Assistive Technology: Shaping a Sustainable and Inclusive World
D. Archambault and G. Kouroupetroglou (Eds.)
IOS Press, 2023

doi:10.3233/SHTI230619

Learning About Assistive Technology from High School

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Abstract. This communication will present an educative and research project that has linked the creation of 3D Assistive Technology (AT) for people with disabilities with the training of students of secondary education. STEMBach educational program aims to provide quality scientific education to secondary school students in the fields of science, technology, engineering, and mathematics (STEM) through research projects. Specifically, the text focuses on one project proposed by the TALIONIS research group, which uses 3D printers to design and create assistive technology (AT) for people with disabilities. The project involves students from eight different high schools and ten individuals with disabilities from four non-governmental organizations. The students design and print the AT using software such as Tinkercad and Cura Software. After testing the AT, outcome measurement instruments are used to validate their effectiveness. The project is based on a Learning-by-doing methodology with a structure of service-learning, and the involvement of the students is voluntary. The objectives of the project are to involve the students in research and innovation, to generate resources and AT for people with disabilities, and to determine the effects of AT on the lives of its users. Finally, the project leads to identifying new needs of people with disabilities that could be addressed through further research work.

Keywords. STEM, Learning-by-doing, Assistive Technology, 3D Printer

1. Introduction

STEMBach is an educational program that seeks to achieve excellence and quality in the training of secondary school students in the scientific field (Science, Technology, Engineering and Mathematics - STEM). Its objective is to promote critical thinking and the acquisition of the students' competencies in science and technology through a research project [1]. The projects are proposed and tutored by professors from the university, with a follow-up from the high school teachers. The students of secondary education join this program voluntarily and can choose the research project that most motivates them and generates concern. Each student can work independently or in a

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group and does her / his project in two academic courses. The final work is presented in public defense in view of a tribunal.

The STEMBach program of the University of A Coruña, in the biennium of 2019-2021, and 2020-2022 offered more than 25 proposals of research projects to the students of secondary education. Among them, is the one that will be presented in this communication: Innovation with 3D printers for the design and creation of AT for people with disabilities [2].

This project was proposed by the TALIONIS research group, based on its field of expertise and the collaboration with different NGOs of people with disabilities in our region. The proposal aims to cover the real demand of these individuals, their families, as well as the NGO that represent them. Thus, the direct beneficiaries of the proposal are the people who present some type of limitation in the activity or restriction in the participation, caused by a functional deficit.

In addition, as a research project and after the assistive product was created and used by the person in their daily activities, students should verify the effectiveness of this device. To do so, the use of outcome measurement instruments is proposed to them. These steps are guided and followed by the teachers of the university.

2. Purposes

The project has several objectives: (1) to involve the students of secondary school in a research and innovation project, from the University, (2) to generate resources and AT with a 3D printer for people with disabilities to improve their performance of daily life activities, (3) to validate and determine the effects of AT on the life of its users. In addition, the development of this project leads to identifying new needs of people with disabilities that could be affordable through research work.

3. Methodology

From the educational perspective, the project has a design based on the methodology of Learning-by-doing, with a structure of service-learning. The research project done by STEMBach's students has a descriptive, observational and cross-sectional design. It was performed between 2020 and 2022, with the participation of 8 students of secondary education (from 4 high schools located in two cities: A Coruña and Ferrol) and 10 persons with disabilities (the users, belonging to 4 NGOs, in the same cities). Being several students, from different schools, 4 working groups were created, with their own support product developments.

For each student, the participation in STEMBach initiative is voluntary, and as a result, he/she can obtain a recognition in their baccalaureate degree. So, the motivation and the implication of the participants are normally high. To start the process and facilitate the contextualization, students assisted a webinar offered by university's teachers, in which the basic concepts of disability, assistive technology and conditioning factors were presented. In addition, during a second webinar session, the students learned how to design simply with 3D software and how to manage the parameters to print with a 3D printer.

After that, the fieldwork was implemented. Students contacted the NGOs selected close to their residences and met with users of these organizations.

Through a small interview, they could obtain a set of data from people with disabilities. This process was useful to know the specific needs of that people, the activities in which they had more difficulties and the priorities to use any AT to solve these problems.

