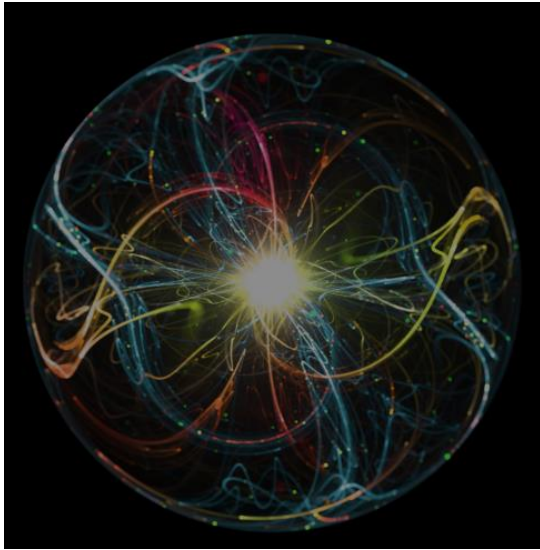


# Quantum Education and Workforce Development

Donn M. Silberman, Fellow of the [OSSC](#) & [SPIE](#)



## National Q-12 Education Partnership

Quantum Workforce: Q-12  
Actions for Community Growth



2/02/2022  
Virtual



Educating our population about the quantum world so they can actively participate in the next generation of innovation as we build a better tomorrow is essential. This effort is already underway locally, nationally, and globally; here the reader is introduced to quantum education and career pathways for students.



**In my previous article, [Quantum Theory with Current and Future Cybersecurity Applications](#)**, I mentioned that the US Federal Government passed the [National Quantum Initiative](#)<sup>1</sup> and other countries have similar programs<sup>2,3,4</sup>. Due to the continuing global shortage of skilled technical workers in advanced science, the new quantum ecosystem is also in need of educated people.

**From the above article,** *'Some very excellent work<sup>5,6</sup> has been done assessing the needs of the quantum industry. Most of this work has been for people with undergraduate<sup>7</sup> and graduate degrees in physics, chemistry, math, engineering, computer science, material science and related technologies. In line with some of my past educational endeavors, I have been consulting with [EdQuantum](#) to develop a hybrid curriculum in advanced optics, spectroscopy, and quantum technologies for technicians to fill the workforce gap between those with undergraduate and high school degrees.'*

**We published a very detailed paper<sup>8</sup>,** ['Quantum Technician Skills and Competencies for the Emerging Quantum 2.0 Industry'](#) that describes work done by others, work that EdQuantum is doing and some current and future efforts. *'To develop a smart workforce, the EdQuantum will integrate into the curriculum higher-level skills such as critical thinking, problem-solving, creativity, and digital literacy as well as the STEM pedagogy and practices for diversity and inclusion. To help fill the quantum education pipeline for future years, the EdQuantum project will use educational tools and recruiting networks for K-12 so EdQuantum students, teachers, and professional industry volunteers can work with K-12 educators in their local regions to prepare K-12 students for college and university programs that include quantum technologies. To expand our outreach across the country, the EdQuantum team will leverage the assets of the Optics and Photonics College Network (OPCN)—currently consisting of 44 college programs in 29 states (see Fig. 1)—to promote the quantum educational content.'*



**Fig. 1** Map of LASER-TEC Optics and Photonics College Network (OPCN) partners and collaborators.

*‘Finally, to support the global science and engineering community, the EdQuantum project will seek partnerships with compatible educational institutions in Canada and Europe. Such a collaboration has already been established with a university in Canada<sup>9</sup> regarding curriculum and materials for teaching quantum science to high school students. There is a prospect of establishing a similar partnership with another college in Canada<sup>10</sup> that is already an OPCN member. A future EdQuantum effort may involve reaching out and cooperating with professional societies such as SPIE<sup>11</sup> and Optica<sup>12</sup> as well as with photonics clubs at colleges and universities in Central America, South America, and the Caribbean to share our curriculum and materials for teaching quantum science.’*

### **Quantum for High School & College Students**

Recently, I developed a new presentation, ‘Quantum for High School and College Students’<sup>13</sup> (and associated webpage) and given it to two groups of engineering (3<sup>rd</sup> and 4<sup>th</sup> year) students, prior to the end of their academic year at the Samueli Academy<sup>14</sup>, a Public Charter (High) School in Santa Ana, California. The host engineering instructor<sup>15</sup>, subsequently asked the students to complete an on-line survey of their impressions of the presentation and the results are available<sup>16</sup>. In general, the presentation was very well received.

