is your program currently at full enrollment?

Education - 5 levels	Only one program	N	Mean
Certificate only	Radiography	159	.686
	Radiation Therapy	24	.375
	Nuclear Medicine	26	.692
	Total	209	.651
Associate degree only	Radiography	303	.842
	Radiation Therapy	20	.650
	Nuclear Medicine	20	.800
	Total	343	.828
Bachelor's degree only	Radiography	21	.619
	Radiation Therapy	21	.667
	Nuclear Medicine	22	.682
	Total	64	.656
Certificate and Associate degree	Radiography	9	.778
	Radiation Therapy	5	.200
	Nuclear Medicine	7	.857
	Total	21	.667
Certificate and/or Associate degree and Bachelor's degree	Radiography	16	.563
	Radiation Therapy	3	.000
	Nuclear Medicine	13	.385
	Total	32	.438
Total	Radiography	508	.774
	Radiation Therapy	73	.507
	Nuclear Medicine	88	.682
	Total	669	.732

Overall, radiography had a higher percentage of programs at full enrollment (77.4%) than did radiation therapy and nuclear medicine (60.3%, t_{687} = 7.925, P < .001). This difference held at every educational level except for programs offering only a bachelor's degree. In these programs, percentage of full enrollment only varied from 62% to 68%. Overall (i.e., averaging across educational levels), a higher percentage of nuclear medicine technology programs (68%) than of radiation therapy programs (51%) were at full enrollment (t_{687} = 4.345, P < .001). This was true at every educational level, but was much smaller among bachelor's-only programs (68.2% vs. 66.7%) than among the other four educational levels (68.2% vs. 45.3%).

2b. [If not at full enrollment,] approximately how many additional students could be accommodated by your program?

Only one discipline	Mean	Std. Deviation	No. of Responses	Total no. of Programs in Population	Proportion of Programs Not at Full Enrollment	Estimated Total Expansion Capacity[a]
Radiography	6.992	6.6852	118	723	.226	1,142
Radiation Therapy	6.419	6.8982	31	118	.493	373
Nuclear Medicine	5.714	5.2271	28	131	.318	238
Total	6.689	6.4991	177	972		1,753

[a](no. of programs in population) x (proportion not at full enrollment) x (mean no. of additional students)

Unused capacity did not differ significantly across program types (but is listed separately for each program type above to facilitate computation of total expansion capacity; the number of programs of each type in the population is known, but not the population distribution of programs' educational levels). Unused capacity differed significantly as a function of educational level ($F_{4,158} = 3.302$, $P = .012$) and the discipline x educational level interaction ($F_{8,158} = 4.299$, $P < .001$).

Programs offering a certificate only had significantly less unused capacity (mean number of additional students who could be accommodated = 5.8) than did the other four educational levels (7.4 additional students). This difference held within radiography and radiation therapy programs, but was quite small and in the opposite direction (6.0 additional students among certificate-only programs vs. an overall mean of 5.7 additional students) among nuclear medicine programs.

2c. If "yes," approximately how many qualified students did you turn away this fall?

Only one program	Mean	Std. Deviation	No.of Responses	Total no. of Programs in Population	Proportion of Programs at Full Enrollment	Estimated Excess Demand[a]	Ratio of Qualified Students Turned Away to Total Admitted
Radiography	59.2351	62.79193	353	723	.774	33,148	1.914
Radiation Therapy	21.5833	23.86315	36	118	.507	1,291	.997
Nuclear Medicine	30.1875	36.84508	48	131	.682	2,697	1.327
Total	52.9428	59.54424	437	972		37,136	1.798

[a](no. of programs in population) x (proportion at full enrollment) x (mean no. of qualified students turned away)

There were no radiation therapy programs with multiple educational levels reporting full enrollments, so the factorial ANOVA of number of qualified students turned away as a function of specialty (discipline) and educational level examined only programs with a single educational level. That ANOVA yielded statistically significant effects for type of program (finite-population-adjusted $F_{2,394} = 17.23$, $P < .001$), educational level ($F_{2,394} = 11.78$, $P < .001$) and their interaction ($F_{4,394} = 3.15$, $P = .014$).

The mean number of qualified students turned away was significantly higher for radiography programs (59.2) than for the other two specialties (26.5, $F_{1,434} = 21.88$, $P < .001$), and associate-level programs turned away significantly more qualified students (mean of 65.0 students) than did programs offering only a certificate or bachelor's degree (combined mean = 33.0, $F_{1,405} = 28.05$, $P < .001$). However, as suggested by the statistically significant interaction effect and as shown in the following table, neither of these main effects was consistent across levels of the other factor.

2. If "yes," approximately how many qualified students did you turn away this fall?

Only One Program	Education Levels	N	Mean	Std. Deviation	Grouped Median	Minimum	Maximum
Radiography	Certificate only	99	38.2980	47.96730	25.5556	.00	300.00
	Associate degree only	222	67.4662	57.60632	50.2000	.00	300.00
	Bachelor's degree only	12	56.0833	99.33914	16.0000	.00	350.00
	Total	333	58.3844	58.23039	40.8571	.00	350.00
Radiation Therapy	Certificate only	8	14.5000	9.08688	16.5000	3.00	25.00
	Associate degree only	11	21.9091	22.58519	17.7500	2.00	80.00
	Bachelor's degree only	14	28.7857	30.79755	16.6667	.00	100.00
	Total	33	23.0303	24.41117	16.8000	.00	100.00
Nuclear Medicine	Certificate only	16	11.8750	8.34965	10.0000	.00	30.00
	Associate degree only	10	65.6000	41.28815	45.0000	26.00	135.00
	Bachelor's degree only	11	12.9091	12.62897	9.5000	.00	40.00
	Total	37	26.7027	32.79724	15.6667	.00	135.00

Within programs offering only a certificate or bachelor's degree, the radiography programs turned away substantially more qualified applicants (on average) than did nuclear medicine technology and radiation therapy programs. However, among those offering only an associate degree, radiography and nuclear medicine technology programs turned away many more applicants (means of 67.5 and 65.6, respectively) than radiation therapy programs (21.9). And the pattern of the educational-level means was different for each discipline. Only nuclear medicine technology programs replicated the overall pattern of turning away many more applicants from associate than certificate or bachelor's programs. Among radiography programs both associate and bachelor's programs turned away substantially more qualified applicants than did certificate programs. Among radiation therapy programs the mean number of qualified applicants turned away increased monotonically (though only modestly) with educational level.

Radiography programs are, on average, larger than nuclear medicine and radiation therapy programs. However, the ratio between total number of qualified students turned away and total fall 2006 entering-class enrollments was substantially higher (1.9) for radiography programs than for radiation therapy (1.0) or nuclear medicine technology (1.3) programs.

