Trainers for Visually Impaired Students Introduce 3D Printing

CURRICULUM

Training of visually impaired participants in 3D printing with FDM 3D printers

Curriculum for the T4VIS-In3D Trainer Course
Training of visually impaired participants in 3D printing

Published by the
T4VIS-In3D Project Consortium

Version 2

Co-funded by the
Erasmus+ Programme
of the European Union

The project "T4VIS-In3D" was co-funded by the "ERASMUS+" programme of the European Commission.

This curriculum is published by the T4VIS-IN3D project consortium.

Printed:
June 2023 by Berufsförderungswerk Düren gGmbH

The T4VIS-In3D project consortium:

Berufsförderungswerk Düren gGmbH (project coordination)
Karl-Arnold-Str. 132-134, D52349 Düren, Germany, http://www.bfw-dueren.de

Fundacion ASPAYM Castilla Y Leon
C/ Severo Ochoa 33, Las Piedras 000, 47130, Simancas Valladolid, Spain, https://www.aspaymcyl.org/

Hilfsgemeinschaft der Blinden und Sehschwachen Österreichs
Jägerstraße 36 - 1200, Vienna, Austria, https://www.hilfsgemeinschaft.at

Instituttet for Blinde og Svagsynede, IBOS
Rymarksvej 1, 2900, Hellerup, Denmark, https://www.ibos.dk

Istituto Regionale Rittmeyer per i ciechi di Trieste
Viale Miramare 119, 34136 Trieste, Italy, http://www.istitutorittmeyer.it/

NRCB
24 Landos Str., Plovdiv, 4006, P. Box 11, Bulgaria, http://www.rehcenter.org

Curriculum for the T4VIS-In3D Trainer Course

Number of modules: :	Modules
Average learning time:	40 learning units (CU) á 45 minutes
Group size: :	Trainers: 1 Participants: 3-10
Target group:	• Mobility teacher • ADL Trainer • Physiotherapy instructor for blind and visually impaired participants • STEM teachers and trainers for technical professions for visually impaired people Occupational therapists
Prerequisites of the participants:	1. Basics of training theory for visually impaired people 2. Experience in working with people with visual impairments 3. Knowledge in the operation of FDM 3D printers 4. Knowledge in the operation of the slicer CURA 5. Knowledge in the use of Autodesk Fusion360 6. No medical restrictions regarding the operation of machines. 7. No diagnosed plastic allergy 8. Visual acuity of 0.5 or better

Required material/infrastructure	1. For each participant 1 notebook or PC/MAC with min. 12 GByte RAM and 3D compatible graphics adapter 2. Internet connection 3. 1 FDM printer per 3 participants 4. Tools supplied for the operation and maintenance of the 3D printers used 5. Optical or electronic magnifying glass, or smartphone app 6. Required Software: + Autodesk Fusion360 Education or Regular Version+ Autodesk Meshmixer+ Ultimaker Cura or Slicer software supported by the procured 3D printers. 7. Tutorials of this course for each participant 8. Operating instructions for the 3D printers used 9. 500 g PLA filament per participant 10. Deburring tool and key files 11. 1 pair of safety goggles per participant 12. Heat and cut-resistant gloves 13. Simulation glasses for visual impairments 14. Spare parts for demonstration (extruder, nozzle, heating elements and thermistor) 15. Pocket light 16. Pointer

Module 1 - Assessment of the participants

Learning objective	At the end of this module, course participants will be able to assess how accurately visually impaired students can operate 3D printers and construct models	
CU[1] 's	***Topic***	***Comment***
4 CU's	Assessment	
1 CU	Short introduction: going through the modules of the course: 1. Assessment: the present module 2. Improving accessibility of FDM printers for VIP users 3. Introduction of visually impaired participants to the operation of FDM 3D printers 4. Introducing visually impaired participants to work with Slicer software 5. Introducing visually impaired participants to the operation of Autodesk Fusion360 6. Post-processing of components 7. Preparing and executing a lesson	Implementation by the participant according to the guidance of the trainer
1 CU	Determination of the ability to operate the slicer software 8. Introduction to the Cura GUI 9. Loading STL files 10. Moving and rotating the components 11. Setting the material and unit parameters 12. Carrying out the slice process 13. Assessment of the result in the layer view 14. Export of the Gcode file	Implementation by the participant according to the guidance of the trainer
1 CU	Determination of the ability to operate the CAD software 1. Introduction to the GUI 2. Correct positioning of the mouse pointer 3. Rotating and moving the working area, correct functioning of the zoom function 4. Drawing defined sketches, circle, rectangle, triangle, trapezium	Implementation by the participant according to the guidance of the trainer
1 CU	Operating an FDM printer according to instructions 1. Operating the display 2. Leveling the build plate 3. Loading the filament 4. Preparatory activities 5. Starting the print 6. Removal of the component 7. Unloading the filament	Implementation by the participant according to the guidance of the trainer

