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A New Model Alternative Certification Program For HS Physics Teachers: New Pathways to Physics Teacher Certification at SUNY- Buffalo State College

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Abstract

We describe the need for, development and deployment of a new model graduate level alternative certification program for physics teachers at SUNY- Buffalo State College. The *Masters of Science Education (Physics with NYSED Transitional B Certification)* program accommodates science and engineering professionals with appropriate bachelors degrees who wish to change career paths into physics teaching. The alternative certification program is distinctive in that candidates minimize their income disruption and bypass student teaching through an intensive full time Spring-Summer introductory component leading to NYSED Transitional B Certification, followed by paid, mentored teaching employment and evening coursework for two calendar years. This alternative certification program is made possible through intensive physics teachers' summer academy courses, supplemented by regular semester evening course and online offerings. Courses are shared with a second new program - the *Masters of Science Education (Physics)*, which serves already certified science teachers (usually in subjects other than physics) who wish to obtain a master's degree for permanent teacher certification and usually teacher certification in a second discipline -- physics.

Acknowledgements

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Introduction: National and New York State Demand for Physics Teachers

Scholars of teacher preparation have observed that currently there is *not*, in fact, a general nation-wide shortage of teachers in the United States (Darling-Hammond, 2000; 2001). In general, there are adequate numbers of prepared and certified teachers to meet most of the nation's needs, with waiting lists of teacher applicants for positions in affluent suburban districts, yet "we face shortages of people willing to work at the salaries and under the working conditions offered in specific locations" -- in rapidly growing, *rural* and *urban* areas (Darling-Hammond,

2001). Real teacher shortages do exist in a few subject fields -- most particularly in special education, mathematics, *physics*, chemistry, and Spanish, in order of national demand (AAEE, 2003). Teacher shortages in science and mathematics subjects are exacerbated by the fact that these fields require knowledge and skills in demand by other non-educational employers at higher rates of compensation (Darling-Hammond, 2001).

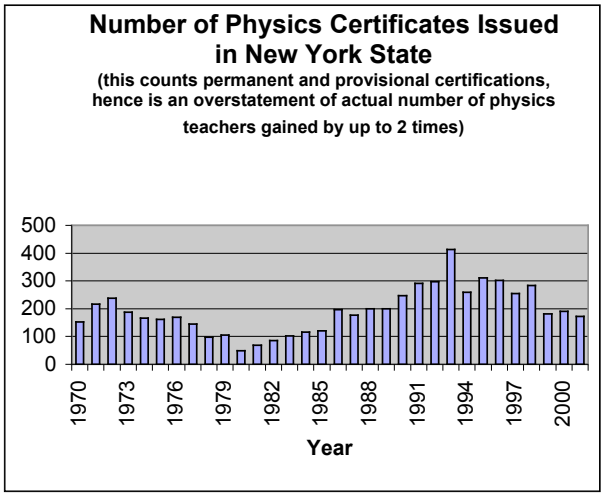
Currently, there is intense demand for highly qualified and certified high school physics teachers both nationally and in New York State. Recently, US high school physics enrollments have experienced continued growth leading to fifty-year high enrollment levels (AIP, 1999; Neuschatz & McFarling, 2000). Fewer science teachers major in physics than in the other science disciplines, and many physics teachers (particularly urban and rural teachers) only teach physics a small percentage of the time compared to other sciences (Neuschatz & McFarling, 2000; UTC, 2000). Only about one-third of all physics teachers received a major (or graduate degree) in physics or physics education, and adding physics minors only raises this total to 45% (Neuschatz & McFarling, 2000). As a result, the claim has been widely made that nationally more than half of all physics teachers (AIP, 1999) are actually teaching *out-of-field,* – that is without a degree or a minor in physics or physics education (Ingersoll, 1999; CSMTP, 2001). This definition must be tempered by recognizing that 61% of public and 27% of private high school physics teachers are in fact state certified to teach physics, though state certification requirements vary widely and may be grandfathered from weaker historical requirements. The recent US federal law concerning K-12 education known as the *Elementary and Secondary Education Act (ESEA) of 2001 (No Child Left Behind or NCLB)* (US Department of Education, 2003) has directed changes to teacher certification practices but has not standardized this issue.

