



Ecosystem infrastructure for smart and personalised inclusion  
and PROSPERITY for ALL stakeholders

## **D302.1 FLOE Resources and Tools for Open Educators**

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## Executive Summary

The FLOE Project (Flexible Learning for Open Education) is an international community of educators, designers, developers, and learners who are dedicated to building an open *inclusive design for learning* ecosystem<sup>1</sup>. This ecosystem is driven by open educational resources (OER), which are freely available, reusable, remixable learning resources<sup>2</sup> that are licensed under the Creative Commons open content license, ensuring that students and educators have full access to use, adapt, and combine resources to support personalized education. When inclusive design is part of the content authoring process, OERs represent a unique opportunity to grow a diverse collection of context- and learner-specific materials and their accessible alternatives, which can be linked together to create educational experiences that are individualized, inclusive, and evolving.

The FLOE Project's Inclusive Learning Design Handbook (ILDH)<sup>3</sup> is a collection of guides, resources, and tutorials that are intended to help the OER community better address accessibility and inclusive design within their teaching and curriculum development activities. Itself a free and open resource, the ILDH contains guidance on how to conceptualize, design, and implement learning materials that take web accessibility and one-size-fits-one personalization into account.

As its contribution to the Prosperity4All project, FLOE has: 1) contributed a collection of reusable user interface components that support accessible learning to the Developer Space; 2) helped build capacity for inclusive design within the OER community by promoting and disseminating the use of Prosperity4All design tools and technologies in several educational hackathons, co-design sessions, and events; and 3) published resources and tutorials in the Inclusive Learning Design Handbook that help to describe how teachers, learners, and content creators can use the outputs of Prosperity4All, along with other accessible tools and components, within the context of constructionist, maker-based education.

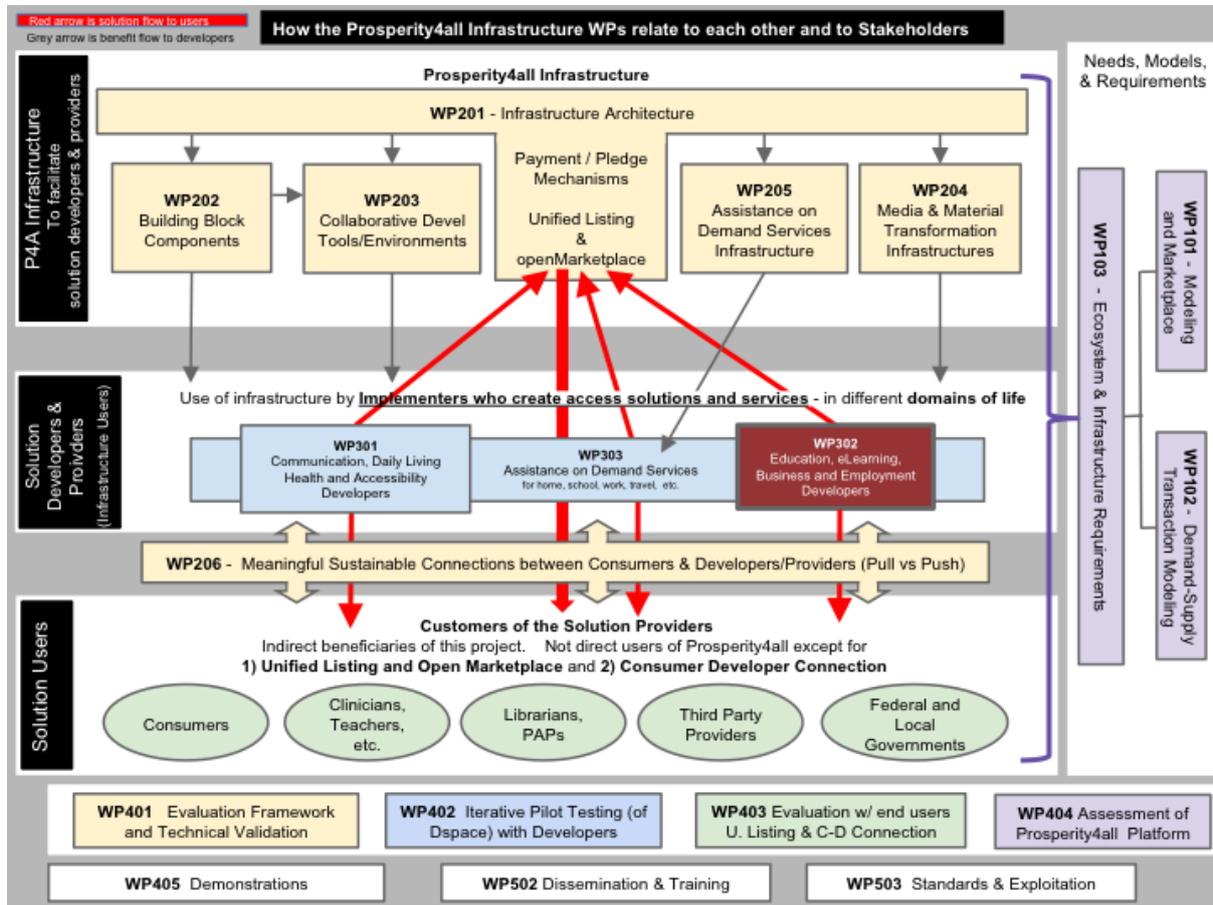
<sup>1</sup> We use the term *ecosystem* here consistently with the definition used throughout the Prosperity4All project: *a complex system of interacting entities that depend on each other and, in balance, support each other.*

