Comparing Finnish (Helsinki) and New York (Buffalo State) Physics Teacher Preparation

Finland has been spectacularly successful in school science student learning according to PISA 2006 (#1 in Science; #2 in Reading; #2 in Math) and PISA 2009 (#1 in Science; #2 in Reading; #1 in Math).

OECD (2010), PISA 2009 at a Glance, OECD Publishing.

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Finnish physics teacher candidates are supported by the state with free tuition and an independent living allowance for a five year program of study (three years B.S. plus two years M.S.); teachers are a small and highly select population. A considerable proportion of Finnish physics teachers are initially trained as mathematics teachers and add physics as a secondary certification. Finnish high school teachers earn salaries comparable to their NY public school counterparts, well above the general US average.

Finnish physics teacher candidates have a varied High School (yhteiskoulu) physics background (comparable to a partial progress through a College algebra-based physics sequence) in Finnish depending upon the individual and their school. All Finnish candidates previously had several years of physics as a separate Middle School subject in Finnish, roughly equivalent to an extended scope NY conceptual-Regents physics course. Finnish HS mathematics is much more rigorous than NY Regents mathematics requirements, with *most* teacher candidates completing the *long form* mathematics sequence – basically mathematics every semester with extended conceptual and word problem solving practice ending at about a US *University Calculus II* level. Students completing the yhteiskoulu *long form* maths sequence are an elite group.

Hence, Finnish physics teacher candidates may have little or NO university level mathematics course requirements. Buffalo State physics teacher candidates have at least 15cr of mathematics course requirements. NY physics teacher candidates are required to take more advanced mathematics content coursework than their Helsinki counterparts (compared to those Finnish teachers without mathematics certification).

Finnish physics teacher candidates spend a great deal of programmatic time conceptually spiraling through the physics material they will teach (only) establishing an enriched conceptual consolidation known as *kasitteellinen lujittaminen* *–* which we abbreviate as *lujitta (lou–weet–tyah). Lujitta* involves revisiting physics material comparable to the entire canon in US calculus-based texts (e.g. Knight’s *Physics for Scientists and Engineers with Modern Physics* is the text at the University of Helsinki) at least twice for most candidates, and for many three separate times. Each pass strives for greater conceptual linkage and sophistication augmented with extended practical (phenomenological laboratory) experience and increasing didactical analysis within the same well-defined and delimited scope of physics content. Rich applied conceptual physics understanding builds from a canon first seen in middle school, and is not essentially mathematical in nature. This contrasts sharply with the US bachelors degree practice of presenting (largely by mathematics) and extending new topics beyond the scope of the high school classroom content in upper level undergraduate courses for physics teacher candidates. At Buffalo State, PHY510, 620 and 622 are three courses that are essentially *lujitta* courses.

Buffalo State undergraduate students complete a writing intensive laboratory course, and complete a laboratory report in their capstone laboratory course. Buffalo State masters students complete a master’s project. Helsinki students complete three major written projects (undergraduate teaching report and physics teaching report plus their *Gradu* master’s dissertation).

Buffalo State undergraduates complete intermediate physics courses on many more physics topics than their Finnish counterparts, including theoretical physics, computational physics and a more advanced mathematical course on electricity and magnetism. Many Buffalo State students also complete undergraduate courses on classical (Lagrangian and Hamiltonian) mechanics, and quantum mechanics.

Buffalo State physics teachers have typical US laboratory coursework (a three semester calculus based intro sequence with labs, an electronics course with lab, a capstone lab course). Helsinki physics teachers have far more laboratory (practical) coursework – a two year long calculus based sequence with lab, and extended laboratory coursework every year of the five years.

Conclusions:

In the US, a few physics teachers’ graduate courses run by physics departments such as those at ASU *(Modeling),* Buffalo State , NCSU *(Matter and Interactions)* and U VA reprise introductory physics content at a mathematical level no higher than their introductory calculus based sequences, while adding laboratory and reflective work and pedagogical content knowledge (PCK). These courses are a US manifestation of *lujitta,* thoughunfortunately most US physics teachers do not take these latter US *lujitta* physics courses. Such courses should be more widely offered in the US to physics teachers and candidates, E.g. *Modeling Physics Workshops*.

The widespread US claim that “every physics teacher should have an undergraduate major or minor in physics” should be challenged; clearly our highly successful Finnish physics teaching counterparts have a very different scope and sequence of coursework than standard US physics major and minors do. Specialty programs with limited physics content scope and *lujitta*-like consolidation with PCK and reflection seem quite effective elsewhere, and should be considered in the US.

A five year bachelor’s plus master’s degree including math and physics certification program might be an interesting Buffalo State experiment, particularly given NYSED teacher licensure.

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