During the presentation, a ‘call to action’ was provided to the students and the list of things they can do includes, ‘join or start a club’. Directly after the presentation, two 3<sup>rd</sup> year students contacted me to request assistance in starting a quantum school club. This sparked a new thread to a discussion I have been having with a professor<sup>17</sup> at a local university who is the Co-Director of their Institute for Quantum Studies.

A revised version of the presentation, including the Kahoot<sup>18</sup> quizzes, was given to another class of students at a summer program<sup>19</sup> also at the Samueli Academy. These students wrote the author letters of appreciation<sup>20</sup> which provided an indication that they learned much and may follow up to learn more about quantum science and technology. Also, some of the letters were from fellow students who did not attend and would like to have an opportunity to learn about quantum; this was a surprising and welcome result.

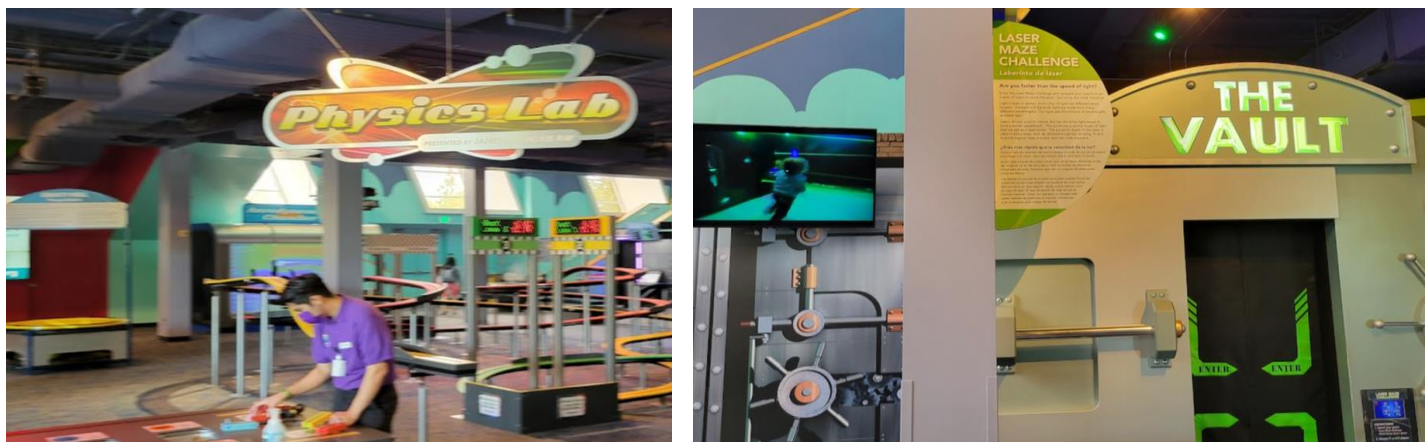
Several months ago, I was invited to participate in the Quantum Economic Development Consortium’s Workforce Development Technical Advisory Committee (QED-C – TAC)<sup>21</sup> and have meet some key people. The presentation, ‘Quantum for High School and College Students’<sup>13</sup> has been shared with TAC and other committee members will modify it with QED-C templates and make it available for other QED-C members.