<sup>2</sup> Such as textbooks, educational web content, interactive simulations, games, etc.

<sup>3</sup> <http://handbook.floeproject.org/>

# 1 Contribution to the global architecture

Figure 1: Overall Picture of Prosperity4all, highlighting WP302.



This deliverable documents the FLOE Project’s contribution to WP302 *Education, eLearning, Business, and Employment Developers*, which is highlighted in crimson at the middle-right of the diagram. This work significantly leverages SP1’s design models and strategies, providing educators and eLearning developers with tools and resources to better understand and include their users in the instructional design process. Additionally, FLOE has led workshops and hackathons for the open educational resources community that feature components and tools from SP2, including AsTeRICs, the Developer Space, Fluid Infusion, the Nexus, and the Quality Infrastructure. FLOE has also contributed user interface components to the Prosperity4All Developer Space.

## 2 What is the FLOE Project?

The FLOE Project, Flexible Learning for Open Education, is an international community of educators, inclusive designers, software developers, learners, and accessibility experts who are helping to build an open ecosystem for inclusive learning design<sup>4</sup>. Led by the Inclusive Design Research Centre at OCAD University, FLOE works with the open educational resource community to provide training, advice, design support, and reusable software components that help them to deliver personalized learning experiences. FLOE's primary activities include:

- Providing design tools and resources to help teach the OER community how to design inclusively
- Developing software components such a sonification framework, chart authoring tool, and inclusive learning labs, which are designed to be adaptable and support personalized accessibility
- Hosting and participating in community events, hackathons, and collaborations that help disseminate inclusive, personalized accessibility strategies, tools, and design methods

One of the main outputs of the FLOE Project is the Inclusive Learning Design Handbook, which documents the philosophy, strategies, and technologies that can be used to support inclusive design for learning within open education.

### 2.1 What Are Open Educational Resources?

Open Educational Resources are “educational materials produced by one party that are licensed to be used free of charge by others. OER come in many forms—from curriculum to homework assignments to textbooks. And OER exist for all levels of education, from kindergarten through college.”<sup>5</sup> In particular, the open educational resources community emphasizes its role in supporting the important activities of *revision*, *reuse*, *remixing*, and *redistribution*. These activities are explicitly permitted and encouraged under the Creative Commons licence<sup>6</sup>. This gives educators, instructional designers, and learners the ability to freely adapt, combine and modify OERs to suit their curriculum, teaching style, and student needs.

