

Education Council Symposium: Defining and Measuring Quality in Medical Physics Education – July 14, 2019

Assessment of Quality of Medical Physics Graduate Programs

Edward F. Jackson, PhD Professor and Chair, Department of Medical Physics Professor of Radiology and Human Oncology Director, Medical Physics Graduate Program





Declaration of Financial Interests or Relationships

Speaker Name: Edward F. Jackson, PhD

I have no financial interests or relationships to disclose with regard to the subject matter of this presentation.

Disclaimer:

I currently serve as the Vice Chair of the AAPM Education Council. The views and opinions reflected in this presentation do not necessarily reflect those of the Education Council.



Learning Objectives:

- 1. To present several definitions of the phrase "quality of education"
- 2. To identify and evaluate methods for assessing quality of education.
- 3. To apply these methods to assess the quality of a didactic educational medical physics program.
- 4. To apply these methods to assess the quality of a clinical medical physics training program.

How to Define & Measure "Quality"

- The definition of *quality* in graduate education is:
 - Ill-defined; no generally accepted standards
 - Program- and/or institutional-specific
 - Multi-dimensional
 - Dynamic (or should be)
- Quality assessment methodologies:
 - Program-specific longitudinal (e.g., assessment evaluations, CQI initiatives)
 - Cross-program comparisons (*e.g.*, accreditation reviews, peer comparisons)



• Requires that a program defines quality and the measures it will consistently use to track it.

• First step: Defining the program's learning objectives

- What, where, and when?
 - Knowledge and skills a student is expected to have mastered by completion of program.
 - Identifying where the expected learning takes place in the curriculum / training and by when.
- Second step: Defining the assessment plan
 - Evidence
 - How well are students, collectively, meeting the learning objectives?
- Third step: Assessing results and improving the program
 - Faculty engagement



Program-Specific CQI Approach

- Quality assessment should rely on data, but which data?
- Common metrics for graduate programs:
 - student evaluations of courses
 - rubric scores and pass rates on qualifier, prelim, and defense examinations
 - percent of students who meet program milestones for all exams, etc.
 - number of publications (first author vs. contributing author)
 - time to degree and completion rates
 - rate of desired post-graduate employment or residency program acceptance
 - licensure or certification exam pass rates (*e.g.*, ABR Part 1 for individuals pursuing residency program)





Program-S	pecific CQ	I Approach
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Clear research of	opectives / specific aims				*	0.71
Clear expected o	utcome(s) and alternative strategies for e	ach specific aim			3.4	0.55
Proposal extends	previously reported work				3.4	0.55
Experimental or	model design, statistical analysis and valid	ation			2.8	0.45
Quality of writter	n proposal (grammar, spelling, clarity)				3.8	0.45
Presentation a	nd Examination					
Organization of p	resented materials				4	0
Clear and concise	e description of background and objectives	s / specific aims			3.6	0.55
Appropriate use	of communication aids and overall quality	of the presentation			3.4	0.55
Demonstrated un	iderstanding of relevant peer-reviewed lite	arature			3.4	0.55
Demonstrated un	nderstanding of subject matter and concept	ts			2.8	0.84
Demonstrated ap	opropriate critical thinking / reasoning skill	s			3.2	0.45
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What was the result of the student's qualifying exam? Unconditional Pass Conditional Pass Partial Re-examination Re-exc Please enter a description of the result of the qualifying exam, including sugges improvement (this textbox will be preloaded with individual comments from the screece less that here usere alworn	amination stions for e committee, if any	Unconditional Pass Cond Please enter a description of th Improvement (this textbox will scores less than three were give	itional Pass he result of the l be preloaded ven):	Re-examination e preliminary exa l with individual	n am, including comments fr	suggestions fo om the committ	r xe, if any	Please enter a description of the result of the defense, includin textbox will be preloaded with individual comments from the co were given):	g suggestions ammittee, if a	for improvement ny scores less ti	nt (this han two
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(Mass: 10 (94%) Conditional Pass: 1 (6%) Re-examination: 0 (0%)						
min three years: / (41%) Average time to complete: 3.22 years						ia Pub