Partially in response to national NCLB legislation, the New York State Education Department (NYSED) recently intensified teacher certification and high school science graduation requirements (NYSED, 2000), established a new Regents' physics core curriculum (NYSED, 2001) and revised the statewide Regents' Physics exam, incorporating increased levels of conceptual understanding (Zawicki, Jabot, Falconer, MacIsaac, Henry & Fischer, 2003). This has further increased the NY demand for high school physics teacher certification (Willie-Schiff, 2002), particularly for those non-physics certified science teachers who have been teaching physics (so-called cross-certification candidates). NYSED physics certification requirements were increased to include thirty credits in physics (NYSED 2004) and the successful completion of a *Content Specialty Test* in Physics (NES, 2002). In 2001-02, NY State exceeded national norms for certification prevalence (Table 1) and 65% of the 1700 NYS high school physics teachers were certified to teach physics (Willie-Schiff, 2002). However, another 21% of those teachers were not certified, were temporarily certified or were not recognized by the system, and an additional 14% of the total physics teacher pool was working under provisional certification. Following either initial or provisional certification, teachers must complete an approved Masters degree, depending upon the teacher's initial certification date, within either three or five years to earn full professional certification in NY (NYSED 2004).

New York physics teachers lead the aging and imminent retirement trends of the general US national science and mathematics teacher population. A great many NY physics teachers are nearing retirement -- of the 65% of NY teachers with permanent certification, 728, (43% of the entire NY HS physics teaching population, or *over half of the 2002 NYSED physics- certified HS*

physics teaching population) are over the age of fifty. Estimates of prospective retirements are not available, but these data strongly support the conclusion that there will be a significant number of retirements over the next decade. NY acutely needs a larger pool of physics teachers including new physics teachers from traditional preparation paths, career-changer becoming physics teachers from non-teaching technical and engineering professions, and teachers cross-certifying into physics from other teaching disciplines. This last group is, in fact, already teaching physics and forms a significant needful population.

While under-represented minority high school physics student enrollments are increasing along with the entire population, the enrollment gap between under-represented and majority students in physics courses remains 'well-entrenched.' Alarmingly, non-white physics teachers are 'virtually non-existent' (AIP, 1999). About a quarter of current high school physics teachers are female (Ivie & Stowe, 2000), and about 47% of high school physics students are female (AIP, 1999). In conclusion, there is a tremendous demand for certified physics teachers, particularly in rural and urban core schools, and most acutely for certified minority physics teachers both nationally and in NY state.



NYS Physics Teacher Data for the 2001-02 school

		FTE	# Classes	Ave FTE/Teacher	% of total (FTE)
Total number of physics teachers	1691	783	3132	0.46	100.0
Physcis teachers with no physics certification, temporary certification, or not in system	351	132	528	0.38	16.9
5 yr provisional & CQ	242	126	504	0.52	16.1
permanent certification	1098	525	2100	0.48	67.0
Over age 55	454	221	884	0.49	28.2
Over age 50	728	337	1348	0.46	43.0
Regents Physics		584			74.6
Second Year Physics		2.6			0.3
AP Physics		106			13.5
Other		90			11.5

Fig 1 And Table 1: Select Data Describing The NYS Physics Teacher Shortage And Population Inversion By Age

Alternative Teacher Certification

Irregular certification has most recently become a political 'hot button' issue due to calls by the Bush administration for effectively dismantling teacher education systems and redefining teacher qualification to espouse alternative certification (US Department of Education Secretary's Annual Report, 2002, p21; Darling-Hammond, 2002; Darling-Hammond & Youngs, 2002). Alternative certification refers to a teacher certification program that differs from standard college programs of teacher preparation, usually by avoiding the extended guided field experience of student teaching. Alternative certification is frequently insufficiently discriminated with emergency certification, which usually refers to a complete waiver of any teacher preparation to obtain a teacher who is otherwise unavailable. Other certification routes intermediate to these exist, particularly individual (transcript) evaluation in NY.

