Comments on Chapter 10:

The Talent Competition, Blueprint for Action

within the Final Report

National Security Commission on Artificial Intelligence

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Full Disclosure, about Ed Barker:

I have expertise in certain STEM Education initiatives, including federal and state STEM/CS/STW education and teacher development initiatives.

I am a graduate student at Georgia Tech with a BS degree in electrical engineering, M.S. Public Policy, and near completion of a M.S. in History of Technology, working toward a Ph.D. specializing in Federal Science & Technology Education Policy.

I am employed full time as a lead software engineer for L3Harris, Space & Airborne Systems Division, Mission Avionics. My work there is in next generation computing for the F-35 TR3 aircraft. The next-gen system will host a variety of mission avionics applications including signals processing, AI, and mission systems software.

My views here do not represent L3Harris, Georgia Institute of Technology, Kennesaw State University, the University System of Georgia, or anyone else. These views are solely my own, based on 8+ years of research into STEM / CS / STW human resource / teacher and student supply issues.

The remainder of this document is excerpts from Chapter 10 of the report, the original text is in black.

Generally, my comments are in red, and blue.

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• Increase Funding for STEM- and Al-Focused After-School Programs

o STEM and Al-focused after-school learning programs expose students to STEM-and Al-related programs beyond normal school hours. The length of the school day limits teachers' ability to cover a myriad of topics. American elementary school students are exposed to an average of 20 minutes of science and 60 minutes of math during the school day.3 Given the short amount of time that teachers are able to spend on STEM in their classrooms, some school districts have begun to offer after-school programs that expose students to STEM in a less structured environment. More time spent studying STEM topics helps students' test scores, and for those who are underrepresented in STEM fields, federal funding for after-school programs will increase students' accessibility to quality educational tools.4 Appropriations for after-school programs should favor applications that are jointly submitted by a local educational agency and a community-based organization or other public or private entity as a way to defray costs and encourage community engagement.

The ESSA Act of 2015, Title IV Section A, was intended to be a unified program that generally seeks to accomplish the goal stated above. https://www.ed.gov/essa

The applications are submitted by the state lea as stated above and are plans designed by the states. The authorizations and appropriations to date are as below.

	FY2017	FY2018	FY2019	FY2020
Authorization	$ 1,650,000,000	$ 1,650,000,000	$ 1,650,000,000	$ 1,650,000,000
Appropriations	$ 400,000,000	$ 1,100,000,000	$ 1,170,000,000	$ 1,120,000,000

It appears that the recommendation is duplicative to ESSA Title IV, Sec. A. Leveling the appropriations with the authorization would provide an in-place vehicle to provide this effort.

I have not done an exhaustive analysis but at first glance I am not sure that the legislation is accomplishing what some of the proponents sought.

https://crsreports.congress.gov/product/details?prodcode=R45977

https://www.ed.gov/essa

Question: Where is the human capital to conduct the teaching ?

• Increase Funding for STEM- and Al-Focused Summer Learning Programs

o STEM- and Al-focused summer learning programs will encourage students to engage in STEM and Al activities during the months when students are typically unengaged and experience learning loss. The 21st Century Community Learning Centers Act is an example of a program that funds "academic enrichment opportunities during non-school hours for children, particularly students who attend high-poverty and low-performing schools" and has exhibited proven, positive results.5 Much like the after-school initiative, priority should be given to those applications that are jointly submitted by a local educational agency and a community-based organization or other public or private entity.

Question: Where is the human capital to conduct the teaching ? See last section.

• Allocate Funds for K-12 STEM Teacher Recruitment, Retention, and Training

o Teachers are an integral part of the learning experience for STEM subjects. One inequity is the lack of teachers with the requisite proficiency in STEM. Evidence shows that STEM teacher training for current teachers is sporadic, ineffective, and not effective in addressing the specific needs of individual students.6 Moreover, recruiting high-quality K-12 teachers with STEM experience and proficiency is difficult. This is particularly concerning, as teachers are one of the most influential aspects of school, having two to three times the impact of other components, such as leadership and school services? *As the world continues to integrate technology into education, teachers must be taught how to use this technology as well as how to teach students the critical foundations and basic functions that come with it*.8 Support should be given to school districts to create and execute teacher training in Al concepts. techniques, and curriculum design, with preference given to professional development courses that count against continuing education requirements for teacher certification.

I mostly agree with the comments above except for 'professional development' and the comment on 'integrate technology into education'.

Professional Development:

I have a difficult time finding an educator respects and finds PD useful. The observation is not a nationwide scientific study. There is some good PD, but it is hard to find. PD for CS and some math teacher teachers may have some impact, but beyond that I'm doubtful.

