"2nd Workshop on Astronomy Beyond the Common Senses for Accessibility and Inclusion (2022)"
Revista Mexicana de Astronomía y Astrofísica Serie de Conferencias (RMxAC), **54**, 71–74 (2022)

https://doi.org/10.22201/ia.14052059p.2022.54.15

2nd Workshop on Astronomy Beyond the Common Senses for Accessibility and Inclusion (2WAI)(Virtual-Modality, November 17-18, 2021)
Editors: S. Vargas, B. García, G. Hemming, S. Duffau, N. Vázquez, and A. Pérez-DOI: https://doi.org/10.22201/ia.14052059p.2022.54.15

ASTRONOMY FOR STUDENTS WITH VISUAL IMPAIRMENTS: DEVELOPMENT OF THE CAREER EXPLORATION LAB

T. I. Madura[1], C. Christian[2], T. Wild[3], D. Hurd[4], J. Harris[5], L. Bartolone, K. Silberman[6], S. McVoy[7], and K. Walker[8]

ABSTRACT

For students with visual impairments (VI), the possibility of a future in astronomy, or any science, technology, engineering, and mathematics (STEM) field, seems daunting. In order to bolster astronomy and STEM opportunities for high school students with VI in the United States, we developed the STEM Career Exploration Lab (CEL). Our STEM CEL methodology employs tactile astronomy instruction via 3D printing technologies and unique 3D-printed models, professionals with VI acting as role models, and partnerships with local STEM industries that provide insights into possible career paths. In partnership with the South Carolina Commission for the Blind (SCCB) and the Michigan Bureau of Services for Blind Persons (MBSBP), to date we have held four week-long CELs (June 2017, June & July 2018, August 2019) and a 3D printer build workshop (September 2018), thus far serving about fifty students with VI. We have also held one professional development workshop for teachers of the visually impaired at the Maryland School for the Blind in October 2021. We gathered pre- and post-intervention data via student surveys, assessments of students astronomy knowledge, and video recordings of the CEL activities in order to study to what extent the CEL model can enhance the students attitudes towards, interests in, and capacities to participate in astronomy and STEM careers. Once fully tested and refined, we will make our 3D model files and activities freely available for further use and study. This work serves as a testbed for an expanded CEL program aimed at helping increase the representation of persons with VI in astronomy and STEM fields. This work is supported by a generous Innovative Technology Experiences for Students and Teachers (ITEST) grant from the National Science Foundation.

RESUMEN

Para los estudiantes con discapacidades visuales (VI), la posibilidad de un futuro en astronomía o cualquier campo de ciencia, tecnología, ingeniería y matemáticas (STEM) parece abrumadora. Con el fin de reforzar las oportunidades de astronomía y STEM para estudiantes de secundaria con VI en los Estados Unidos, desarrollamos el Laboratorio de Exploración de Carreras STEM (CEL). Nuestra metodología STEM CEL emplea instrucción de astronomía táctil a través de tecnologías de impresión 3D y modelos únicos impresos en 3D, profesionales con VI que actúan como modelos a seguir y asociaciones con industrias STEM locales que brindan información sobre posibles trayectorias profesionales. En asociación con la Comisión para Ciegos de Carolina del Sur (SCCB) y la Oficina de Servicios para Personas Ciegas de Michigan (MBSBP), hasta la fecha hemos realizado cuatro CEL de una semana (junio de 2017, junio y julio de 2018, agosto de 2019) y un taller de construcción de impresoras 3D (septiembre de 2018), que hasta ahora atiende a unos cincuenta estudiantes con VI. También realizamos un taller de desarrollo profesional para maestros de personas con discapacidades visuales en la Escuela para Ciegos de Maryland en octubre de 2021. Recopilamos datos previos y posteriores a la intervención a través de encuestas de estudiantes, evaluaciones del conocimiento de astronomía de los estudiantes y grabaciones de video de la Actividades CEL para estudiar en qué medida el modelo CEL puede mejorar las actitudes, intereses y capacidades de los estudiantes para participar en carreras de astronomía y STEM. Una vez probados y refinados por completo, haremos que nuestros archivos y actividades de modelos 3D estén disponibles gratuitamente para su uso y estudio posteriores. Este trabajo sirve como banco de pruebas para un programa CEL ampliado destinado a ayudar a aumentar la representación de personas con VI en astronomía y campos STEM. Este trabajo está respaldado por una generosa subvención de Experiencias tecnológicas innovadoras para estudiantes y maestros (ITEST) de la Fundación Nacional de Ciencias.