Cogent and compelling scholarly critiques of irregular certification pathways exist, in particular Darling-Hammonds' research on alternatively and emergency certified teachers in New York City during 1997-8. These teachers were disproportionately hired to teach the least advantaged minority, lower-income urban students (a disconcertingly common characteristic for such irregular teacher hiring and preparation practices). Darling-Hammond received survey responses from some 3000 of a possible 9000 NYC teachers hired within their first three years in 1997-98 (many missing respondents were no longer employed by NYC schools), and discovered that some on temporary or emergency certification had little more preparation than brief summer workshops (Darling-Hammond, 2002; Darling-Hammond, Chung & Frelow, 2002). These candidates included those from several pathways, including *Teach for America (TFA),* the *Peace Corps, Troops to Teachers* and *Teacher Opportunity Corps* – who almost universally (90%-100%) left the profession by their third year. This compares to a third year departure figure of about one-third of traditionally trained teachers and about 10% of teachers prepared in extended five-year programs that include a full year of student teaching (Darling-Hammond, 2001, p15). Darling-Hammond then went on to do a detailed cost analysis on both the longer-term financial and education costs of such 'drive-by' teacher hiring policies, including a cost analysis of differing variables in student achievement. Darling-Hammond constructed a strong case that short-term hiring policies are costly in the long term, and that dollars spent upon teacher preparation are one of the most cost-effective predictors of student achievement.

However, Darling-Hammond identified some very few alternative certification programs as quite successful – those few incorporating extended teacher mentoring and induction support interwoven with coursework and clinical training (Darling-Hammond, 2001). Furthermore, she explicitly called for the creation of "*extended teacher education programs with year-long internships in … high quality alternative pathways at the post-graduate level… for mid career changers…*" (Darling-Hammond, 2000, p35).

Researchers note that though alterative certification teachers leave the profession at higher rates than do traditionally prepared teachers, they are preferentially hired by Local Education Authorities (LEAs – schools and districts) as new teachers and are far more likely to seek immediate employ after certification. Notably, up to 30-40% of new teachers graduating from traditional certification programs are not immediately employed as teachers. Due to this common hiatus in accepting employment, of all 15,000 teachers prepared in Texas in 1995, the alternative certification program graduates still held the highest percentage of employment after five years despite having the highest attrition rate from the profession as working teachers (Harris, Camp and Adkinson, 2003). Alternative certification candidates are much more dedicated to finding immediate employment than are teachers from other certification, a fact confirmed by Darling-Hammond (2000). Shen (1998, 1999) further found that alternative certification programs recruit significantly more minority teachers than traditional programs; these teachers are significantly more likely to be employed in urban schools serving minorities, are significantly more likely to teach mathematics and science and are significantly more likely to have considerable business or military experience.

Although problematic, alternative certification programs can be done well, and can provide a viable pathway to physics teacher preparation. Alternative certification program candidates

bring uniquely attractive backgrounds and interests to address needs for under-represented teachers sought by schools. Alternative certification programs can address needs not adequately met by traditional programs.

Overview of the Two BSC *M.S.Ed. (Physics)* Programs

The BSC *M.S.Ed. (Physics)* programs are summarized in Figure 2. Admissions require either current NYSED secondary science certification (the right hand side of Figure 2), or for alternative certification (the left hand side of Figure 2), a bachelor's degree meeting NYSED language and content requirements for physics certification, and successful completion of the NYSED state teacher competency examinations (LAST and the Physics Content Subject Test) required for physics teacher certification. Certified participants do not have to take any additional education courses or workshops, unlike alternative certification candidates who must take an early field experience and some education courses before they can be awarded the Transitional B certification and can accept classroom employment.

Alternative certification candidates typically complete their initial employment requirements through full-time enrollment in the spring semester, followed by an intensive summer academy, then teach the following school year under Transitional B certification under both BSC Physics mentorship and an intense LEA induction program. Alternative certification candidates can be in the classroom employed as full-time transitionally licensed teachers after as little as two semesters of full time student study (one spring and one summer semester), and we have had several candidates succeed with exactly this arrangement.

During the regular academic year, *M.S.Ed. (Physics)* candidates also take some combination of evening and distance education courses. Although coursework for the alternative certification program can be completed in the following summer academy, the NYSED Transitional B certification agreement requires a minimum of one full year of intensively mentored teaching experience for regular teacher licensure.

M.S.Ed. (Physics) program candidates who are already NYSED certified in another subject can add physics certification and complete their program in about four semesters if they enroll in two successive summer academies together with the regular fall and spring semester evening and web courses. Each summer, 18 credits of summer academy courses are offered for teachers (including six credits for K-8 teachers), with a minimum of 6 credits of evening classes (9 cr. this academic year) between regular Fall and Spring semesters. We have also placed some few of these offerings online as appropriate (E.g. PHY500 and PHY690) and we are creating online support materials (and local tutorials) for NYSED Physics CST exam preparation. This greatly extends statewide reach for our coalition and meets teacher demands. We accept transfer credit and some of our downstate candidates have taken some of the online course offerings for graduate credit in physics from the NTEN/NSTA and University of Virginia programs in particular (NTEN, 2004; University of Virginia, 2004).