'school districts to create and execute teacher training in AI…..' – in general, school districts do not create and execute PD, they contract it out to vendors.

The ideas expressed here on PD are not new, and date back to the Eisenhower Administration. Historically, I am not convinced of the lasting positive impact.

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Big Problem:

As the world continues to integrate technology into education, teachers must be taught how to use this technology as well as how to teach students the critical foundations and basic functions that come with it.

This statement has two parts, with ambiguous meaning. For example:

***Use** the internet versus **build** the internet. USE and BUILD are different.*

'integrate technology into education'. The wording of this sentence is very problematic. There is ongoing chronic confusion in education and teacher education about the terms 'technology education' and 'educational technology'. The terms are dramatically different in meaning and practice. There are experts at Virginia Tech that spend way too much time explaining the difference to the educational community.

USE will send the issue to the 'educational technologists', which in turn will motivate smartboard vendors and others in that complex. Also, universities would leap at the opportunity to make money in their educational technologies program with PD and masters programs. Education technology is a cash cow for many universities. The ed tech industry was born in part by the birth of digital technologies and their introduction into classrooms with 'old-school' teachers. New teachers are 'digital-natives' and have a different approach to technology and would naturally be more comfortable with this topic.

Through the effect of 'satisficing', providing PD in 'USE of ai' would create an illusion of success in ai, but would NOT accomplish the goal of increasing literacy in statistics, math, computer science, or the underlying technology of ai. If the goal was USE, them success is no longer an illusion but real.

BUILD sends the issue to the 'technology educators', in this case the computer science teachers and math teachers.

The goals, USE and/or BUILD needs to be separated and explicitly articulated!!

The USE / BUILD ('technology education' and 'educational technology'.**) confusion could cause billions of dollars in misdirected funds and result in a 'lack of fidelity' in the intended policy, both in program implementation and in PD.**

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• Direct and Fund the National Science Foundation to Create STEM Scholarships and Fellowships
o We recommend that the NSF create 25.000 STEM undergraduate scholarships, 5,000 STEM PhD fellowships, and 500 postdoctoral positions over five years to increase the number and quality of STEM and Al practitioners that will reach the job market in a few years.9 Growing the nationwide STEM talent pool in high-demand areas requires a pipeline of students who have studied relevant STEM coursework during their undergraduate careers. Between 2000 and 2017, the share of STEM bachelor's degrees earned—as a percentage of total bachelor's degrees earned in the U.S.—rose from 32% to 35%.1° The sharpest recent increases were among computer science and engineering majors." For Al specifically, a degree in cognitive science or computer science with concentrations in Al or machine learning (ML) can pave the way for future careers in Al research or practice. Al is rarely offered as a major at the undergraduate level. Instead, universities offer standalone courses, a sequence of Al courses, or the option to study a technical major with a concentration in Al. Until a major in Al is more universally offered at U.S. universities, STEM scholarships will increase the number of individuals with the skills necessary to work on Al.

o Scholarship and fellowship recipients should receive full tuition and room and board. Undergraduate recipients should receive a stipend of $40,000 a year. and graduate recipients should receive a stipend of $70,000 a year.12 Combined with postdoctoral positions; this will bring the total cost to $7.2 billion over five years.13

Full Disclosure: I am a member of the Georgia Tech and Kennesaw State University systems. The following is NOT intended as a sales pitch but as an illustrative example.

The request to provide 25,000 STEM undergraduate scholarships is open to improvement and cost reduction. The most effective thing that can be done in the undergraduate system is to fix the secondary education teacher supply ($ 200 M) . The teacher supply issue is the primary determinant of throughput in undergraduate education.

The phrase “25.000 STEM undergraduate scholarships” should be stricken and re-written as “25,000 STEM **Masters Level Graduate** scholarships” contingent on the CS degree being taken within a CS-AI threaded model. See OMCS at Georgia Techs as an example.

Georgia Tech and Kennesaw State are bursting at the seams with computer science majors. The Georgia Tech online master’s in computer science is huge, with nearly 11,000 candidates in process. Georgia Tech this spring could have made the incoming freshman class 100% computer science majors without any degradation in qualification. The last time I met with the Dean of CS at Kennesaw State he told me they are beyond capacity and have been for a long while.

Any Federal sector employee, including DoD personnel, military or civilian, enlisted or officer, should receive as an employment benefit, full tuition benefits to CS/AI training programs, including online masters in CS (AI) as is offered at Georgia Tech and other universities. Also, see post WW2 GI Bill as a template for training ex-military.