3. Do you plan any changes related to enrollment?

			3. Do you plan any changes related to enrollment?			Total
			Plan to increase	Plan to decrease	Plan to remain the same	
Single Discipline	Radiography	Count	60	30	428	518
		Percent within program type	11.6%	5.8%	82.6%	100.0%
	Radiation Therapy	Count	11	9	57	77
		Percent within program type	14.3%	11.7%	74.0%	100.0%
	Nuclear Medicine	Count	16	7	68	91
		Percent within program type	17.6%	7.7%	74.7%	100.0%
Total		Count	87	46	553	686
		Percent within program type	12.7%	6.7%	80.6%	100.0%

About three-fourths of the program directors in each of the disciplines plan to hold enrollment levels at about their current level. Among those indicating plans to change, a considerably higher percentage (45%) of radiation therapy program directors than of radiography and nuclear medicine technology program directors (33%) plan to decrease enrollments (finite-population-adjusted $\chi^2_1 = 21.295$, $P < .001$). The interaction between educational level and program type with respect to net intention to increase enrollments (scored as -1 for "decrease;" 0 for "remain the same;" and +1 for "increase") was statistically significant, as was the main effect of educational level. Overall, programs offering a bachelor's degree (only or in addition to a certificate and/or an associate degree) had a higher mean intention to increase enrollments (+.156) than did the other three educational levels (+.036, $t_{660} = 4.300$, $P < .001$). However, as suggested by the statistically significant interaction effect, the pattern of differences across educational levels was not consistent across disciplines. In particular, the pattern described above held among radiography and radiation therapy programs, but nuclear medicine technology program directors' mean intention to increase enrollments was high among programs offering only associate and only bachelor's degrees (+.211 and +.227, respectively), near zero for those only offering a certificate and for and bachelor's-combination programs, and low (-.143) among certificate-associate combination programs.

4. How viable is your program over the next few years?

Discipline	Statistic	4. How viable is your program over the next few years?			Total
		Will definitely continue to operate	Possibly will be closing	Will be closing	
Radiography	Count	508	8	5	521
	Percent within Radiography	97.5%	1.5%	1.0%	100.0%
Radiation Therapy	Count	74	4	1	79
	Percent within Radiation Therapy	93.7%	5.1%	1.3%	100.0%
Nuclear Medicine	Count	89	1	0	90
	Percent within Nuclear Medicine	98.9%	1.1%	.0%	100.0%
Total	Count	671	13	6	690
	Percent within all three disciplines	97.2%	1.9%	.9%	100.0%

Approximately 97% of the program directors anticipate that their programs will continue to operate, with 1.9% indicating the possibility of closing. Only 0.9% of all programs (five in radiography, one in radiation therapy) indicated they will be closing. Radiation therapy program directors were significantly less likely (94%) to indicate that their programs would definitely continue to operate (finite-population-adjusted $\chi^2_1 = 13.269$, $P < .001$) and significantly more likely (5%) than the other two types of programs (1%) to indicate that their programs might be closing ($\chi^2_1 = 15.196$, $P < .001$).

Further, directors of programs offering certificates only were significantly less likely (94%) than directors of associate or bachelor's programs (99%) to be definite about continued operation and more likely both to report the possibility of closing (4% vs. 1%) and to report that they will be closing (2% vs. .2%); all three chi-squares were 20.5 or higher ($P < .001$) in each case

Educational level for programs w only one level		Statistic	4. How viable is your program over the next few years?			Total
			Will definitely continue to operate	Possibly will be closing	Will be closing	
	Certificate	Count	199	8	5	212
		%	93.9%	3.8%	2.4%	100.0%
	Associate Degree	Count	345	2	1	348
		%	99.1%	.6%	.3%	100.0%
	Bachelor's Degree	Count	63	1	0	64
		%	98.4%	1.6%	.0%	100.0%
Total		Count	607	11	6	624
		%	97.3%	1.8%	1.0%	100.0%

4y. If your program is closing, how many more years will it continue to operate, including this academic year?

Combined programs	Mean	N	Std. Deviation
Radiography	1.43	7	1.134
Radiation Therapy	1.33	3	1.528
Nuclear Medicine	1.00	1	.
Total	1.36	11	1.120

Among the 11 program directors who provided an estimate of the years of operation left for their programs, the estimate ranged from zero (the three programs having already discontinued operation) to three years.

EDUCATIONAL ISSUE: RESOURCES FOR TEACHING DIGITAL IMAGING

Types of Imaging Systems in Use at Associated Clinical Sites

9. Please indicate what percent of your clinical sites have converted from film-screen imaging to digital imaging systems.

		Percent clinical sites using film-screen imaging	Percent clinical sites using CR	Percent clinical sites using DR	Percent filmless[a]	Percent other (Please specify)
N	Valid	604	585	589	606	610
	Missing	114	133	129	112	108
Mean		24.3222	57.8744	31.7384	76.0587	.2639
Median[b]		18.5957	60.8333	19.1200	81.8298	.0543
Mode		.00	100.00	.00	100.00	.00
Std. Deviation		25.24281	33.74765	34.22221	25.19849	4.54471
Minimum		.00	.00	.00	.00	.00
Maximum		100.00	100.00	100.00	100.00	100.00
Percentiles[b]	5	.02	1.55	.01	24.81	.28
	95	75.38	99.85	98.89	99.99	9.9866
Percent zeroes		28.1%	14.5%	28.9%	2.1%	99.5%
Percent 100% responses		2.1%	16.9%	9.0%	28.8%	.2%
No. of semiquantitative responses ("a few", etc.)		5	19	20	3	1
No. of don't know, unsure		2	2	2	2	2

[a] Percent filmless = 100 minus percent film-screen. However, if percent film-screen was left blank but a percentage was entered for at least one of CR, DR, "Other," then percent filmless was calculated as either 100 minus the sum of percent CR, percent DR and percent other (i.e., as 100 - %CR - %DR - %Other) or 0.0%, whichever was larger.
[b] Calculated from grouped data.