The *M.S.Ed.-Physics* degree programs at SUNY- Buffalo State College

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	M.S.Ed.-Physics (NY Alternative Certification via Transitional B) New teacher cert for Science/Tech/Engg/Math professionals	M.S.Ed.-Physics (usually second NY Cert) STEM teacher cross certifies to physics
Program admission requirements	Physics or related bachelor's degree	NYS certification in a secondary science
	3.0 GPA	2.5 GPA
	18 cr of non-physics science	n/a
	language req	n/a
	NYSED Tchrs exams (LAST & Physics CST)	n/a
	3 written references & interview	3 written references & interview

Coursework			e = existing course n = 2002 new course r = 2002 revised course
Seminar (3cr)			
PHY500: Physics Education Research Seminar	Y	Y	r
Physics Teaching Methods (6cr)			
PHY510: Process Skills in Physics Teaching (6 cr)	Y	Y	r
w/ 40h early field experience grades 7-12	Y	N	
Physics Content w/Model Pedagogy (12cr)			
PHY620: Powerful Ideas & Quantitative Modeling: Force, Motion & Energy (6cr)	Y	Y	n
PHY622: Powerful Ideas & Quantitative Modeling: Electricity & Magnetism (6cr)	Y	Y	n
Project (3cr)			
PHY690: Research Project	Y	Y	e
Electives			
PHY518: Wave Phenomena and Optics	6cr	9cr	r
PHY520: Modern Physics			r
PHY525: Nuclear and Particle Physics			e
PHY616: Advanced Dynamics			e
PHY618: Advanced Electricity and Magnetism I			e
SCI527: Current Topics in Science			e
SCI632: Curricular Trends in Science Teaching in the Secondary School			e
SCI664: Teaching Science with Media			e
SCI685: Evaluation in Science Education			e
Or other courses by advisement			
Teacher Cert Requirements			
EXE633: Adapting Content Area Instr for Children & Adolescents w/Disabilities	Y	N	e
EDF529: Adolescent Psychology	Y	N	e
EDU417: Adolescent Literacy	Y	N	e
plus one of			
EDU416: Teaching Literacy in Middle and Secondary Schools	3cr	0cr	e
EDU609: Improving Reading in the Content Areas			e
NYSED 52.21(b)(3)(xvii)-regulated college mentored physics teaching experience			
paid employment for 1 year w/ NYSED Transitional B Certification	Y	N	
Total number of required credits:	**42cr**	**33cr**	

Figure 2: The *M.S.Ed.-- Physics* programs at SUNY- Buffalo State College.

The graduate physics courses for these programs include a mixture of undergraduate physics content and graduate level physics pedagogical content knowledge (physics and science education research PER and SER findings, and science teaching methods), presented at an undergraduate mathematical level. Physics content is largely shaped by research findings and state requirements, and frequently departs from traditional physics course curricula – for instance there is essentially no treatment of thermodynamics, while there is a significant treatment of modern physics dictated by the state via PER-informed curricula.

Checklist for *M.S.Ed. (Physics)* with NYSED Transitional B Certification Candidates

1. Admissions Requirements. To be *fully* accepted (not *provisionally*; we accept both) into the M.S.Ed. program:
- bachelor's degree in physics or related area (engineering)
- cumulative GPA of 3.0 / 4.0
- minimum of 18hrs in 2 other teachable sciences (we prefer 6cr CHM, 6cr BIO, 6cr ESci)
- one year college or two years HS of foreign language
- passing scores on LAST and Physics CST NYS teacher certification exams; see <http://www.nystce.nesinc.com/> for arrangements. Exams require registration 2-3 months ahead to avoid late fees; 2 weeks in advance is "emergency" registration
- full application packet including three letters of reference

2. Introductory Component. For the NYSED Transitional B Certificate, you must complete all of the above and add the following before you are permitted to take a job:
- 200 clock hours of pedagogical core study; usually by PHY510 and PHY600 (or PHY622) from the summer physics teacher's academy. Clock hours = instructor contact hours.
- 40 clock hours of field experience; with selected certified local area physics teacher during regular school semester hours - see Field Experience Agreement Form at <http://physicsed.buffalostate.edu/programs/pgmdox/>
- EDF529 Adolescent Psych (or equivalent)
- EXE500 Individuals with Special Needs (or equivalent)
- professional workshops available through <http://www.buffalostate.edu/academics/cenc/>:
  - Child Abuse Workshop
  - Drug and Alcohol Workshop
  - Fire and Arson Workshop
- start career planning / placement and professional folder process on 3rd floor Grover Cleveland bldg or alternative <http://www.buffalostate.edu/offices/cdc/index.html>
- contact BSC certification officer for application / completion / approval of NYSED Transitional B Certification <http://www.buffalostate.edu/depts/teachercert/>
- get a job! :^)