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Actions for the Department of Education:

• Add Elements of Computational Thinking and Statistics to Student Testing

o Computational thinking and statistics are vital for students to understand how Al works.14 As interdisciplinary fields, the use of computational thinking and statistics within Al can be found at all stages of discovery, from developing and planning studies to assessing the results. Critical thinking along with problem-solving are vital skills taught in statistics. Unfortunately. the majority of high schools in America do not require testing for skills related to computational thinking for graduation.15 There is no way to comprehensively measure U.S. students' overall abilities or aptitude for skills related to computational thinking and statistics. Students are taught what is needed to pass exams. Compared to other countries. many of which have statistics in their curriculum, the United States ranks low in math.16 By including subjects critical for computational thinking and statistics in standardized testing at the state level, the United States can gain a better understanding of students' capabilities and work to implement curriculum and lessons focused more on computational thinking and statistics in order to ensure students' success.

Recommendation: Require Statistics in Middle School and Computer Science Principles in High School

I did a non-published research project in 2016 through to about 2018 on STEM/CS/CTE courses in Georgia.

The research question:

Of a selected group of STEM / CS / CTE courses in secondary education, what is the course ***availability*** and the course ***popularity***?

Sub-Question: If the course is not available, then why?

The method:

Using data from the Georgia Department of Education (GaDOE), I analyzed each school in the state, looked at what courses were offered (availability) and the percentage of students in that school taking the course (popularity).

Findings:

- The courses we want students to take, are popular with students.
- The courses are not widely available, negatively impacting success.
- Meeting with the GaDOE, and school superintendents, it was determined that the schools want to teach the high demand course, attempting to open new courses and programs, and closing the programs even before they start or shortly thereafter due to teacher supply problems.
- Department of Labor statistics on teacher demand is meaningless because of non-reporting by the districts. They know in advance there is an inability to open a course or program. Consequently, universities perceive zero demand for many high demand teaching fields.

Actions for State Legislatures:

• Require statistics as a required course in middle school and computer science principles in high school. Many fundamental concepts in Al, ML, and their subfields are applied statistics in disguise.17 The techniques and algorithms used are heavily based in statistical methods, such as cluster analysis and model selection. Statistics and computer science principles are needed to prepare students for Al courses, concentrations, and internships. Providing training in statistics starting in middle school will better prepare students for the increasingly advanced analytic techniques in demand for Al and STEM careers. Similarly, currently only 47% of U.S. high schools offer computer science coursework.18 This is much higher than just a decade ago, thanks to nationally organized initiatives, but this still leaves many high schools without computer science education. Moreover, adoption has been piecemeal and curriculum depth varies widely. Therefore, state action is needed.

• On their own, neither statistics nor computer science are sufficient to teach students the concepts needed to understand Al. Having both allows students to experience the critical bases that must be covered early on in order to prepare students for a technological career. Simple math such as basic probability and summarizing numerical data is applying concepts of statistics and computer science.

Answer to Where is the human capital to conduct the teaching ?

Federal action is needed to create a cooperative (respecting the 10th Amendment) system of teacher development for STEM / CS / STW / AI subjects. Following the template of the Morrill Act of 1862 and Smith-Hughes Act of 1917, the HDTI, High Demand Teacher Initiative will create a framework for organizing teacher development that support national priorities.

Please see ***"The High Demand Teacher Initiative (HDTI) , An Act to Provide for the Creation of Teachers in High Demand STEM, CTE, and STW Fields."***

The HDTI provides for:

- Initial training and induction of teachers into high-demand teaching field by highly-qualified candidates
- Provides for additional opportunities for qualifying teachers to continue their studies by pursuing a qualifying MS degree in a STEM, CS/AI field. (different paradigm than pursuing a master's in education)

The provision provides for attracting, and retaining, highly-qualified teachers.

The success of the recommendation by the National Security Commission on Artificial Intelligence, the Skilled Technical Workforce Initiative at the National Science Board/ National Science Foundation, and other programs are contingent upon solving the teacher supply problem.

This report is placing demands on education for which there is insufficient capacity in the teacher workforce. The reverse salient that teacher supply impacts all segments of the CS/AI, STEM, CTE, and STW education and workforce development efforts. $ 200M / year is a game changer.

I have been working on this problem of education and teacher supply for about eight years. I have worked with state and local government, state agencies, and industry on this issue. My focus has been on the larger problem of teacher supply.

A colleague of mine, Mike Reilly, is a well-respected computer science (soon to be AI) teacher in Gwinnett County. Gwinnett County Public Schools is the 13th largest school district in the United States. Mike is 'the go-to' resource for advice within GCPS when it come to CS education in that district.

Mike was instrumental in creating the major policy shift in Georgia's computer science education initiatives. Mike met with Governor Nathan Deal, they worked the issue out, a commission was established to review and finalize the matter, and we have a new framework for doing education.

I'm still working on filling out the framework with teachers. It's a work in progress.

Feel to contact me or Mike with any questions.

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