Key Words: sociology of astronomy — tactile models

[1]San José State University, One Washington Square, San José, CA 95192-0106, USA (thomas.madura@sjsu.edu).
[2]Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218, USA.
[3]College of Education and Human Ecology, The Ohio State University, 172 Arps Hall, 1945 N. High Street, Columbus, OH 43210, USA.

2nd Workshop on Astronomy Beyond the Common Senses for Accessibility and Inclusion (2WAI)(Virtual-Modality, November 17-18, 2021)
Editors: S. Vargas, B. Garcia, G. Hemming, S. Duffau, N. Vázquez, and A. Pérez-DOI: https://doi.org/10.22201/ia.14052059p.2022.54.15

1. INTRODUCTION

Nearly everything we know about the Universe comes from studying light and performing computer simulations. Moreover, most astronomy data consists of two dimensional (2D) images or spectra. Together, these make teaching astronomy to students with visual impairments (VI) particularly difficult. One may ask if astronomers can do better than simple 2D images and if it is possible to teach the wonders of the Universe to those with visual impairments. The answer is "Yes!" But how?

In order to bolster astronomy and STEM (Science, Technology, Engineering, Mathematics) opportunities for high school students with VI in the United States, the authors have developed the STEM Career Exploration Lab (CEL). Funded by a generous Innovative Technology Experiences for Students and Teachers (ITEST) grant from the National Science Foundation (NSF), our STEM CEL methodology employs tactile astronomy instruction via three dimensional (3D) printing technologies and unique 3D-printed models, professionals with VI acting as role models, and partnerships with local STEM industries that provide insights into possible career paths. Our team of scientists consists of experts in a variety of fields, including astrophysics and the learning of STEM by students with visual impairments. Key team members also include STEM professionals with VI, who provide important insights into the design of learning activities and 3D models.

2. THE STEM CAREER EXPLORATION LAB (CEL)

In partnership with the South Carolina Commission for the Blind (SCCB) and the Michigan Bureau of Services for Blind Persons (MBSBP), to date we have held four week-long STEM CELs (June 2017, June & July 2018, August 2019) and a 3D printer build workshop (September 2018), thus far serving about fifty high school students with VI. We have also held one professional development workshop for teachers of the visually impaired at the Maryland School for the Blind in October 2021. During each of our summer STEM CEL workshops, about 10-15 students with VI participate in several hands-on 3D printing activities using on-site 3D printer lab facilities located at the SCCB and the MBSBP (see Fig. 1). Students learn about the basic parts and operation of 3D printers and 3D print various objects of their choosing. Students then use specially designed 3D printed tactile models to explore a variety of astronomy topics, ranging from constellations to galaxies (Fig. 2). The activities are designed to emphasize students' spatial thinking skills and consist of handling the 3D models and answering questions about the models and current astronomy topic. Pre- and post-activity surveys and astronomy assessments are used to gauge the accuracy and effectiveness of the 3D models and lessons. During the week, students stay in the SCCB and MBSBP on-site dormitories, where they participate in planned evening social and recreational activities.

During the 3D printer build component of the CEL workshops, high school students with VI work in pairs to assemble and test a Creality Ender 3 desktop 3D printer, which comes as a kit and costs only ∼170 USD (see Fig. 3). The 3D printer build component provides students with VI a hands-on engineering-centered instructional activity that helps build confidence in the ability to perform complicated STEM tasks. As far as we are aware, our 3D printer build workshops for students with VI are the first of their kind in the US, and possibly the world.

In order to learn about STEM career paths, as part of the CELs, students also visit local STEM industries and hear from successful STEM professionals with VI. Students in our programs have visited the 3D printing companies Zverse and Express Printing Solutions, and the Boeing factory where the 787 Dreamliner commercial aircraft is assembled. Students get private tours during these trips and learn about the STEM work performed, STEM careers available, education requirements for obtaining such careers, and the daily working lives of STEM professionals. Finally, students receive mentoring and STEM education and career advice from STEM professionals with blindness, including engineer and patent attorney Ken Silberman of NASA and International Astronomical Union (IAU) astronomer Dr. Wanda Diaz-Merced.