Responses to request to "Please specify" other image acquisition system by program directors who cited a nonzero percentage of sites using "Other" image acquisition systems:

	Response	Frequency	Percent
	Blank	715	99.6%
	Bone densitometry/CT/MR	1	.1
	In radiation therapy 50% of our sites only have a CT sim, which is digital, while the other 50% of the sites have both CT/sim (digital) and film-screen conventional sim.	1	.1
	Single and multislice imaging	1	.1
	Total non-blank	3	100.0

Semi-quantitative responses with respect to percentage of sites employing various image acquisition systems:

Response	Frequency	Percent
About 60+% are now filmless. Physicians read from the computer. Data stored on PACS.	1	4.5
Digital fluoroscopy (DF)	1	4.5
Digital PAC stored data - Nuclear medicine	1	4.5
Digital PACS	1	4.5
I am not sure. I am going to say 1 out of 11 sites uses film; the rest use PACS	1	4.5
In nuclear medicine all four clinical sites have some form of digital imaging, which is digitally sent to the physician.	1	4.5
In nuclear medicine all of our images are acquired digitally and are now being stored and displayed via PACS.	1	4.5
Most still take beam films, but 1 center is totally computerized charting and portal imaging (don't know whether it is CR or DR).	1	4.5
Not sure of exact number but many are now using PACS; maybe 75%?	1	4.5
Not sure. We believe that none of our 12 affiliates are using film-screen. All have converted to digital imaging to the best of our knowledge.	1	4.5
Nuc med departments are essentially "filmless"	1	4.5
Nuclear medicine	1	4.5
Only a few of our therapy clinical sites are using digital imaging	1	4.5
Our nuclear medicine department is connected to PACS, therefore we are a completely digital department - no films.	1	4.5
PACS	2	9.1
Question is hard to understand. Out of 9 clinic sites for our program 6 have digital systems while only 3 still have film-screen remaining	1	4.5
Some clinical sites are in transition and offer a combination of film-screen imaging and CR	1	4.5
Some have both CR and DR	1	4.5
The majority of our sites have a combination of CR and DR.	1	4.5
Unsure; many have both (in transition)	1	4.5
We have been 100% PACS for 2-3 years.	1	4.5
Total	22	100.0

Other responses to "Other (Please specify)":

(Responses specifying a percentage of sites using a particular system were also converted to numerical values and included in the computation of descriptive statistics.)

Response	Frequency	Percent
Blank	555	89.8
2 of the 8 sites have both CR and DR systems	1	.2
71.4% (5 of 7) affiliates use a combination of CR and direct capture systems.	1	.2
88% of our affiliates have converted to a combination of both CR and DR.	1	.2
A combination of CR and DR	1	.2
A couple of our sites do continue to use film-screen imaging for the purpose of doing 72"SID scoliosis spine imaging per physicians request, otherwise everything else is CR and some DR.	1	.2
All clinical sites a combination of CR and DR	1	.2
All of our clinical sites have converted to digital systems. 10% have a combination of CR and DR.	1	.2
All of our sites have DR fluoroscopy devices and use CR for routine exams.	1	.2

	All of our sites use CR or DR as well as film-screen.	1	.2
	All of the DR sites also have CR in parts of their facility.	1	.2
	Anger scintillation camera systems are almost always tied in to computer digital imaging systems.	1	.2
	C-arm/surgical suite only	1	.2
	Combination of CR and DR	1	.2
	Digital currently being installed in mammography	1	.2
	Digital sites have a combination of both CR and DR technology.	1	.2
	Don't know	1	.2
	DR in the areas of fluoro and specials	1	.2
	DR is both DR and CR	1	.2
	Each clinical site has a combination of both CR and DR technology.	1	.2
	Information not available at this time for our radiation therapy program.	1	.2
	It will be 100% CR by the end of 2006. 50% of the clinical sites have both CR and DR.	1	.2
	Just FYI, the percents don't add up to 100. Some of our clinic sites have more than one of the above.	1	.2
	Mammography at the breast center use film-screen. There are 4 hospitals and 3 imaging centers. CR is used with the exception of 2 DR rooms. 1 at 2 different clinical sites. The number is constantly changing depending on construction and equipment changes.	1	.2
	Most nucs are digital	1	.2
	Numbers reported indicate how many clinical sites are using this type of system. Question not very clear.	1	.2
	One clinical site has one DR room; the rest of the clinical sites use CR/PACS	1	.2
	One of our clinical sites has CR and DR, so the total above is more than 100%	1	.2
	One of the above hospitals has CR and DR	1	.2
	One of the CR sites also has some DR equipment, that is why the percentages do not add up to 100%	1	.2
	Only 1 clinical site still has film-screen imaging	1	.2
	Only mammography is still film-screen at one clinical site otherwise everything is CR or DR	1	.2
	Our sites have a mixture of CR and DR. With CR being the most frequent system.	1	.2
	PACS	2	.3
	Percentage may not equal 100% because some sites have combination of CR and DR and other sites have combination of CR and film.	1	.2
	Program has access to 1 film-screen system in an office setting within the hospital.	1	.2
	Q6: 9 is a small class and numbers can vary significantly. I.e., 2/9 = 22%, 1/9 = 11%. Q7: Or continued education. A.S. ,R.T.(R) -> B.S., R.T.(R) or nuc med, Rx, DMS	1	.2
	Q7: New program. 1st yr all student had a job.	1	.2
	Radiation therapy technology: OBI (onboard imaging)	1	.2
	Several of the clinical education sites have converted to some combination of CR and digital ... only 1 is completely digital. The others have some CR and some digital. Students have done well in adapting to either and at the same time, recognize that we are in a state of transition.	1	.2
	Several sites have both CR and DR so the total is above 100%	1	.2
	Sites which started as CR several years ago, have added DR capability to a number of their rooms, this the	1	.2
	Six clinical sites: 1 uses film only, 1 uses film, CR and DR, 2 use CR only, 2 use CR and DR	1	.2
	Some clinical facilities have a combination CR/DR	1	.2
	Some clinical sites have both CR and DR; therefore the percentage exceeds 100%.	1	.2