[1] CU = Course unit á 45 minutes

Module 2 - Improving accessibility of FDM printers for visually impaired users

Learning objective	At the end of this module, each participant should know how to improve the accessibility of 3D printer hardware to facilitate its use by visually impaired users.	
CU's	***Topic***	***Comment***
5 CU's	Introduction to common problems visually impaired people might have while using FDM printers. Possible hazards and tools to improve contrast to facilitate use	
1 CU	Elaboration of possible difficulties of visually impaired participants in the operation of FDM printers	Group work, brainstorming
2 CU	Improving the accessibility of FDM printers for visually impaired users 1. Improving the contrast 2. Tools and software to improve the contrast and magnification of printer displays 3. Methods for tactile demonstration and explanation of the components of a 3D printer	Demonstration, self-experience with simulation glasses
1 CU	Screen settings for operating the software by visually impaired users 1. The incompatibility with screen magnification software such as: Zoomtext 2. Enlarged character display through the WINDOWS settings 3. Enlarged mouse pointer setup 4. Increased contrast setting	Presentation, implementation
1 CU	Operation of the 3D printer via apps and software of the printer manufacturer 1. Example Ultimaker App 2. Example IdeaMaker Software	Presentation, exercise

Module 3 - Introduction of visually impaired participants to the operation of FDM 3D printers

Learning objective	At the end of this unit, participants will be able to safely instruct visually impaired users in the operation and setup of FDM printers.	
CU's	***Topic***	***Comment***
7 CU's	Explanation and demonstration of the essential components. Commissioning, loading and decommissioning of an FDM 3D printer.	
2 CU	Demonstration of the construction of an FDM printer 1. Axes and bearings of the X and Y axis 2. Build plate and Z-axis 3. Extruder and extruder components 4. Filament guide 5. Display and controls for controlling the printer 6. Interfaces for data media 7. Short list of extension files in connection with printer machines	Demonstration, self-experience with simulation glasses Hand lamp, pointer and spare parts for better demonstration. Pay special attention when indicating a danger zone
2 CU	Preparing the 3D printer 1. Adjusting the build plate 2. Loading the filament 3. Start a test print to check correct adjustment and adhesion 4. Detaching the component from the build plate 5. Adjustment 6. Cleaning the build plate 7. Improving the adhesion of the build plate 8. Short list of extension files in connection with printer machine softwares	Demonstration, self-experience with simulation glasses Hand lamp, magnifier or magnifier app
2 CU	Decommissioning the 3D printer 1. Unloading the filament 2. Checking the functional parts 3. Care and maintenance of the functional parts	Demonstration, self-experience with simulation glasses Pocket light, magnifier or magnifier app
1 CU	Control of the printers via app and/or software	Demonstration, exercise

Module 4 - Introducing visually impaired participants to work with Slicer software

Learning objective	At the end of this module, the course participants will be able to methodically teach visually impaired users how to use the slicer software (e.g.: Cura, IdeaMaker) correctly.	
CU's	***Topic***	***Comment***
4 CU's	Explanation of essential functions and avoidance of sources of error for use with visual impairment	
2 CU	Potential sources of error in operation by visually impaired users: Various views (Solid, Layer X-Ray) 1. Checking the correct positioning (rotating, shifting) 2. Checking the settings 3. Performing the slice 4. Visual inspection of the layers	Demonstration, self-experience with simulation glasses
2 CU	Configuring and adding printers 1. Menu control 2. Unit parameters 3. Potential sources of error 4. Backup and restore settings	Demonstration, self-experience with simulation glasses, exercise

Module 5 - Introducing visually impaired participants to the operation of Autodesk Fusion360

Learning objective	At the end of this module, students will be able to communicate the settings and operation of Autodesk Fusion360 to visually impaired users in a way that is accessible to people with disabilities.	
CU's	***Topic***	***Comment***
11 CU's	Optimisation of the GUI for visually impaired users. Use of the basic functions "Construction" and "Modification".	
2 CU	Introduction to the Graphical User Interface and its customisation + Changing the background colour + Setting the grid + Popular shortcuts + Toolbar and menu bar, + Workspace + Browser palette, perspective view, timeline + Navigation area, comment field + Context menu + Timeline	Demonstration, self-experience with simulation glasses, exercise
3 CU	Sketches. Create, edit and move sketches + The Sketch Menu + Background grid settings + Units of measurement and dimensioning + Selecting and deleting sketches + Creating selection sets + Edit, move, rotate and copy sketches + Creating sketches from photos with paste and view area	exercise
3 CU	Creating solids via the "Create" menu + Difference between direct and parametric modelling + Workspace + Combining bodies + Creating solids with construction tools + Extrusion + Sweeping + Turn + Arrange	exercise

