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

Assessment of Quality of Medical Physics Graduate Programs

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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.

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Objectives

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)

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Program-Specific CQI Approach

- 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

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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)
  - *etc*.

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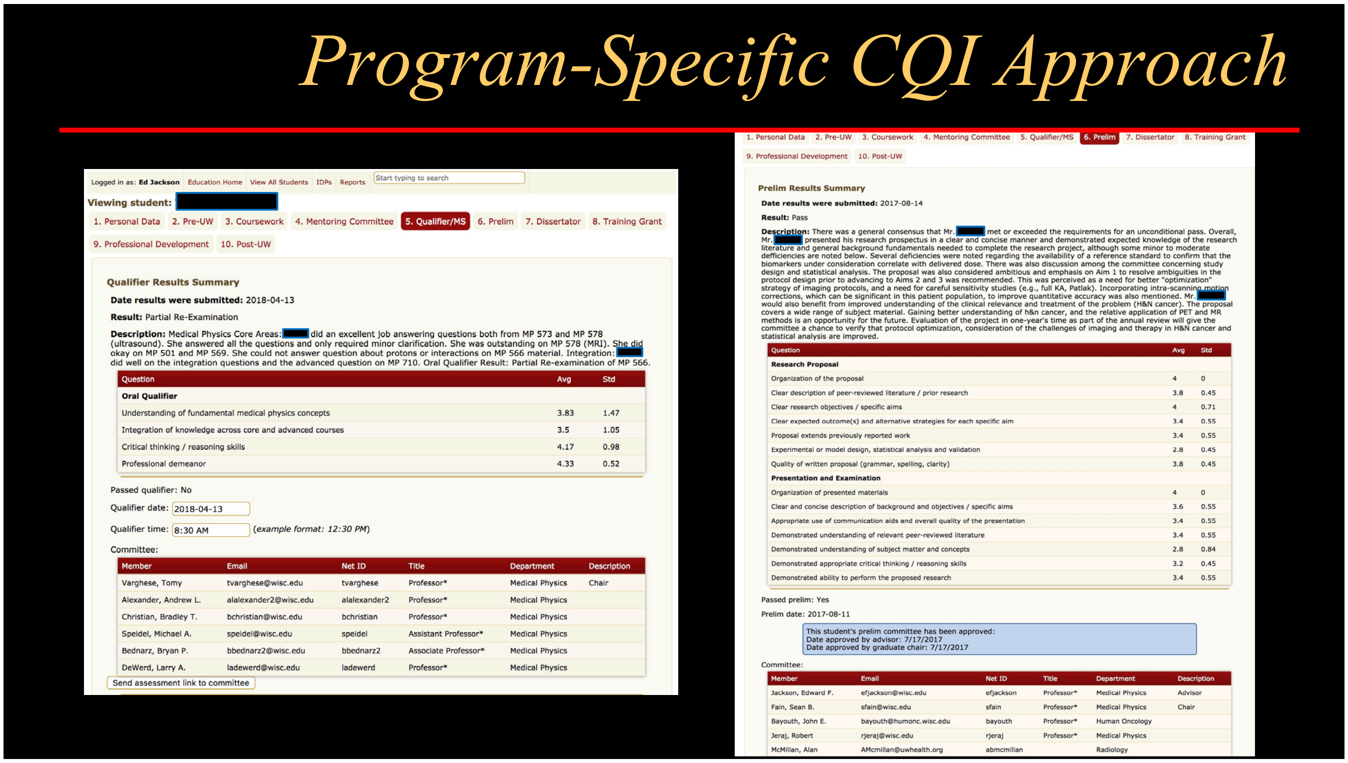
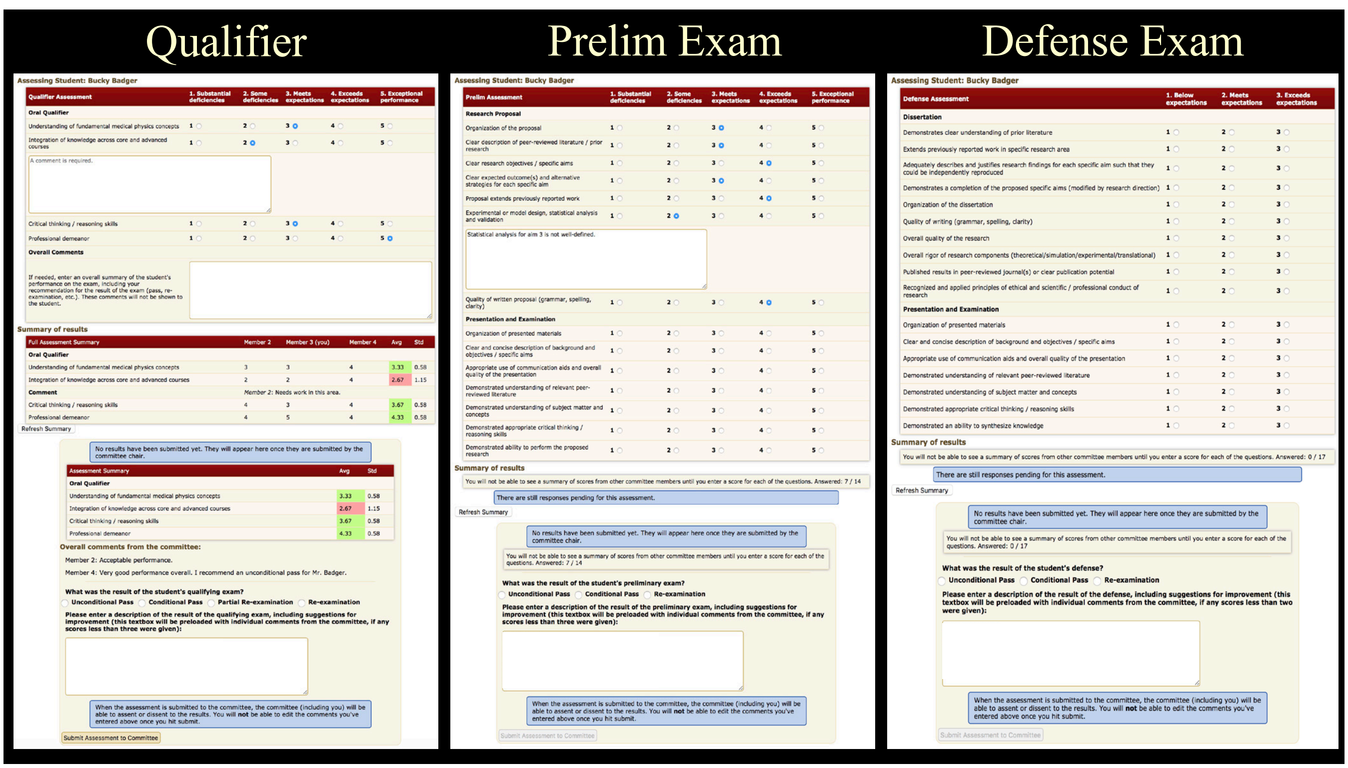