- Necessary, but is this sufficient?
- "Not everything that can be counted counts, and not everything that counts can be counted." --- William Bruce Cameron
- How do we objectively assess "softer", but highly important quality measures?
 - Frequency and outcomes of in-depth program reviews
 - Implementation and assessment of substantive curricular and pedagogical changes to remain current
 - Inter-disciplinary vs. disciplinary curricular and experiential offerings
 - Frequency of active vs. passive student learning opportunities
 - Quality of mentoring
 - Diversity, equity, and inclusion





Graduate STEM Education for the 21st Century (2018)

DETAILS

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CONTRIBUTORS

Alan Leshner and Layne Scherer, Editors; Committee on Revitalizing Graduate STEM Education for the 21st Century; Board on Higher Education and Workforce; Policy and Global Affairs; National Academies of Sciences, Engineering, and Medicine

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Program-Specific CQI Approach

"A Call for Systemic Change"

- Recommendations for federal and state government agencies, institutions of higher learning, and graduate schools / departments / programs.
- <u>Agencies</u> should, among other things:
 - Require institutions to develop policies that require <u>data collection and public</u> <u>posting</u> on demographics, funding mechanisms, career outcomes, etc.
 - Embed <u>diversity and inclusion metrics</u> in their funding criteria.
 - Require the use of individualized development plans.
 - Issue calls for proposals to better understand the graduate education system and <u>outcomes</u> of various policies and interventions.
 - Support <u>studies on how different STEM disciplines can integrate the changing</u> <u>scientific enterprise</u> into graduate education programs and curricula.



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Program-Specific CQI Approach

"A Call for Systemic Change"

- Recommendations for federal and state government agencies, institutions of higher learning, and graduate schools / departments / programs.
- Institutions should, among other things:
 - Require the use of <u>core competences</u>.
 - Increase priority for and reward faculty that demonstrate high-quality teaching and inclusive mentoring practices.
 - Require faculty to undergo training in mentoring and teaching (with refreshers).
 - Develop a <u>uniform model for data collection and dissemination</u>, *e.g.*, time to degree, completion rates, career outcomes, disaggregated by gender, race, *etc*.
 - Develop comprehensive strategies to <u>ensure a diverse</u>, <u>equitable</u>, <u>and inclusive</u> <u>environment</u>.
 - Make available and advertise <u>effective mental health services</u>.



"A Call for Systemic Change"

- Graduate programs should:
 - Review and modify curricular and dissertation requirements on a periodic basis.
 - Scrutinize the curricular and program requirements for features that lie outside of the core competencies and learning objectives but add to time to degree without adding value.
 - Facilitate mentor relationships and create opportunities for students to develop additional mentor / advisor relationships with faculty within and outside of the home department / program.
 - Encourage students to involve dissertation committees more extensively.
 - Collect and make widely available information about degree completion rates, time to degree, and career outcomes, disaggregated with respect to demographics, including gender, race, ethnicity, and visa status.

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Program-Specific CQI Approach

- <u>Graduate programs</u> should (continued):
 - Post publicly core competencies for the students, including milestones and metrics used for evaluation and assessment.
 - Engage in discussions with professional societies, employers, and other stakeholders to develop innovative approaches and receive feedback on how to align curricular and other educational experiences with changes in the field.
 - Incorporate full awareness of mental health issues into the training experience for both students and faculty, and assess services to ensure they are meeting needs.
 - Develop, adopt, and regularly evaluate strategies to accelerate increasing diversity and improving equity and inclusion.
 - Encourage students to engage as a group in activities outside the traditional academic settings.
 - Encourage students to provide feedback on their experiences.

Program-Specific CQI Approach

Core competencies for PhD degree:

- Develop Scientific & Technological Literacy and Conduct Original Research
 - 1. Develop deep specialized expertise in at least one STEM discipline.
 - 2. Acquire sufficient transdisciplinary literacy to suggest multiple conceptual and methodological approaches to a complex problem.
 - 3. Identify an important problem and articulate an original research question.
 - 4. Design a research strategy, including relevant quantitative, analytical, or theoretical approaches, to explore components of the problem and begin to address the question.
 - 5. Evaluate outcomes of each experiment or study component and select which outcomes to pursue and how to do so through an iterative process.

