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We are the makers – IoT Learning Scenario
Assemble e-Nable hands

1. Title of the Scenario	**Assembling e-Nable hands**
2. Target group	Secondary school and vocational school students between 14-17 years old
3. Duration	This scenario can be divided in 3 different sessions each lasting 1 teaching hours.
4. Learning needs	Basic 3D modeling and 3D printing experience. Fishing skills a plus.
5. Expected learning outcomes	Understanding the limits of 3d when printing for assembly. Understanding the benefits of thinking about mechanical constraints and print orientation at design time. Understanding how post-processes like thermoforming can save matter and print time, and help create stronger parts, when taken in account at design time. Learning the importance of mechanical clearance (slack / play / float ?) in mechanical assembly.
6. Methodologies	Lesson 1 : mechanical assembly Lesson 2 : Wiring Lesson 3 : Finishing
7. Place / Environment	Tech classroom
8. Tools / Materials / Resources	Projector if possible but not mandatory, printed assembly documentation, unassembled hands, assembly material kits, assembly tools (on set of each per two students).

9. Step by step description of the activity / content	Lesson 1 : Mechanical assembly
	Presentation of the assembled e-Nable hand and how it works. Explanation of the three assembly stages, corresponding to the three lessons.
	- Form teams of two or three, each team chooses a name and writes it on a pos-it note (it is a collaboration exercise, not a competition).
	- Each team gets an unassembled hand and a set of tools.
	- If all hands are printed at the same size, parts can be traded between teams to create colourful hands.
	- Get familiar with the parts :
	  ○ Find their name and shape in the documentation
	  ○ Identify and group the parts together on a large sheet of paper (A3), write down their names
	- Start assembling, following the documentation.
	- At each step, make sure all parts are cleaned from any support or extra material, and that all moving parts are moving freely. Depending on the quality of the 3D print there may be some filing or sanding involved.
	- Since thermoforming the gauntlet involves manipulating boiling water and risks of skin burns it should be made under teacher surveillance. And since all team do not go at the same speed, you may want to begin with thermoforming, before starting assembly.
	- If a team finishes before the others they go help the ones in difficulty.
	- At the end of the session each team lives its assembled hand in a bag or box with the post-it with their team name on it.
	- Wrap up
	
	Lesson 2 : Wiring
	- Reform the teams of the previous session
	- Each team gets a wiring kit (elastics, nylon fishing line, screws).
	- Explanation of the mechanical principle of the hand : elastics for opening at rest, tendons for closing on wrist actuation.
	- Making knots on nylon line, a fisher's knowledge. Explanation of the role of the tensioner to help set the right tension on the tendons.
	- Start wiring, following the documentation.
	- If a team finishes before the others they go help the ones in difficulty.
	- At the end of the session each team lives its assembled hand in a bag or box with the post-it with their team name on it.
	- Wrap up
	
	Lesson 3 : Finishing
	- Reform the teams of the previous session
	- Each team gets a finishing kit (foam, scratch)
	- Explanation of the security and comfort requirements.
	- Start finishing, following the documentation.
	- If a team finishes before the others they go help the ones in difficulty.
	- Wrap up

10. Feedback	Each session is ended by a few minutes wrap up to gather feedback around two questions : - What was important ? - What was difficult ?

11. Assessment & Evaluation	Lesson 1 : - Has each team finished assembly at the end of the session ? - Has the first teams to finish helped the others ? - Have they understood the negative impact of friction in mechanical assembly? Lesson 2 : - Have they understood the importance of precision in order for a mechanical device to work ? Lesson 3 : - Have they understood the importance of security and comfort in an e-Nable device ?