## The National Q-12 Education Partnership



Q2Work and Quantime are associated with the Q-12 Educational Partnership

The National Q-12 Education Partnership<sup>22</sup> is sponsored by the US Federal government and supported by some large corporations and professional scientific societies. *Q2Work is a member of the National Q-12 Education Partnership and provides coordination and leadership, to ultimately facilitate the community in its efforts to bring Quantum Information Science into the classroom and other learning environments.* One of the Q2Work leaders and I briefly discussed the opportunities to bring informal quantum education to local science centers and museums. Over a nine year period, (from [2004](#)<sup>23</sup> to [2012](#)<sup>24</sup>) I hosted annual Optricks Days at the local DiscoveryCube<sup>25</sup> (Science Center) in Santa Ana, CA and recently contacted their president and chief operating officer to offer my assistance in adding some quantum educational materials to their Physics Lab and Laser Maze Challenge exhibits and perhaps do some live in-person presentations. As the DiscoveryCube being closed for about 18 months due to COVID-19 and just reopening recently, it may be some time before this project gets some direction and then implemented.



**Fig 2.** The Physics Lab and Laser Maze Challenge at the DiscoveryCube in Santa Ana, CA





Another local non-profit educational outreach program I have worked with prior to COVID-19, *Vital Link*<sup>26</sup> provides hands-on, career exploration experiences for high school students, helping them carve out their own unique career path. From 2014<sup>27</sup> to 2019<sup>28,29</sup>, I volunteered with Vital Link at some of their Career Exploration events at local middle and high schools and their annual STEM events at the Orange County Fair Grounds.



**Fig 3.** Hands-On Optics exhibits at Vital Link Career Exploration events in Orange County, CA

Recently, Vital Link relaunched their programs, after being essentially closed for 18 months, with a new president, some new staff and a new website. Once Vital Link gets back to visiting local schools, a new quantum education and career pathways exhibit will be developed and implemented for their use.

As a Fellow of the OSSC & SPIE, I lead a lot of my educational outreach and workforce development projects with other professional society members. These projects and programs are developed in ways that lend them to be used as models for others to use in their local communities. As mentioned above in the paragraph under the map, *A future EdQuantum effort may involve reaching out and cooperating with professional societies such as SPIE<sup>11</sup> and Optica<sup>12</sup> as well as with photonics clubs at colleges and universities in Central America, South America, and the Caribbean to share our curriculum and materials for teaching quantum science.* I have already reached out to the SPIE Student Chapter Coordinator who has reviewed the 'Quantum for High School and College Students' presentation materials and will make it known to all the SPIE Student Chapters worldwide<sup>11</sup> after I give a presentation to the SPIE Optic Education and Outreach Conference<sup>30</sup> in San Diego in August. A paper<sup>31</sup> based on this will be published that will include information for these SPIE Student Chapter members and other interested people on how to modify the presentation to make it their own.

[Link to references](#)

**Donn M. Silberman** is an SPIE Fellow, and Past President of the Optical Society of Southern California. He has provided technical engineering, management, and education to many precision optical and optical instrument companies and educational entities in Southern California for over 35 years. Recently retired from Starrett Metrology Solutions, he has been focusing on current and new quantum technological applications as they are impacting the lives of people globally.

Donn is currently consulting with EdQuantum, an NSF funded educational program to develop curriculum and lab experiments for community college students that have completed at least some laser electro-optics courses. He holds a BS in Engineering Physics from the Univ. of Arizona (Honors in Physics) and an MS in Technology Management from Pepperdine University.

He was an advisor to Irvine Valley College's Laser Electro-Optics Technology programs from the early 1990s to 2020, and he helped move the program to Pasadena City College. Donn founded the UC Irvine's Optical Engineering and Optical Instrument Design programs in 2009; and received the UC Irvine Extension's Dean's Outstanding Service Award in Nov 2012; and was the 2012-2013 Univ. of Arizona Honor's College Advocate for Education Award Winner.

Donn was a Senior Applications Engineer for PI (Physik Instrumente) L.P. for over 10 years, where he worked on many world-class optical instruments for science and industry, including the world's largest astronomical and solar telescopes and the highest precision measurement systems for today's Quantum Photonic (Silicon) Integrated Circuits (QPICs) that are being used in Quantum Computers.

For exercise, Donn trained for and participated in over 65 Sprint and Olympic distance triathlons starting in 2008 and is still training now. Organized races stopped during the COVID pandemic and may start up again in 2022. Donn lives with his wife Ana Maria in Rancho Mission Viejo.