3. CONCLUSION

To date, our STEM CEL workshop approach has been very successful. Data collection and analysis, which includes a series of teacher demographic

[4]Edinboro University, 219 Meadville Street, Edinboro, PA 16444, USA.
[5]Georgia Institute of Technology, North Avenue, Atlanta, GA 30332, USA.
[6]NASA Goddard Space Flight Center, 8800 Greenbelt Road, Greenbelt, MD 20771, USA.
[7]Michigan Bureau of Services for Blind Persons, 1541 Oakland Drive, Kalamazoo, MI 49008, USA.
[8]South Carolina Commission for the Blind, 1430 Confederate Avenue, Columbia, SC 29202, USA.

2nd Workshop on Astronomy Beyond the Common Senses for Accessibility and Inclusion (2WAI)(Virtual-Modality, November 17-18, 2021)
Editors: S. Vargas, B. García, G. Hemming, S. Duffau, N. Vázquez, and A. Pérez-DOI: https://doi.org/10.22201/ia.14052059p.2022.54.15

Fig. 1. Students with VI have access to on-site 3D printer lab facilities during the STEM CEL workshops, where they learn about the basic components and operation of 3D printers.

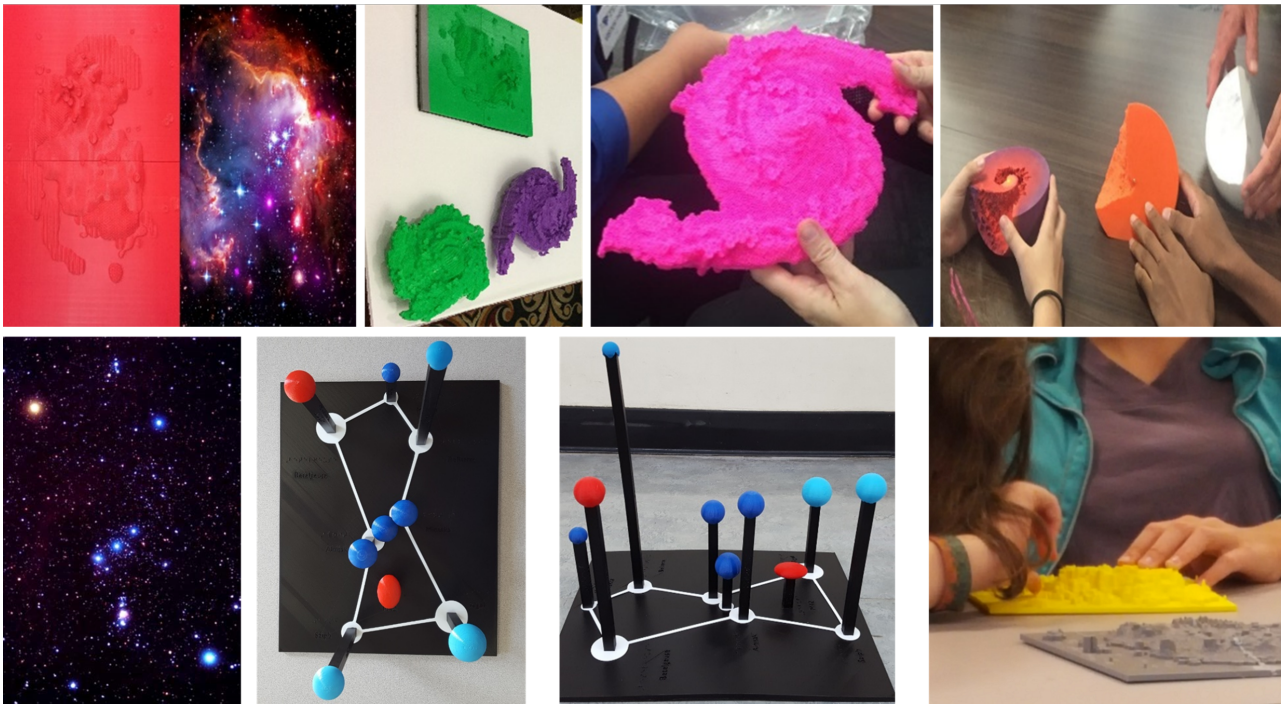

Fig. 2. During the STEM CEL workshops, students with VI use our specially designed 3D printed tactile models to explore a variety of astronomy topics, ranging from constellations to galaxies.