	Some clinical sites have digital fluoroscopy with film-screen imaging for general/mobile. The majority of clinical affiliates have digital fluoroscopy and CR for the nonfluoroscopy areas of the radiology department.	1	.2
	Some hospitals have a combination of film-screen and CR.	1	.2
	Some of our sites have both CR and DR.	1	.2
	Some sites have a combo of DR/CR	1	.2
	Swiss Ray Equipment	1	.2
	The 8% film-based imaging represents (1) clinical site out of (12).	1	.2
	The percentages are more than 100% because some sites have multiple systems.	1	.2
	This figure represents 1 clinical site out of 8 that has not converted to CR/DR. It has the intention to convert to CR/DR in the near future.	1	.2
	This is portal imaging for radiation therapy	1	.2
	This question is difficult to answer with the choices provided. We have 2 clinical sites. One site has completely converted to PACS and has both CR and DR technology. The other site is in the process of converting to CR technology, but also uses film-screen imaging.	1	.2
	Three of our five clinical sites are in the process of converting to CR and DR combinations. Two of the five clinical sites already possess CR and DR rooms but are not completely filmless at this time. It is expected that they will be totally filmless within the year.	1	.2
	Two of three sites have a combination of CR/DR - 75%. All 3 have CR - 100%	1	.2
	We are changing soon.	1	.2
	We do not currently have any other clinical sites. The hospital currently has CR imaging. The radiography program is being forced to move to the local college of technology due to the master's degree requirement. This will take place in 2007. It will then become an associate Degree program. At that point the enrollment will increase from six to eight students per year and we will have two clinical sites, the hospital and a local clinic that has both CR and DR.	1	.2
	We have 6 clinical sites. 1 is still film-screen. The other five have both CR and DR	1	.2
	We have 7 sites - 2 are film and CR, 4 are CR and DR and 1 is completely DR	1	.2
	We have both film-screen and CR at the college energized lab	1	.2
	We have two clinical sites. One uses film-screen and the other uses both CR and digital modalities	1	.2
	Total	618	100.0

The percentage of clinical sites employing the various imaging acquisition systems was very different for the three disciplines.

Only one program	Statistic		Percent clinical sites using film-screen imaging	Percent clinical sites using CR	Percent clinical sites using DR	Percent filmless, incl. CR vs. DR breakdown not specified
Radiography	N	Valid	515	511	513	516
		Missing	14	18	16	13
	Mean		24.8351	63.7789	27.8195	75.4692
	Median[a]		19.4667	68.8857	15.3077	80.8444
	Mode		.00	100.00	.00	100.00
	Std. Deviation		25.02973	29.85110	31.81269	24.98985
Radiation Therapy	N	Valid	31	29	30	31
		Missing	48	50	49	48
	Mean		30.0000	9.3103	58.0000	71.2903
	Median[a]		25.0000	1.8182	60.0000	77.5000
	Mode		50.00	.00	50.00(b)	50.00
	Std. Deviation		26.77063	19.67250	32.55235	26.73848
Nuclear Medicine	N	Valid	41	28	29	42
		Missing	51	64	63	50
	Mean		10.8902	10.3571	74.8966	89.3690
	Median		3.2692	10.3846	95.3125	96.8519
	Mode		.00	.00	100.00	100.00
	Std. Deviation		20.02983	30.48766	37.60162	19.85529

[a] Calculated from grouped data.

This question is most relevant to radiography programs, in which 25% of the associated clinical sites still employ film-screen systems while 75% are completely filmless, with a predominance of CR systems over DR systems. As expected, a substantial majority of radiation therapy and nuclear medicine technology program directors either left this question blank or explicitly said that it was inapplicable to their programs. However, a sufficient number considered the question relevant to show that 71% of radiation therapy programs' associate clinical sites are filmless, with a predominance of DR over CR systems. About 30% still employ film-screen systems. Finally, only about 11% of nuclear medicine programs' associated clinical sites still employ film-screen systems, while 89% are filmless and more than seven times as many nuclear medicine technology clinical sites employ DR systems as CR systems. (The differences among these three disciplines with respect to each of the four percentages are all statistically significant at the .001 level after application of the finite-population adjustment.)

There also was a statistically significant interaction between educational level and program discipline with respect to the percentage of associated clinical sites that employ DR. At all three educational levels radiography program clinical sites employed DR substantially less than did nuclear medicine technology and radiation therapy program sites. However, among certificate programs a higher percentage of radiation therapy program sites (71.5%, on average) employed DR than CR (57%); among associate programs DR usage was about the same for nuclear medicine technology and radiation therapy program sites (57% vs. 59%); while among bachelor's programs only 40% of radiation therapy clinical sites but 91% of nuclear medicine technology clinical sites employed DR systems ($F_{4,517}$ for this interaction effect = 7.94, $P < .001$).

Adequacy of Resource Materials for Instruction in Digital Imaging

10. Do you believe you have adequate resource materials on the topic of digital imaging to adequately prepare instruction?

		Frequency	Percent	Valid Percent
Valid	No	411	57.2	63.3
	Yes	238	33.1	36.7
	Total	649	90.4	100.0
Missing	NA	46	6.4	
	System	23	3.2	
Total		718	100.0	

Only about one third of the program directors who answered this question felt that the resources available were adequate to prepare instruction on digital imaging. This percentage was much lower (32%) among radiography programs than among radiation therapy (57%) and nuclear medicine technology (60%) programs ($\chi^2_1 = 87.649$, $P < .001$). It also was lower (26%) among programs offering only associate degrees than among certificate (43.5%) and bachelor's (46%) programs ($\chi^2_1 = 62.617$, $P < .001$).

10. If not, what resource materials do you find are lacking in this area?

		Frequency	Percent of Responses	Percent of Respondents
Valid	Textbooks	207	41.9	54.2
	On-campus laboratory equipment	163	33.0	42.7
	Access to clinical resources for simulation and training	63	12.8	16.3
	Other	61	12.3	16.5
	Total responses	494	100.0	129.7
	Number who listed one or more needs	381	---	100.0
Missing	System	337	---	47.3
Total Cases		718	---	100.0

Other resource materials lacking (specified):

	Response	Frequency	Percent
	Blank	658	91.6
	A/V material (CDs, PowerPoint, etc)	1	.1
	A/V material, or CBT course, as well as textbooks	1	.1
	All of the above are lacking as far as I am concerned. Additionally professional organizations have not been proactive in providing educators with continuing education regarding digital. More CE programs need to be made available that don't just talk about an individual hospital's experience or education theories. The nuts and bolts of digital imaging need to be presented for educators to obtain a more solid foundation on the subject.	1	.1
	All of the above!! Each vendor is so specific in its own operation and there are so many changing versions it makes it difficult to understand for faculty and students.	1	.1
	All of the areas above (unable to check them all). Also helpful would be videos, CD/DVD, and workbooks.	1	.1
	Also have conventional sim on campuses. we use CT sim and have CT planning sim	1	.1
	Other: PowerPoint presentations, DVDs, etc.	1	.1