Program-Specific CQI Approach
Qualifier Results Summary
Date results were submitted: 2018-04-13
Result: Partial Re-Examination
Prelim Results Summary
Date results were submitted: 2017-08-14
Result: Pass


Qualifier
Prelim Exam
Defense Exam
Assessing Student: Bucky Badger
Qualifier Assessment
Prelim Assessment
Defense Assessment
Summary of results

Program-Specific CQI Approach

Reporting Tools

Medphysics Education System - Administration

Logged in as: **Ed Jackson** | Education Home | View All Students | IDPs | Reports | Start typing to search

Limit by academic year: All-time Go

Viewing Assessment Results from all time

Qualifying Exam Averages

Question	#	Avg	Std
Oral Qualifier			
Understanding of fundamental medical physics concepts	25	3.22	0.54
Integration of knowledge across core and advanced courses	25	3.23	0.41
Critical thinking / reasoning skills	25	3.41	0.57
Professional demeanor	25	3.69	0.4
Average	*25*	*4.27*	*0.22*

Unconditional Pass: 11 (44%) | Conditional Pass: 4 (16%) | Re-examination: 10 (40%)

Preliminary Exam Averages

Question	#	Avg	Std
Research Proposal			
Organization of the proposal	17	3.83	0.56
Clear description of peer-reviewed literature / prior research	17	3.69	0.46
Clear research objectives / specific aims	17	3.7	0.61
Clear expected outcome(s) and alternative strategies for each specific aim	17	3.39	0.75
Proposal extends previously reported work	17	3.84	0.46
Experimental or model design, statistical analysis and validation	17	3.25	0.61
Quality of written proposal (grammar, spelling, clarity)	17	4.06	0.49
Average	*17*	*4.21*	*0.28*
Presentation and Examination			
Organization of presented materials	17	4.09	0.47
Clear and concise description of background and objectives / specific aims	17	3.97	0.62
Appropriate use of communication aids and overall quality of the presentation	17	3.98	0.59
Demonstrated understanding of relevant peer-reviewed literature	17	3.72	0.44
Demonstrated understanding of subject matter and concepts	17	3.56	0.59
Demonstrated appropriate critical thinking / reasoning skills	17	3.6	0.55
Demonstrated ability to perform the proposed research	17	3.78	0.62
Average	*17*	*4.39*	*0.2*

Unconditional Pass: 16 (94%) | Conditional Pass: 1 (6%) | Re-examination: 0 (0%)

Completed within three years: 7 (41%) | Average time to complete: 3.22 years

Doctoral Defense Averages

Assessment

Yearly Averages - By Question Category

Year	Category	Avg	Std
2016	Qualifier - Oral Qualifier	3.47	0.19
2017	Qualifier - Oral Qualifier	3.35	0.24

Year	Category	Avg	Std
2016	Prelim - Research Proposal	3.75	0.28
2017	Prelim - Research Proposal	3.63	0.28
2016	Prelim - Presentation and Examination	3.76	0.23
2017	Prelim - Presentation and Examination	3.85	0.21

Year	Category	Avg	Std
2016	Defense - Dissertation	2.54	0.08
2017	Defense - Dissertation	2.69	0.11
2016	Defense - Presentation and Examination	2.6	0.07
2017	Defense - Presentation and Examination	2.72	0.12

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Program-Specific CQI Approach

- 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

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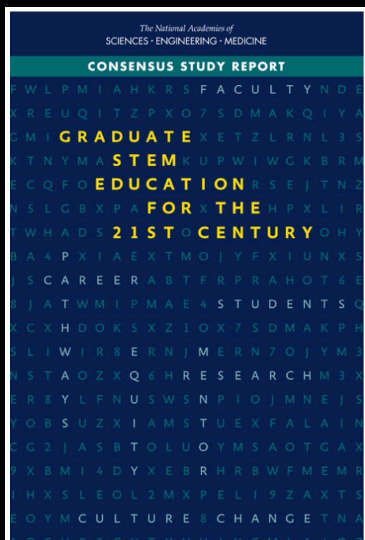
Program-Specific CQI Approach



Graduate STEM Education for the 21st Century (2018)

DETAILS

202 pages | 6 x 9 | PAPERBACK
ISBN 978-0-309-47273-9 | DOI 10.17226/25038

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

SUGGESTED CITATION

National Academies of Sciences, Engineering, and Medicine 2018. *Graduate STEM Education for the 21st Century*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25038.