3. In-service Component. To receive the NYSED Transitional B Certificate, the above must be *completed* and the following *undertaken* to retain transitional certification and continue towards the appropriate NYSED provisional / permanent or initial/professional certificates:
- good academic progress in the remaining MSED courses listed in the program catalog also listed at <http://physicsed.buffalostate.edu/programs/MSEDPgms.html>
- completion of the remaining required professional workshops (HIV/AIDS and SAVE; available through <http://www.buffalostate.edu/academics/cenc/>) and remaining NYS teacher certification examinations (ATS-W; see <http://www.nystce.nesinc.com/>)
- appropriate mentored teaching in the grade and subject (physics) for which certification is being sought
- a written agreement between the LEA and BSC Physics regarding course loading, mentorship, supervision, and;
- a written plan for mentored improvement signed by the candidate, principal, mentor and program faculty

Table 2: Checklist for Alternative Certification Candidates

The two 600-level summer academy courses are particularly intensive fifteen day workshops modeled after the nationally renowned *Modeling Physics* workshops held at Arizona State University – in each course approximately thirty participants work through PER-informed curricular activities in both student and teacher roles. Besides Hestenes' distinguished and well-researched *Modeling Physics* curriculum, activities from the AAPT's *Powerful Ideas in Physical Science (PIPS)* and Goldberg's *Constructing Physics Understanding (CPU)* curricula also inform these workshops (Wells, Hestenes & Swackhamer, 1995; Hestenes, 1987, 1993; Modeling Physics Group, 2004; AAPT, 2004; Goldberg 2000). PHY510 is a locally developed workshop course originally intended to support new teachers who were assigned to teach physics without

physics certification, and focuses on meeting NYSED requirements through activities NY master physics teachers have selected on an *ad-hoc* basis, leavened with formal PER and SER touchstone activities.

Finally, though not accepted for *M.S.Ed. - Physics* program core credit, the summer academy includes at least one offering for K-8 teachers of physics, usually PHY507, a course dedicated to the appropriate NYSED standards incorporating the above curricula plus Goldberg's *Physics for Elementary Teachers* (Goldberg, 2004) curriculum activities, and frequently incorporating a PER or SER component by blocking it with a second graduate course in science curriculum research for K-8 teachers, EDU671.

The other two notably unique courses are PHY500 --an online seminar of PER readings and findings, and PHY690 -- a terminal masters' project producing a manuscript contributing to the physics teaching community, most of which are web-published, but some of which will be published (shortly) in the peer reviewed literature. This last course is particularly challenging for instructor and candidates, but very rewarding. These last two, together with several topical courses, are offered during the Fall and Spring semesters.

Lessons Learned

There has been considerable demand for our *M.S.Ed. (Physics)* programs. We have stabilized our program size at approximately forty candidates by restricting acceptances to only the best qualified and most likely applicants. Since the programs were inaugurated in fall and summer 2002, three candidates have graduated, with two more to graduate shortly. About two thirds of all candidates are certified working teachers who are seeking either certification to physics and / or a permanent license, with a small few candidates who don't require physics certification or a masters' degree for permanent certification who are simply improving their physics teaching skills. The remaining third of the candidates are alternative certification students. The Physics Teachers' Summer Academy acts as a recruiter for the *M.S.Ed. (Physics)* programs, attracting about a hundred teachers per summer to the BSC campus, with another twenty-five to fifty teachers attending the monthly Saturday morning alliance meetings of the Western New York Physics Teachers' Alliance (WNYPTA, 2003) supplementing the recruiting pool and candidate support network.