	Also, lack of quality monitors in clinical ed. settings.	1	.1
	And A/V materials	1	.1
	As an instructor in computed tomography, I am very disappointed at the lack of teaching materials focused specifically on CT. The majority of the teaching materials are geared toward CT/MR which makes absolutely no sense to me whatsoever. The commonalities in the two modalities are so limited; sectional imaging, the words 'scan' and scanner, the patient is recumbent, on the imaging table or couch while being scanned horizontal, and most recently, both utilize a power injector. Yet it is as if the modalities have morphed into a 'super imaging system' known as CT/MR. CT and MR are and should be thought of independent of one another, especially since MR does not utilize radiation. The physics, procedures, and patient prep for each are in mo way related beyond the obvious. I simply do not understand the thought process that insists on meshing the two modalities.	1	.1
	Availability of resources is improving. At the moment it is necessary to compile from various sources. Textbook references are limited at this point. I am currently looking for a text that approaches digital radiography more comprehensively.	1	.1
	Clinical site labs	1	.1
	Computer software	1	.1
	Continuing education.	1	.1
	Equipment manufacturers do not provide the level of information needed to be able to teach the basics to students or technologists.	1	.1
	Feedback from the ARRT regarding the degree to which film-screen imaging questions will be phased-out would be most helpful. Also, some idea regarding the depth of questions in the ARRT exam directed to SR and DR would also be helpful.	1	.1
	Having this equipment sure would be nice, but without energized lab, wouldn't do much good.	1	.1
	Higher level information about how it works - not the basic stuff.	1	.1
	I am not sure. The Carlton book is good.	1	.1
	I developed curriculum to teach digital radiography. Had I not done the research, I would not feel there were adequate resources or materials. Our college was the first community college in the country to purchase digital equipment for our labs.	1	.1
	I have all the information I need, it would be nice if it were all in one generic source.	1	.1
	I think that we have adequate resources, but to teach more than adequately, we would love to see more information in textbooks or for computer simulation. If anyone has information on computer simulation, I would love to see it. My coordinator and I went to a digital imaging course this year and that helped a lot.	1	.1
	In-line items	1	.1
	Information is either too advanced or too basic, there is little in between these extremes. Something online would be great!!! We could have it posted on the ASRT or AERS Web sites.	1	.1
	Instruction for educators - no current funds to participate in additional training.	1	.1
	Instructor assigned to class isn't seriously taking up challenge of updating material.	1	.1
	It would be most helpful if I knew (1) how long will the registry continue to include questions regarding film imaging and (2) the depth of knowledge required to answer questions regarding CR and DR - a simple listing of terms would be helpful in this regard, and we could arrange theory instruction accordingly.	1	.1
	Lab manual materials; there are some, but I have drafted my own at this point because none of the currently published workbooks adequately cover image critique issues, and the special problems that CR/DR can create	1	.1
	Lack of industry standards make it very difficult to teach CR/DR. There is no consistency of terminology, exposure factors or concern with radiation protection. All information available is brand specific. Textbook information is not applicable or outdated.	1	.1

	Lacking direction in depth expected to be taught and resources we can use. It is expensive to purchase a resource only to discover it does not suffice as a resource. Lacking sources of appropriate level of understanding(many are too in-depth, while others are too simplistic). Lacking instructors with computer background to teach the information on the draft curriculum (may not be an issue if revised considerably)	1	.1
	Material on QC of digital equipment.	1	.1
	My situation is the reverse. All of our equipment is CR and DR so my students have no experience with film-screen. We rely on the textbooks for info.	1	.1
	Nuclear medicine technology program	1	.1
	OH that are from vendors that are up-to-date with technology	1	.1
	On campus, my lab includes 2 fully operational radiographic suites, a CR system (Orex) and a functional darkroom. During the next fiscal year, we anticipate converting the upright chest unit in one of the rooms to a DR device.	1	.1
	Our department has CR and we are getting DR in a few months. The staff and students learn how to operate the equipment but not necessarily getting an education on the specifics. Textbooks are an issue too.	1	.1
	Our program was able to purchase a used CR unit for the on-campus laboratory using federal grant monies.	1	.1
	Programs are in need of an approved curriculum for the teaching of computerized/digital imaging and for intensity modulated radiation therapy (IMRT). Also, it is very difficult to teach without the access to the equipment. Schools are financially unable to keep up with the dynamics of new equipment	1	.1
	QC testing for digital imaging equipment and how to troubleshoot technical errors.	1	.1
	Qualified instructors who really have an understanding of the CR and DR world of radiography. And can bring it down to the level for student understanding and retention.	1	.1
	Regarding question two: We could enroll more students however the job market does not warrant additional enrollments at this time.	1	.1
	School closing September 2006	1	.1
	Simple explanation of digital imaging	1	.1
	Simple materials on subject	1	.1
	Software	1	.1
	Text banks and PowerPoint presentations to assist with preparation for didactic classes	1	.1
	The biggest issue, in my opinion, is the lack of training of the clinical staff. Some of the vendors simply tell the staff to "make sure the exposure number is above 2." We are finding that more and more of the applications specialists have no background in radiography or a related field.	1	.1
	Information on the Web.	1	.1
	The digital equipment manufacturers use to provide much of the industry literature from which instruction and labs and practical could be based. Doesn't seem this is happening as we transition from film to digital. Therefore, acquiring materials that are relevant to training and credentialing is difficult.	1	.1
	There is a lot written in a variety of textbooks. I have been to lectures. I would like to know how in depth our students need to know "digital imaging." I would like some definite parameters on how much is enough.	1	.1
	Videos, CDs with animation	1	.1
	We are getting a CR unit on campus with a mini PACS this semester.	1	.1
	We are lacking in all of the resources: textbooks, on-campus lab equipment and access to clinical resources for simulation and training. In the choice of textbooks, there is a lack of knowledge to properly explain AEC, CR and DR in the 'traditional terms' of optical density, subject contrast, collimation, photocell choice, mA selection, kVp selection, and adjusting density selection, photocells, mA and kVp to compensate for patient pathology. In a similar manner, there is a lack of knowledgeable clinical R.T.s who can properly explain AEC, CR and DR in these same ‘traditional terms.’ The manufacturer’s preprogrammed AEC exposure factors don’t produce the best images.	1	.1

	We have a CR unit on campus as well as a PACS system on campus.	1	.1
	We have plans to add CR to our on-site laboratory within the next year.	1	.1
	We need a basic or intro discussion and then in the sophomore year a more advanced discussion. I think we need direction with what is needed for entry-level basic, what is needed for entry-level advanced and at what level the registry will test. Some of the texts are great, but how much can we teach and how much time can we spend on this and on film-screen, too.	1	.1
	We need software programs that help students to visualize the theories of digital imaging. We have equipment in lab, resources in the clinicals and the textbooks, however the expertise of individuals really knowing how it works isn't out there. Also, technologists in the clinics are "Just getting by" with it. This speaks highly in terms of the quality of care being received by our patients at the present time.	1	.1
	We will be acquiring a CR and PACS system this month. We feel that our students will be much better prepared for their clinical assignments by virtue of this acquisition. Also, we can better control the radiation protection elements necessary to learn by having students learn on our CR system.	1	.1
	Wider variety of resources for students and instructors, i.e., computer programs, PowerPoint, etc.	1	.1
	Would appreciate any electronic media for classroom presentation, good examples of what images look like when technical problems occur.	1	.1
	Total	718	100.0

IS THE GAP CLOSING?