2nd Workshop on Astronomy Beyond the Common Senses for Accessibility and Inclusion (2WAI)(Virtual-Modality, November 17-18, 2021)
Editors: S. Vargas, B. Garcia, G. Hemming, S. Duffau, N. Vázquez, and A. Pérez-DOI: https://doi.org/10.22201/ia.14052059p.2022.54.15

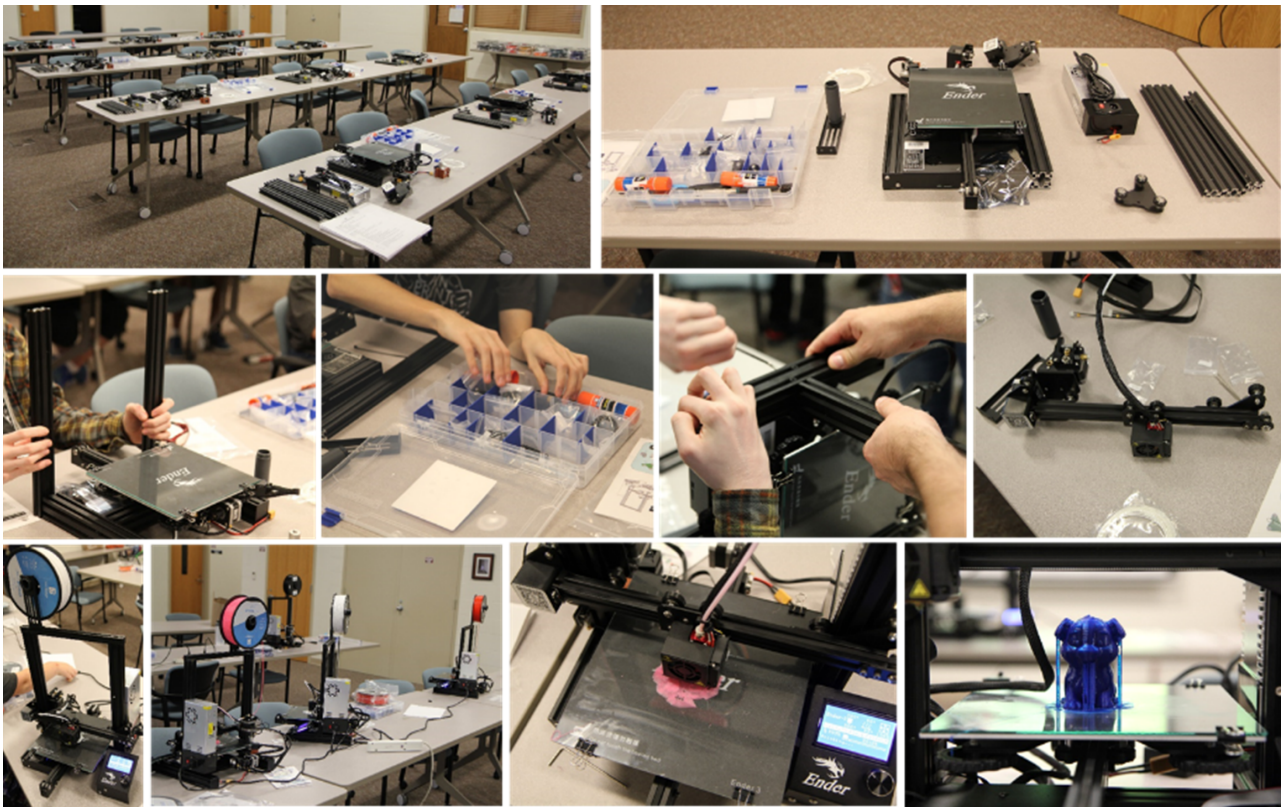

Fig. 3. Pictures from our pilot 3D printer build workshop at the MBSBP in September 2018, during which students with VI each assembled, tested, and took home a desktop 3D printer.

questions, a teacher anticipated experiences questionnaire, a teacher attitudes survey, a teacher actual experiences questionnaire, a student demographic survey, student science and astronomy attitude surveys, a student self-efficacy instrument, and a student astronomy and space science concept test, are in progress and will continue over the next few years. In collaboration with the Council of Schools and Services for the Blind (COSB), we plan to extend our program to 13 US states over the next 2-3 years.

We will work with teachers of the visually impaired, high school STEM teachers, and students to refine our 3D models and associated activities. Once we have thoroughly tested and refined our models and activities, we will share what we have learned, as well as our models and activities, with the broader community via various online repositories (IAU tactile respository 2021).

REFERENCES

IAU tactile model, 2021, repository