The non-certification *M.S.Ed. (Physics)* candidates are mostly (65%) HS science and math teachers seeking certification in physics, with some (30%) already holding initial physics certification and a small number (5%) of elementary and middle school teachers (usually those with minors in physics) seeking secondary physics certification. Second subject certification for science teachers via a discipline-specific masters degree intended for teachers is growing common and greatly improves employment flexibility for NY science teachers. A very few certified candidates have no NYSED need for another masters' degree and simply want to improve their physics teaching; we tend to attract these candidates to satisfy their NYSED graduate physics content credit requirements or to attend physics alliance meetings, and they sometimes stay for the reformed teaching and student-centered pedagogy. Although we have essentially no minority candidates to date, we have almost 10% women and we are trying to recruit both populations. We are particularly pleased to have candidates who are working

teachers in urban, high-needs school settings, including one starting a physics program at her school which presently does not offer physics. We hope to have these candidates support future recruiting of undergraduate student and graduate student physics and physics education candidates from amongst their own students and colleagues.

The remaining third of our *M.S.Ed. (Physics)* candidates (fourteen) are career-switching technical professionals; of these all save three (77%) hold bachelors' degrees in various fields of engineering. Most are young men who have practiced engineering for several years and are seeking more rewarding careers with greater employment stability. The other three include two alternative certification (AC) candidates with a B.S. in physics and a Ph.D. physicist switching careers to teaching. These AC candidates are usually altruistic and reflective about their reasons for career change (we are not admitting simple economic refugees), and some have worked as substitute teachers, which is something we strongly encourage. Our AC candidates are almost universally looking to move directly into the classroom as quickly as possible, want to minimize their time in university classrooms (they seem particularly hostile to education coursework) and want to minimize the financial disruptions due to full time student enrollment. One exception to this is still working as an engineer and taking one program course per semester. Like many traditionally prepared teacher candidates, they also resent the unpaid-while-paying-tuition nature of traditional student teaching.

Alternative certification programs incorporating physics content for these individuals are quite rare, though these candidates could readily locate other certification programs without physics content such as an *M.Ed.* or *M.S.Ed. (Science)* or a post-baccalaureate non-degree program in general science teaching, and we don't believe we are cannibalizing such programs. Only one AC candidate holds a Buffalo State Physics department undergraduate degree. Alternative certification candidates present unique issues in physics teacher education; our candidates sometimes hold inappropriately optimistic estimations of their subject expertise and strong, under-informed preconceptions of good teaching practices. A reflective exposure to SER and PER instruments and literature, and explicit instruction via student-centered constructivist reformed teaching methods helps them address these issues. Abd-El-Khalick (2003) has referred this as the expert-novice-expert problem; AC candidates need to recognize that their expertise in one area doesn't map onto a new subject area before they can progress in their development as teachers. Traditional undergraduate teachers in preparation move through a novice-expert development cycle (often holding naive images of good teaching), and experienced teachers from other science disciplines may need to move through a different kind of expert-novice-expert developmental sequence with regard to acquiring new pedagogical skills in inquiry-based, student-centered, constructivist (reformed) teaching (MacIsaac, Sawada & Falconer, 2001; MacIsaac & Falconer, 2002).

Because the AC candidates require monthly observation visits from a faculty member for a year and incumbent travel time, the program is currently limited to approximately this number, and we no longer advertise the AC program except by word of mouth and posters at state science conferences. We do advertise the non-certification program in yearly mailings to physics departments and high schools statewide. We currently have no out-of-state candidates, though we have a very few out-of-state Summer Academy registrants every summer.

These forty candidates represent maximum capacity for a program dedicating approximately 1.0 FTE year round faculty without research release (three graduate courses each semester year round). To staff these programs at SUNY-BSC, one new full-time faculty member was hired and is supported by another faculty from physics and faculty from two other departments to teach these course offerings. In particular, the summer academy courses require additional instructional personnel, both BSC faculty and master physics teachers, making the programs extremely faculty time intensive. Despite receiving NSF supplementary funding (for candidate scholarships and support), the *M.S.Ed. (Physics)* program courses alone are run on a cost-recovery basis; BSC makes money on the summer academy courses in particular (six graduate credits of in-state tuition cost approximately $1800). Summer academy courses routinely fill to capacity and students are turned away. SUNY- Buffalo State College is historically a teacher preparation institution, famed for preparing high-quality teachers, and successfully competes with over a dozen regional teacher preparation institutions. BSC has no other graduate programs in physics, due to the close proximity of SUNY University at Buffalo which has a complete offering of physics graduate programs and is the Western New York regional flagship institute for physics research. As a result of the success in these endeavors, the *M.S.Ed. (Physics)* programs and associated activity (the *Summer Physics Teachers' Academy* and the *Western New York Physics Teachers' Alliance*) are viewed with considerable institutional pride, and we consider these as institutionalized.

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