To be more specific, if 2006 first-year enrollment figures are maintained, will the profession meet the need for additional R.T.s between 2004 and 2014 projected by the BLS? In answering this question, we assume that each of the following factors will remain constant for the three radiologic technology disciplines between now and the end of 2014:

- Total first-year enrollment rates in each discipline.
- Attrition rates, i.e., the percentage of first-year students who ultimately fail to graduate from these programs.
- Pass rates, i.e., the percentage of graduates who pass an ARRT primary certification exam in on the first attempt.
- Discipline retention profile, i.e., the ratio of number of R.T.s whose primary sphere of employment is within the discipline to the number of R.T.s who passed the certification exam one, two, …, 10 years ago.
- For nuclear medicine, the percentage of program graduates who choose to take the ARRT (N) examination, the NMTCB examination, or both.

In addition, these estimates are based on currently available data and are assumed accurate. These assumptions can be referred to collectively as "steady-state" assumptions. The radiography example below details how the various statistics were estimated and then combined to predict the 2014 supply of radiographers. Briefer summaries of the calculations for the other two disciplines follow. Where multiple estimates of the same statistic are available (e.g., enrollment figures for 2002 as reported directly in the 2002 Snapshot and retrospectively in the 2003 and 2004 reports), the simple average of the estimates is employed.

Radiography

BLS projects that 76,000 additional radiographers will be needed between 2004 and 2014. Given the estimate of 17,323 students entering radiography programs in 2006, together with program directors' estimated attrition rate of 19.1% and an 89.4% pass rate for the certification exam, this discipline would appear to be adding new radiographers to the profession at a rate of 12,529 per year.

However, not all new radiographers still will be practicing radiography in 2014. How many of a given year's new radiographer cohort remain in the profession for one, two or even 10 years? The ARRT database provided information to determine the number of registered R.T.s who in late August 2006 listed radiography as their primary area of employment and who had been working in radiography for less than one year, one to three years, etc. Data were compared with the number of R.T.s who passed the radiography certification exam for the first time (a close equivalent to the number of R.T.s who graduated from a radiography program) each year from 1996 to 2005.[1] This information provides the following estimate of the overall retention profile for radiographers:

[1] American Registry of Radiologic Technologists. 2001, 2002, 2003, 2004, 2005 annual reports of examinations. Available at www.arrt.org/website/newsite/Psychometrics/AnnualReportofExams.pdf. Accessed November 2006.

Year	No. of First-Time Certificants	No. in Radiography for X Years as of 8/2006	No. Reporting __Years in Radiography as of 8/2006	Percent Retained
2006(est)	11,531	.333(11800) + .667(11,531) = 11,621	< 1 year: 7286	63%
2005	11,800	.667(11800) = 7867		
2004	10,532	10,532	1-3 years: 17,792	17,792/26,929
2003	8530	8530		= 66%
2002	7221	7221	4-5 years: 8493	8493/13,785
2001	6564	6564		= 62%
1996-2000	8579, 7848, 7356, 6684, 6341	36,808	6-10 years: 15,806	= 43%

Similar retention profiles were computed based on demographic data supplied by ARRT in late September 2004 and 2005, August 2003 and March 2002. Despite being based on somewhat different cohorts of radiographers (e.g., about one-third of the radiographers who fell into the 1-3 years category in March 2002 fell into the 4-5 years category in August 2003), the retention percentages generally were comparable to those given above. Therefore, the five retention profiles were averaged to increase the reliability of the estimates as follows:

No. of Years in Radiography	Percent Still in Field
< 1 year	62%
1-3 years	73%
4-5 years	60%
6-10 years	39%

Assuming that this profile holds true for the radiography cohort of 2006 and subsequent cohorts, it can be expected that, on average, 39% of radiographers who were first-time certificants between 2004 and 2008 will still be practicing radiography as their primary specialty in 2014; 60% of the classes of 2009 and 2010 will still be practicing radiography in 2014; about 73% of the classes of 2011, 2012, 2013. Further, 62% of the class of 2014 will be practicing at the end of 2014. ARRT's 2002 Report of Exams reports that the class of 2004 consisted of 10,532 new certificants and the class of 2005, 11,800. The class of 2006 is estimated to include 11,531 new certificants (15,944 students who entered radiography programs in 2004, decreased by a 19% attrition rate and a 10.6% examination failure rate), while 2007 will see 12,290 newly certified radiographers. The class of 2008 (and, under steady-state assumptions, each subsequent class) should consist of approximately 12,529 new radiographers. Combining these figures with the above retention profile leads to an estimate that 58,683 (the number of new radiographers certified in 2002 – 2006) x .39 + 25,058 x .60 + 37,587 x .73 + 12,529 x .62 = 72,825 additional radiographers by the end of 2014. However, this year's estimate shows that an average of 1.8% of new ARRT (R) certificants take jobs outside the U.S., so between 2004 and 2014 a total of about 71,486 radiographers – or about 5.9% short of the BLS-estimated need – will have been added to (and remain in) the U.S. labor pool of radiographers. Note that 12% of radiography program directors plan to increase their enrollments; 6% plan to decrease them.

Radiation Therapy

BLS projects that 7,000 radiation therapists will be needed between now and 2010. The ARRT 2005 Report of Exams states that the classes of 2004 and 2005 consisted of 813 and 841 new certificants, and it is estimated that the class of 2006 will number 955 new certificants (1,352 students who entered radiation therapy programs in 2004, decreased by a 17% attrition rate and a 14.5% examination failure rate), while 2007 will see 961 newly certified radiation therapists. Further, the class of 2008 (and, under steady-state assumptions, each subsequent class) should consist of approximately 915 new therapists. Combining these figures with the retention profile estimated for radiation therapists leads to an estimate of 4,484 (the number of new radiation therapists certified in 2004 – 2008) x .86 + 1830 x 1.20 + 27245 x 1.04* + 915 x .77 = 9,360 additional radiation therapists by the end of 2014. However, an average of

6.7% of new ARRT (T) certificants take jobs outside the U.S. This means that between 2004 and 2014 and estimated 8,729 radiation therapists will have been added to (and remain in) the U.S. labor pool of radiation therapists, thereby exceeding the BLS-projected need in this specialty by about 25%. Note that 14% of radiation therapy program directors plan to increase their enrollments – slightly more than the 12% who plan decreases.