Subsequently, they designed the assistive technology in 3D, using the Tinkercad software [3], that would respond to the identified needs. Then, the AT was printed with the Ultimaker S3 printer, using the Cura Software®[4], and were delivered to persons with disability. They could try them in their daily life activities, during a period from 2 to 4 weeks. After the test time, the students met again with the users and applied two instruments of outcome measures.

The registered variables were: demographic data (gender, age, place of residence, and diagnosis), the activity with limitation or restriction identified by the person with a disability, the satisfaction with the 3D printed AT, and the matching degree between the person and the assistive technology. The tools used to recover the data were a semi-structured interview, the Quebec User Evaluation of Satisfaction with Assistive Technology (QUEST 2.0)[5], and the form for the device of the Assistive Technology Device Predisposition Assessment (ATD PA) of the Matching Person & Technology (MPT) model [6].

The procedure was done in three phases, according to the framework proposed in research previously [7]: Phase 1 – Design (identifying), including the exploration of the needs of the person with disability and the detection of those that could be met with the use of 3D AT printed; phase 2 – develop of the prototype (creating), this step is focused on the creation of a first sample of the AT (or prototype) for testing, that will allow checking if the initial idea answers effectively to the demands of the user; and phase 3 – outcome measures (implementing), when the 3D printed AT is incorporated to the daily life of the person for doing the activities for which had been created, and finally, to assess his/her satisfaction and match with the device.

The data were registered using RedCAP, a secure web application for building and managing online surveys and databases [8], and privacy and data confidentiality were kept during the project. The professor from the university supervised all development of the research project, and guided the work of STEMBach's students, tutoring periodically.

4. Results

Finally, 10 AT were created and printed in the four working groups for 10 people with disabilities. In Table 1 are shown the results with the designed AT during the development of the project. Figures 1-4 shows the assistive technology created by the students during this project.

After delivering and using the assistive technology, the STEMBach's students implemented the scales of outcome measures, obtaining very good results.

In relation to the satisfaction of the designed AT (measured with the QUEST 2.0 – only the items for the device), the mean score obtained was 4 (SD= 0.48), on a maximum of 5 points. The criteria with more importance about the product, and identified from the QUEST 2.0, were "the facility of use" (N= 10), the weight (N= 10), and the dimensions (N= 7). The best-reported satisfaction was for the model cylindrical for low-cost switch with 4.88 points.

Table 1. Distribution of AT created by each group and for the people with disability

Work Group	No. of students	Assistive technology designed in 3D	Diagnosis of the user person and No.
1	2	Low-Cost Switches (3 models were created): Circular / Quadrate / Cylindrical	Amyotrophic Lateral Sclerosis (1)
2	2	Double AT: Page turner & bag opener (2 models were created)	Neoplasia (2)
3	2	Case for TV remote control Handle for brush	Cerebral Palsy (3)
4	2	Support for smartphone Ergonomic handle for comb Door opener	Tetraplegic (2), Muscular Dystrophy (2)

In general, the degree of match between the person and technology (measured with the ATD PA) was moderately high, with a mean of 3.04 (SD= 0.56), on a maximum of 5 points. The items scored with the higher score were “the user feels physically, emotionally and socially secure when using the device” (M= 5), and “the user feels comfortable (not self-conscious) using the device around family” (M= 5). Again the AT that obtained a higher degree of matching was the cylindrical low-cost switch.