National Academies of Sciences, Engineering, and Medicine 2018. Graduate STEM Education for the 21st Century. Washington, DC: The National Academies Press.





Core competencies for PhD degree:

- Develop Scientific & Technological Literacy and Conduct Original Research
 - 6. Adopt rigorous standards of investigation and acquire mastery of the quantitative, analytical, technical, and technological skills required to conduct successful research in the field of study.
 - 7. Learn and apply professional norms and practices of the scientific or engineering enterprise, the ethical responsibilities of scientists and engineers within the profession and in relationship to the rest of society, as well as ethical standards that will lead to principled character and conduct.

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Program-Specific CQI Approach

Core competencies for PhD degree:

- Develop Leadership, Communication, and Professional Competencies
 - 1. Develop the ability to work in collaborative and team settings involving colleagues with expertise in other disciplines and from diverse cultural and disciplinary backgrounds.
 - 2. Acquire the capacity to communicate, both orally and in written form, the significance and impact of a study or a body of work to all STEM professionals, other sectors that may utilize the results, and the public at large.
 - 3. Develop professional competencies, such as interpersonal communication, budgeting, project management, or pedagogical skills that are needed to plan and implement research projects.

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- Such systemic change requires ongoing dedicated CQI efforts using not only standard institutional metrics, but novel metrics developed and implemented by the program.
- Assessment reviews should not always be positive
 - "Status quo" good reviews are always nice, but disruptive, positive changes in a program will often be associated with at least temporarily decreased rating in one or more categories.
 - Change in pedagogical approach or content => lower course evaluation scores
 - Graduate programs should always be undergoing CQI, with such disruptive changes occurring as needed.



Cross-Program Comparisons

- Even more non-standard and challenging than program-specific assessments.
- Most commonly recognized graduate program rankings
 - US News & World Report
 - National Research Council (NRC)
 - do not specifically address medical physics graduate programs
- Required posting of common data driven by accreditation requirements
 - CAMPEP posting requirement for all accredited programs (very limited data)
 - Extensive CAMPEP annual survey data not publicly available (GPA, GRE, etc.)
- Limited standardized metrics for medical physics program comparisons
- More metrics exist for comparisons with other disciplines at a given institution



Cross-Program Comparisons

Data Required by CAMPEP to be Publicly Available

Table 1. Admission Statistics for MS applicants						Table 3. Initial Placement for M	S Graduates					
Catego	ry 2014	2015	2016	2017	2018	Category	2014	2015	2016	2017	2018	Cumulative
Applicar	ts* 60	56	62	68	54	Clinical	2	4	2	2	2	70
Admit	ted 33	38	46	38	34	Residency	6	3	4	6	5	36
Matricula	ted 16	13	16	18	13	PhD/MD	4	2	5	5	5	37
*May include some applic	ants who origina	lly applied to F	PhD program			Academic	0	1	0	0	0	1
						Industry	3	2	2	3	0	14
Table 2. Admission Statistics for PhD applicants						Other	1	4	3	1	1	19
						TOTAL MS	16	16	16	17	13	177
Catego	ry 2014	2015	2016	2017	2018							
Applica	nts 97	80	77	84	92							
Admit	ted 9	8	8	7	7	Table 4. Initial Placement for Ph	D Graduates					
Matricula	ted 5	6	6	4	6	C 1	2014	2045	2017	2017	2010	C 1.1
						Category	2014	2015	2016	2017	2018	Cumulative
						Clinical	1	0	2	1	0	9
						Residency	2	3	4	1	3	17
						Academic	1	1	0	1	1	7
						Industry	0	0	1	1	1	6
						Other	0	0	0	0	2	2
						TOTAL PhD	4	4	7	4	7	37
https://medicalphysics.duke.edu/st	ıts										School of and Publi	Medicine c Health visconsin-madison