*Note that the number of ARRT certificants whose primary sphere of employment in late August 2006 is radiation therapy and who have been practicing in this specialty for 4 - 5 years is 20% greater than the number of radiation therapists who passed the radiation therapy certification exam in 2001 or 2002 (i.e., 4 - 5 years ago), so a multiplier of 1.20 was used in computing the number of 2009 and 2010 new (T) certificants who will be practicing at the end of 2014. This excess is probably due to repeat examinees and to migration into radiation therapy from other specialties (e.g., radiography).

Nuclear Medicine Technology

BLS projects a need for 7,000 nuclear medicine technologists to meet increased demand and attrition between 2004 and 2014. The ARRT 2004 Report of Exams reports that the class of 2004 consisted of 448 new ARRT certificants. However, there were also 1,062 individuals who passed their initial NMTCB certification exam in 2004 (personal communication from NMTCB, 3/04/06). Since many prospective nuclear medicine technologists take both certification exams, the total 2004 new-certificant class is somewhere between 1,062 and 448 + 1,062 in number. Similarly, 2005 saw the addition of 531 ARRT-registered and 1,244 NMTCB-registered nuclear medicine technologists. Rather than hazarding a guess at the degree of overlap between ARRT and NMTCB registrants in 2004 and 2005, the total new certificants projected for those years based on Enrollment Snapshot entering-class enrollment totals for 2002 and 2003 can be used, decreased by estimated attrition and exam-failure rates. This leads to estimates of 1,121 and 1,214 new certificants in 2004 and 2005, respectively – comfortably within the known upper and lower bounds on those figures.

The best estimate of the total number of students entering nuclear medicine technology educational programs in 2004 is 1,650 (averaging the estimates obtained from the 2004, 2005, and 2006 Enrollment Snapshots). Nuclear medicine technology program directors estimate an attrition rate of about 10%, and the pass rate for the 2006 exam will probably be close to the 2005 rate of 92%, so the new-certificant class of 2006 should consist of about 1,365 new nuclear medicine technologists. Similar calculations lead to an estimate of a 2007 class of 1,422 and a 2008 class numbering 1,457 newly certified nuclear medicine technologists. Under steady-state assumptions the same number of 1,457 individuals should pass their nuclear medicine technology certification exam(s) for the first time in each year from 2009 through 2014. From ARRT information concerning certificants and years in specialty for nuclear medicine technologists, we estimate that the number of ARRT certificants primarily employed in nuclear medicine technology for less than one year is about 36% of the number of first-time certificants in this cohort. The number after 1-3 years is about 58% of the first-time certificants for those years, and the number of ARRT-registered R.T.s who have practiced nuclear medicine for four to five years is about 71% of the number who took the primary exam and passed it for the first time four or five years earlier. The number of ARRT registrants who have been in the specialty for six to 10 years would be, on average, 67% of first-time certificants in the corresponding five-year time slot. Thus, under steady-state assumptions about 9,618 additional ARRT-registered nuclear medicine technologists would be practicing in the profession by the end of 2014.

Since 96.7% of graduates of nuclear medicine technology programs take jobs in the U.S., this suggests that about 9,305 ARRT-registered nuclear medicine technologists will have been added to and retained in the U.S. labor pool between 2004 and 2014. However, the nuclear medicine technology program directors who responded to this year's Snapshot (the first to ask the question) indicate that over the past two years only about 45% of their graduates have taken the ARRT exams, which implies that the total number of new certificants in nuclear medicine technology over those two years is about 2.2 times the number of new ARRT nuclear medicine technology certificants. If this ratio remains approximately constant between now and 2014 the profession will have added and retained about 20,471 additional

nuclear medicine technologists between 2004 and the end of 2014 – close to triple the BLS-estimated need for additional nuclear medicine technologists.

Uncertainties in Projections

These projections are subject to a high degree of uncertainty. First, there is statistical uncertainty. The 95% confidence intervals (CIs) around the estimated total entering-class enrollment for 2006 in these three disciplines are ± 584 students for radiography, ± 144 for radiation therapy and ± 210 students for nuclear medicine technology. (The CIs around enrollment figures for 2003 - 2005 are narrower, since they are averages of estimates from more than one annual Snapshot.) There is also statistical uncertainty in the estimate of the attrition rate for each type of program.

Producing even more uncertainty are the possible systematic changes in enrollment rates and attrition rates (e.g., 12% of radiography program directors plan to increase their enrollments in the near future, potential variations in number of applicants due to changes in reimbursement rates for radiologic procedures, etc.). Moreover, the retention profiles (i.e., ratios between number currently practicing in a discipline and those who passed their initial certification exam in that discipline a certain number of years earlier) calculated each year are based on calculating backward from a single point in time (i.e., late August 2006) and might not be representative of what will happen to the 2004 to 2014 new-certificant cohorts.

Overall, however, the best current estimate is that radiation therapy is producing new practitioners at about 25% above the rate needed to meet the 2014 demand estimated by BLS, while nuclear medicine will nearly triple the estimated need and radiography is likely to come up somewhat short (by about 6%) of the projected demand unless enrollments and/or retention rates are increased.

APPENDIX A:

QUESTIONNAIRE AND COVER LETTER

ASRT Logo

September, 2006

Dear Program Director:

As director of an educational program in radiography, radiation therapy, or nuclear medicine technology you are both affected by and have a major influence on the supply of radiologic technologists in those professions. For you and your fellow program directors to make informed decisions about enrollment levels in your programs and for the profession to anticipate the effects of those decisions on the number of professionals who will be needed in coming years, it is necessary to have the most accurate possible estimates of educational program enrollments.

In each of the past five years at least 65 percent of program directors in radiography, NMT, and radiation therapy participated in ASRT's enrollment surveys. This enabled us to provide the first hard evidence that the downturn in new enrollment had been reversed. It also has helped us to estimate whether current rates of enrollment, attrition and retention within the work force will enable each discipline to meet the need for additional technologists and therapists the Bureau of Labor Statistics projects by 2012 and 2014. We now need to determine whether the upswing in enrollments has continued or has leveled off, as they appeared to do the past two years. We also need to update our estimates of how each specialty is doing in meeting the need for its technologists.

I would appreciate your participating in the 2006 enrollment survey at your earliest convenience, so that ASRT can put together a quick, accurate snapshot of enrollment trends. You can do this by completing and returning the enclosed, two-page questionnaire or by surfing your way to http://www.asrt.org/content/surveys/enr_snapshot_2006.html to complete the questionnaire online. Please use the online route if possible; this gets your feedback to us more quickly and minimizes administrative data entry errors. We will summarize the data from programs in each discipline and the results will be made broadly available. Individual programs will not be identified.