Learning objective	At the end of this module, students will be able to communicate the settings and operation of Autodesk Fusion360 to visually impaired users in a way that is accessible to people with disabilities.	
CU's	***Topic***	***Comment***
11 CU's	Optimisation of the GUI for visually impaired users. Use of the basic functions "Construction" and "Modification".	
2 CU	Export of created constructions as STL file + About File Menu + About "Workbench" Setup Evaluating the STL file	exercise
1 CU	How to teach VIP students to create an object from start to the end	Exercise

Module 6 – Post-processing of components

Learning objective	At the end of this module, the course participants are able to teach visually impaired users, taking into account occupational health and safety, how to rework components	
CU's	***Topic***	***Comment***
3 CU's	Activities and safety precautions in the post-processing of FDM components	
1 CU	Required and suitable tools, materials and protective equipment for reworking + Adhesives + Primers and varnishes + 3D Printing Pens + Cutter and knife + Deburrer + Side cutters + Safety goggles + Protective gloves	
2 CU	Practical post-processing of FDM components + Assessment of the component + Selection of suitable protective equipment + Deburring and smoothing the surface + Filling gaps + Priming and varnishing + Bonding components with adhesives	Self-experience with simulation glasses, exercise

Module 7 - Preparing and executing a lesson

Learning objective	At the end of this module, the course participants have prepared and methodically carried out a teaching lesson introducing FDM printing to visually impaired users.	
CU's	***Topic***	***Comment***
6 CU's	Content and methodological preparation and implementation of 3D printing lessons for visually impaired participants	
4 CU	Preparation of an assessment or lesson from modules 1-5 + Observance of occupational health and safety + Observance of disability-friendly methodology and scheduling	Individual work, free choice of topic
2 CU	Conducting a prepared training lesson	Implementation with participants Each performer performs an excerpt of their prepared lesson (approx. 10-15 minutes) Assessment by participants and remaining participants. Final assessment by course leader

Co-funded by the
Erasmus+ Programme
of the European Union

Timetable

Hour	Monday	Tuesday	Wednesday	Thursday	Friday
1.	Assessment of the participants Determination of the ability to operate the slicer software	Operation of FDM 3D printers Structure of an FDM printer	Working with Slicer Software Sources of error	Introduction to Fusion 360 Working with sketches	Reworking of components Practical work
2.	Assessment of the participants Determination of the ability to operate the CAD software	Operation of FDM 3D printers Structure of an FDM printer	Working with Slicer Software Configuration	Introduction to Fusion 360 Create solids	Preparing a lesson
3.	Assessment of the participants Operating an FDM printer according to instructions	Operation of FDM 3D printers Preparing the 3D printer	Working with Slicer Software Configuration	Introduction to Fusion 360 Create solids	Preparing a lesson
4.	Improving the accessibility of FDM printers for visually impaired users Problems encountered	Operation of FDM 3D printers Preparing the 3D printer	Introduction to Fusion 360 GUI	Introduction to Fusion 360 Create solids	Preparing a lesson
5.	Improving the accessibility of FDM printers for visually impaired users Improving accessibility	Operation of FDM 3D printers Decommissioning	Introduction to Fusion 360 GUI	Introduction to Fusion 360 Create solids	Preparing a lesson
6.	Improving the accessibility of FDM printers for visually impaired users Improving accessibility	Operation of FDM 3D printers	Introduction to Fusion 360 Working with sketches	Introduction to Fusion 360 Export to STL files	Conducting a lesson

Hour	Monday	Tuesday	Wednesday	Thursday	Friday
7.	Improving the accessibility of FDM printers for visually impaired users Screen setting	Operation of FDM 3D printers Operation via software or app	Introduction to Fusion 360 Working with sketches	Reworking of components Tools and materials	Conducting a lesson
8.	Improving the accessibility of FDM printers for visually impaired users Operation of the FDM 3D printer	Working with Slicer Software Sources of error	Introduction to Fusion 360 Working with sketches	Reworking of components Tools and materials	Course Feedback Issue of the participants' certificates