Snowmass2021 - Letter of Interest Details

Topical Group(s):

☐ (CEF1) Applications & Industry
☑ (CEF2) Career Pipeline & Development
☐ (CEF3) Diversity & Inclusion
☑ (CEF4) Physics Education
☐ (CEF5) Public Education & Outreach
☐ (CEF6) Public Policy and Government Engagement
☐ (Other) *[Please specify frontier/topical group(s)]*

Contact Information: Tiffany Lewis (tiffanylewisphd@gmail.com)
Authors: Tiffany R. Lewis (USRA)

Rethinking Physics in Secondary Education: Purpose and Practice

Purpose: The purpose of government funding for public secondary education is to produce an educated electorate. This is important in a democratic society because each citizen becomes responsible for the betterment of the society through their vote and political activities, including holding elected office. Thus, it is important that the education of the electorate prepare them for these roles, which require an ability to understand and inform themselves about important issues in society, as well as to think critically about topics not every individual will personally experience.

Theory of Knowledge and Developmental Learning: The human ability for abstract thought is gained over the course of childhood and adolescence, aided by education. Early in life, toddlers are only able to think about concrete objects and how they personally interact with those. As children advance through primary school, they begin to understand how to use symbols, then to apply logical reasoning (1). Mathematics and subjects that use math are integral to developing an individual's ability for abstract thought, and thus considerations of experiences beyond their own, which is how math education impacts society indirectly. Additionally, the abstract thought math requires is not available to all ages due to the course of brain development, thus suggesting that advanced math topics be studied ever earlier in the educational process is not consistent with a developmental view of knowledge acquisition.

Physics Prospects and Barriers: Physics is an excellent tool for developing the ability of secondary school students to think abstractly and critically because it involves using symbols, solving problems, and even making decisions using critical thinking. Not all secondary schools in the US offer physics. Those that do may not offer advanced placement courses, or may only offer physics to students who have managed to complete calculus as a junior so that it may be used to teach kinematics to a small cohort of elite seniors. Additionally, there is a shortage of qualified physics teachers for advanced math and physics at the secondary education level, which makes offering such courses either impossible or incredibly confusing for the students

(imagine being taught by someone unable to explain the material). This method of continually weeding out students who are allowed to be exposed to physics at very early levels (or who are exposed in haphazard ways) is not helpful to efforts for a generally educated electorate, nor for diversity and general participation in the field.

Physics also has the potential to teach secondary school students about topics relevant to the electorate directly. While it is difficult to imagine how knowledge of kinematics would directly apply to any political topic, most people will directly or indirectly make decisions related to electricity (how it is produced and managed), atomic and nuclear reactions, use of outer space (space weather, near earth objects, NASA's mission), and the effects of electromagnetic radiation (cell signals, impact on the body, uses for different wavelengths). These types of topics naturally fall into physics 2 or modern physics courses in the present line up, without always noting the specific applications of the science in society. They are also conceptually more interesting to the student not otherwise eyeing a physics program in college, while not requiring prior knowledge of mathematics beyond algebra. This lowers the bar for participation among students who might otherwise not be exposed to physics at all.

Thus, I propose that it would be a greater societal service to focus on teaching the above listed topics, in place of algebra-based kinematics, to sophomore or junior year students at the non-AP level. The same students should in principle be free to take an AP or IB level physics course in a later year if the school offers such a program.

Caveats and Clarifications: It is worth noting that the program I have described is not intended to replace or impact AP Physics, which can be used by some students to reduce their college course load. However, AP Physics 1 and AP Physics 2 are intended for algebra-based instruction, and AP Physics 2 covers most of the topics I have described (2). My intent is to alter the expectation of what a physics course ought to be for an audience of high school students who might otherwise avoid a subject considered dull or "only for geniuses" by making it more accessible and more directly tied to societal impacts. This is in no way a suggestion to alter college level curriculum, but rather a recognition that kinematics will be studied in college at the calculus-based level, for students who choose to pursue it, with little need for previous study of the same topics with algebra-based methods. The better focus for students who know they would like to pursue physics in college being an AP style course and/or keeping up their math preparation.

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