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 posting</u> on demographics, funding mechanisms, career outcomes, etc.
  - Embed <u>diversity and inclusion metrics</u> in their funding criteria.
  - Require the use of <u>individualized development plans</u>.
  - Issue calls for <u>proposals to better understand the graduate education system and outcomes</u> of various policies and interventions.
  - Support <u>studies on how different STEM disciplines can integrate the changing 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 core competences.
  - 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 uniform model for data collection and dissemination, *e.g.*, time to degree, completion rates, career outcomes, disaggregated by gender, race, *etc*.
  - Develop comprehensive strategies to ensure a diverse, equitable, and inclusive environment.
  - Make available and advertise effective mental health services.

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Program-Specific CQI Approach

"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

– Graduate programs 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.

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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.

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Program-Specific CQI Approach

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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Program-Specific CQI Approach

- 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.

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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

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Cross-Program Comparisons

Data Required by CAMPEP to be Publicly Available

Table 1. Admission Statistics for MS applicants

Category	2014	2015	2016	2017	2018
Applicants*	60	56	62	68	54
Admitted	33	38	46	38	34
Matriculated	16	13	16	18	13

**May include some applicants who originally applied to PhD program*

Table 2. Admission Statistics for PhD applicants

Category	2014	2015	2016	2017	2018
Applicants	97	80	77	84	92
Admitted	9	8	8	7	7
Matriculated	5	6	6	4	6

Table 3. *Initial* Placement for MS Graduates

Category	2014	2015	2016	2017	2018	Cumulative
Clinical	2	4	2	2	2	**70**
Residency	6	3	4	6	5	**36**
PhD/MD	4	2	5	5	5	**37**
Academic	0	1	0	0	0	**1**
Industry	3	2	2	3	0	**14**
Other	1	4	3	1	1	**19**
TOTAL MS	**16**	**16**	**16**	**17**	13	**177**

Table 4. *Initial* Placement for PhD Graduates

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/stats

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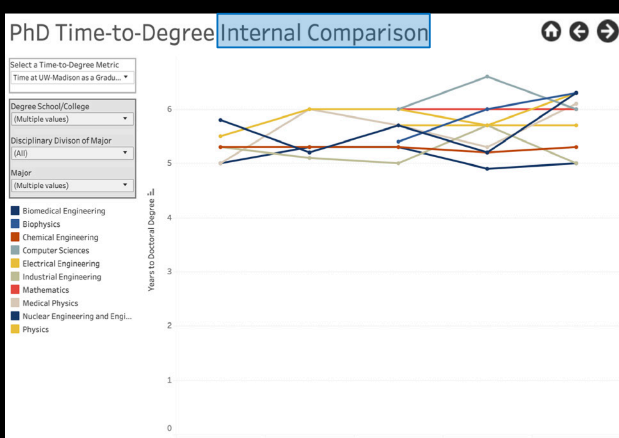
Cross-Program Comparisons



Phd Completion and Time-to-Degree Metrics for Medical Physics

AAU Peer Comparison - Time at UW-Madison as a Graduate Student

	# of Grads	UW-Madison (Years)	AAU Peer (Years)
2012	16	6.0	5.5
2013	19	5.0	5.4
2014	23	5.7	5.5
2015	17	5.3	5.4
2016	12	6.1	5.7

UW-Madison Retention/Completion Rates

Year In Program	% Completed	% Not Enrolled	% Enrolled
1	0.0%	15.0%	85.0%
2	0.0%	21.1%	78.9%
3	11.1%	16.7%	72.2%
4	26.1%	13.0%	60.9%
5	30.0%	25.0%	45.0%
6	80.0%	12.0%	8.0%
7	75.0%	21.4%	3.6%

AAU Peer Retention/Completion Rates

Year In Program	% Completed	% Not Enrolled	% Enrolled
1	1.6%	6.3%	92.2%
2	0.0%	2.2%	97.8%
3	3.4%	3.4%	93.1%
4	29.3%	17.3%	53.3%
5	47.1%	23.5%	29.4%
6	76.3%	10.5%	13.2%
7	78.8%	21.2%	0.0%

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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.

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