Figure 1. Low-Cost Switches created by workgroup 1

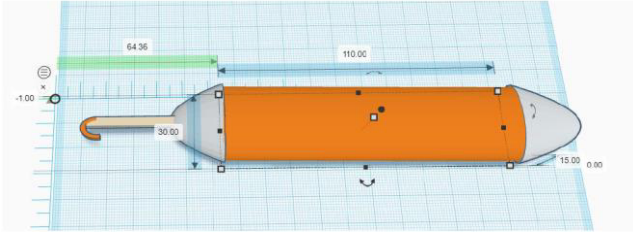

Figure 2. Design of the page turner & bag opener created by workgroup 2

Figure 3. Handle for brush created by workgroup 3

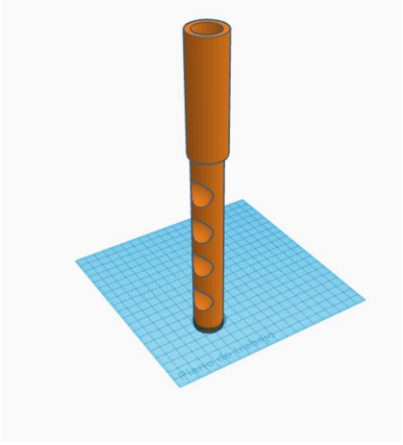

Figure 4. Design of ergonomic handle for comb created by workgroup 4

5. Conclusions

This project has presented an educational program to promote scientific thinking in the students of secondary school. Also, the specific thematic, focused on the life of people with disability, has allowed bringing students closer to the reality and needs of this population.

Ten AT in 3D have been designed and created to meet the needs of 10 persons with disability, based on their identified interests and expectations. The procedure has been done following a structured process, divided into three phases: design, prototype and outcome measures. This fact has given meaning to the research. Further, the use of 3D software has had a positive effect on the imagination and spatial intelligence of the students.

After applying the tools of outcome measures, the level of the user's satisfaction has been high, and the degree of match between person & technology was moderately high.

The development of the program STEMBach, with a research project in the field of assistive technology, has positive results:

- The students of secondary school acquire the awareness of the functional situation and needs of the daily life of people with disabilities.
- The design of low-cost AT with a 3D printer promotes the imagination of the students and the development of ideas to meet the needs identified by people with disabilities.
- The research project responds to a real demand that people with disabilities, their families and NGOs have.
- The implementation of a structured procedure has facilitated the development of AT in which the user is the best important part, with his/her implication from the beginning, and prioritizing his/her opinions, preferences and needs.

Acknowledgments

This research had the support for its publication by National Program of R + D+i oriented to the Challenges of Society 2019 (coordinated research) Grant number: PID2019-104323RB-C33. Ministry of science and innovation. CITIC is financed by the Xunta de Galicia through the collaboration agreement between the Consellería de Cultura, Educación, Formación Profesional e Universidades and the Galician universities for the reinforcement of the research centres of the Galician University System (CIGUS). The research carried out by TALIONIS group is financed by the Xunta de Galicia (Aid from the Consellería de Cultura, Educación, Formación Profesional e Universidades for the consolidation and structuring of competitive research units) ED431B 2022/39

References

[1] University of A Coruña. STEMBach Presentation [Internet]. 2022 [cited 2022 Feb 1]. Available from: https://www.udc.es/en/stembach/presentacion/
[2] University of A Coruña. STEMBach Projects [Internet]. 2020 [cited 2022 Feb 4]. Available from: https://www.udc.es/en/stembach/proxectos-2019-2021/
[3] Autodesk. Tinkercad | Crea diseños digitales 3D con CAD en línea | Tinkercad [Internet]. 2022 [cited 2022 Feb 4]. Available from: https://www.tinkercad.com/
[4] Ultimaker. Ultimaker Cura: Powerful, easy-to-use 3D printing software [Internet]. 2022 [cited 2022 Feb 4]. Available from: https://ultimaker.com/software/ultimaker-cura
[5] Demers L, Weiss-Lambrou R, Ska B. Development of the Quebec User Evaluation of Satisfaction with assistive Technology (QUEST). Assist Technol. 1996;8(1):3-13. https://doi.org/10.1080/10400435.1996.10132268.
[6] Scherer M, Craddock G. Matching Person & Technology (MPT) assessment process. Technol Rehabil. 2002;14:125–31. https://doi.org/10.3233/TAD-2002-14308.
[7] Pousada García T, Garabal-Barbeira J, Porto Trillo P, Vilar Figueira O, Novo Díaz C, Pereira Loureiro J. A Framework for a New Approach to Empower Users Through Low-Cost and Do-It-Yourself Assistive Technology. Int J Environ Res Public Health [Internet]. 2021 Mar 16 [cited 2021 Mar 18];18(6):3039. https://doi.org/10.3390/ijerph18063039.
[8] Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, et al. The REDCap consortium: Building an international community of software platform partners. Vol. 95, Journal of Biomedical Informatics. Academic Press Inc.; 2019. p. 103208.