Cross-Program Comparisons

PhD Time-to-	Degree <mark>Inter</mark>	nal Com	parison	000	Phd Co Degree	mpletion a Metrics fo	nd Time or	è-to-	AAU Pee Time at	er Comparis UW-Madis	son on as a Gra	aduate
Time at UW-Madison as a Gradu *					Medica	I Physics			Student	t		
Degree School/College (Multiple values)	6		\searrow	<u></u>						# of Grads	UW-Madison (Years)	AAU Peer (Years)
(All)			- 52	-					2012	16	6.0	5.5
Major	5								2013	19	5.0	5.4
(Multiple values)	al.								2014	23	5.7	5.5
Riomedical Engineering	Los								2015	17	5.3	5.4
	2 4								2016	12	6.1	5.7
Biophysics	pd le											
Biophysics Chemical Engineering Computer Sciences Electrical Engineering	o Doctoral Do				UW-Mad	lison Retenti	on/Comp	letion	AAU Pee	er Retentio	n/Complet	ion
Biophysics Chemical Engineering Computer Sciences Electrical Engineering Industrial Engineering Mathematics	Years to Doctoral Dr			101010-0010-0010-0010-0010-0010-0010-0	UW-Mad Rates	lison Retenti	on/Comp	letion	AAU Pee Rates	er Retentio	n/Complet	ion
Biophysics Chemical Engineering Computer Sciences Electrical Engineering Industrial Engineering Mathematics Medical Physics Nuclear Engineering and Engi Physics	Years to Doctoral Dr				UW-Mad Rates Year In Program	Scompleted %N	on/Comp	letion % Enrolled	AAU Pee Rates Year In Program	er Retentio % Completed 9	n/Complet	ion % Enrolled
Blophysics Chemical Engineering Computer Sciences Electrical Engineering Inductrial Engineering Mathematics Mathematics Nacical Physics Nuclear Engineering and Engi Physics	Avarato Doctoral Do Varato Doctoral Do S				UW-Mad Rates Year In Program	K Completed % N 0.0%	on/Comp	letion % Enrolled 85.0%	AAU Pee Rates Year In Program	er Retentio % Completed % 1.6%	n/Complet % Not Enrolled 6.3%	% Enrolled 92.2%
Biophysics Chemical Engineering Computer Sciences Electrical Engineering Industrial Engineering Mathematics Medical Physics Nuclear Engineering and Engl Physics	A Vassts to Doctanal Dr				UW-Mad Rates Year In Program 1 2	% Completed % N 0.0% 0.0%	on/Comp lot Enrolled 15.0% 21.1%	letion % Enrolled 85.0% 78.9%	AAU Pee Rates Year In Program 1 2	er Retentio % Completed % 1.6% 0.0%	n/Complet	ion % Enrolled 92.2% 97.8%
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Biophysis Commod Engineering Computer Sciences Electrical Engineering Industrial Engineering Industrial Engineering Industrial Engineering Mathematics Mathematics Mathematics Nuclear Engineering and Engl Physics	ng people of the second of the				UW-Mad Rates Year In Program 1 2 3 4 5	% Completed % N 0.0% 0.0% 11.1% 26.1% 30.0%	lot Enrolled 15.0% 21.1% 16.7% 13.0% 25.0%	% Enrolled 85.0% 78.9% 72.2% 60.9% 45.0%	AAU Pee Rates Year In Program 1 2 3 4 5	* Completed 9 1.6% 0.0% 3.4% 29.3% 47.1%	n/Complet 6 Not Enrolled 6.3% 2.2% 3.4% 17.3% 23.5%	6 Enrolled 92.2% 97.8% 93.1% 53.3% 29.4%
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Summary

- Comprehensive assessment of quality in graduate medical physics education is a complex issue.
- Commonly-available, *i.e.*, institutionally-mandated, metrics are convenient, but only address a limited range of easily-measured data.
- Accreditation processes establish the acceptable lower limit on quality; data posting required by such processes are limited in scope.
- The programs bear the responsibility to comprehensively assess quality.
 - Programs should consider the NAS recommendations for "systemic change" in the development of the full set of quality assessment metrics.
- SDAMPP and AAPM could play a significant role in establishing guidelines for more consistent and comprehensive cross-medical physics program quality assessment and dissemination of information.