We would, of course, be interested in additional comments you might wish to share about these issues or the factors driving recent trends in your program's enrollment figures. However, we would prefer that you respond with the figures requested by the questionnaire as soon as possible and then send additional comments separately to John Culbertson by mail or e-mail at jculbertson@asrt.org.

Thank you very much for your help in gathering this vital information.

Sincerely,

Sal's signature

Sal Martino, Ed.D.
Executive Vice President and Chief Academic Officer

asrt
American Society of Radiologic Technologists
15000 Central Ave. SE, Albuquerque, NM 87123-3917 • 505-298-4500 • 800-444-2778 • Fax 505-298-5063 • www.asrt.org

Radiography, Radiation Therapy and Nuclear Medicine Enrollment Survey Fall 2006

If possible, please respond via an electronic version of the questionnaire at
www.asrt.org/content/surveys/snapshot2006

Indicate your type of program.
- O Radiography
- O Radiation therapy
- O Nuclear medicine technology
- O Other (Please specify)_____

What is the educational level of your program?
- O Certificate
  - If yours is a certificate program, do you have an articulation agreement with a community college?
    O Yes O No
- O Associate degree
- O Bachelor's degree
- O Other (Please specify) _____

In what country is your program located?
- O USA O Australia O Canada
- O Other (Please specify)_____

Please help us document overall trends in enrollment during the past three years.

Note: If yours is a multiple-discipline program, or includes multiple educational levels, please submit responses to questions 1 through 7 separately for each of the types and educational levels represented within your program. You may make copies of this form for this purpose. For a small number of subprograms, add lines to a single copy of the questionnaire.

1. How many students entered your program each of the following years? (A student is considered to have entered a program once he or she is admitted to that program. This may be after a year or more of general course work.)

   2004 ☐☐☐ 2005 ☐☐☐ 2006 ☐☐☐

2. Is your program currently at full enrollment?

   O Yes O No

   If "no," approximately how many additional students could be accommodated by your program? ☐☐☐

   If "yes," approximately how many qualified students did you turn away this fall? ☐☐☐

3. Do you plan any changes related to enrollment?

   O Plan to increase
   O Plan to decrease
   O Plan to remain the same

[A few more questions are on the back of this page.]

4. How viable is your program over the next few years?

   O Will definitely continue to operate
   O Possibly will be closing
   O Will be closing

If your program is closing, how many more years will it continue to operate, including this academic year? ☐☐

5. What was the average attrition rate for your program over the past few years (percentage of entering students who did not complete the program)?
Attrition rate ☐☐%

6. Has this attrition rate varied substantially over the past few years?
O Yes O No
If "yes," how has the attrition rate varied?
O Increased O Decreased O Increased some years, decreased others

7. Over the past five years, what percent of your program's graduates have taken jobs in the United States, including U.S. territories and Puerto Rico?
☐☐☐% **or** O Don't know

8. If yours is a nuclear medicine program, approximately what percent of your program's graduates over the past two years have taken the ARRT certification exam in nuclear medicine technology versus the NMTCB certification exam?

ARRT exam only ☐☐☐% NMTCB exam only ☐☐☐% Both ☐☐☐% Neither ☐☐☐%

Next, please provide any feedback on the following two issues related to education in the radiologic sciences. These issues are likely to be of primary relevance to radiography programs and to some radiation therapy programs, so please don't feel guilty about checking the "NA" alternative.

9. Please indicate what percent of your clinical sites have converted from screen-film imaging to digital-imaging systems.
Screen-film imaging ____% CR ___% DR ___% of this program's clinical sites
Other imaging system (Please specify)_____%
O Not applicable; my program's clinical sites don't provide training on imaging systems.

10. Do you believe you have adequate resource materials on the topic of digital imaging to adequately prepare instruction?
O Yes O No
If not, what resource materials do you find are lacking in this area?
O Textbooks
O On-campus laboratory equipment
O Access to clinical resources for simulation and training
O Other (Please specify)_____
O Not applicable; instruction on imaging, digital or otherwise, is not a part of my program's curriculum.

Thank you very much for your help. Please return the survey in the enclosed business-reply envelope to:
Richard Harris, Director of Research
ASRT
Research Department
P.O. Box 51060
Albuquerque, NM 87181-9980

APPENDIX B

COMMENTS WRITTEN ON QUESTIONNAIRES OR SENT VIA E-MAIL

Via E-mail

“The job market for entry-level radiographers in Illinois is dismal. There is widespread overproduction of graduates. We limit our enrollment to keep the local market from being saturated. If we graduated as few as five to seven more, we would have unemployed graduates.”

“I just wanted to say that I have cut my enrollment by 50% of my capacity because there are very few jobs in radiation therapy available. There are some pockets in the country where the demand is high but they are few and far between. I know many of my fellow therapy program directors have also slashed their enrollment this year because of the job situation.

I am bringing this development to your attention because I was alarmed at the meeting in Denver last June when three different radiography programs came to me wanting advice on starting their new radiation therapy programs. These radiography programs were under the mistaken impression that there is currently a severe shortage of radiation therapists. I informed them to check the need for therapists in their areas (unfortunately, I already knew there was no need in the locations of those specific programs for therapists). All three were very surprised when I told them finding jobs for my students was proving to be extremely difficult and this year one of my competing programs didn’t even graduate a class!!!”

Written on Questionnaire

	Response	Frequency	Percent
	Blank	709	98.7
	University Program, but can only give B.S. degree as the lowest degree - thus our "certificate of completion."	1	.1
	Articulation agreement is with [Name] college.	1	.1
	In progress to have an articulation agreement with a community college.	1	.1
	Q2 (At full enrollment, 5 qualified students turned away); Big question. 75 (unqualified students) did not get into one of the 4 imaging programs, but most of them did not have the min 3.0 GPA.	1	.1
	Q2 (At full enrollment & students turned away): [We are] 10 students below what JRCERT says we can have. 130 qualified students were turned away. Q3 (Plan to stay same): [We are going to] remain the same for now or perhaps decrease if graduates can't find jobs in future. We evaluate the need in area every year before admissions.	1	.1
	Q3 (Plan to increase enrollment): Plan to increase enrollment every other year.	1	.1
	Q5 (2% attrition): 1 student in 4 years failed CAMRT exam. No one left the program before completion.	1	.1
	Q5 (27% attrition): We accepted a few students who were questionable.	1	.1
	Q9 (5% film, 95% CR, 0% DR): Not sure	1	.1
	Total	718	100.0