<sup>4</sup> FLOE Project. “Paving the way toward inclusive Open Education Resources.” *Flexible Learning for Open Education*. <http://floeproject.org/>

<sup>5</sup> Wiley, David, Cable Green, and Louis Soares. "Dramatically Bringing down the Cost of Education with OER: How Open Education Resources Unlock the Door to Free Learning." *Center for American Progress* (2012). <http://files.eric.ed.gov/fulltext/ED535639.pdf>

<sup>6</sup> Creative Commons. “About The Licenses.” *Creative Commons*. <https://creativecommons.org/licenses/>

From the perspective of accessibility, OERs represent an ecosystem in which personalized, one-size-fits-one education can be more sustainably delivered. As Jutta Treviranus et al. (2014) point out, “collectively pooling and sharing resources reduces redundancy and can result in a greater diversity of learning resources to address the broad range of learning needs.”<sup>7</sup> Educators who provide differentiated learning can customize an OER to suit the unique learning needs and accessibility requirements of their students, and then contribute these modifications back to the community. This sharing model has the potential to address some of the key learning design problems associated with a strictly compliance-driven approach to accessibility. Too often, traditional accessibility policy results in educational content that is limited by an overly standardized view of disability that leaves out the “doubly marginalized”—those who may not qualify for special education (due, perhaps, to an invisible or undiagnosed disability) but for whom standardized education is insufficient<sup>8</sup>. FLOE, in contrast, reframes disability in education as a relative characteristic: all learners can face barriers to learning, and each learner learns differently. In this non-binary, highly contextual model, “a resource cannot [simply] be labeled as accessible or inaccessible until we know the context and the learner.” Rather than designing a single “universal” resource that attempts to shoehorn the diverse range of learning styles and needs into it, OER, if inclusively designed, offers the potential to support a community consisting of many interlinked adaptations and alternatives that focus on different learners, accessibility needs, and educational contexts. Accessibility of the learning ecosystem, then, can be measured holistically by assessing the diversity of available resources and their ability to meet the needs of different learners in different contexts. The goal of the FLOE Project is to help catalyze this culture change within the open educational resource community.

## 2.2 The Inclusive Learning Design Handbook

The Inclusive Learning Design Handbook is “a free Open Educational Resource (OER) designed to assist teachers, content creators and web developers in creating adaptable and personalizable educational resources that can accommodate a diversity of learning styles and individual needs.”<sup>9</sup> The Handbook outlines a variety of methods and technical approaches that educators need to know about to design learning experiences that can more readily adapt to the learner. It includes sections that cover, among other things:

<sup>7</sup> Treviranus, Jutta, et al. "An Introduction to the FLOE project." *International Conference on Universal Access in Human-Computer Interaction*. Springer International Publishing, 2014.

<sup>8</sup> Treviranus, Jutta. "Life-long learning on the inclusive web." *Proceedings of the 13th Web for All Conference*. ACM, 2016.

<sup>9</sup> FLOE Project, "Welcome to the Inclusive Learning Design Handbook." *Inclusive Learning Design Handbook*. 2015. <http://handbook.floeproject.org/>

- Textbook and document accessibility using ePub 3<sup>10</sup>
- Accessible standardized testing<sup>11</sup>
- Inclusive simulations and games<sup>12</sup>
- Accessible Scalable Vector Graphics (SVG) for charting and visualization<sup>13</sup>
- Sonification of charts, graphs, and interactives<sup>14</sup>
- Designing for learners with cognitive disabilities<sup>15</sup>

Educators and members of the OER community often use the Inclusive Learning Design Handbook first as an initial primer on commonly-encountered accessibility issues and how to address them, and then later as a reference source for finding technologies and design strategies when building their own tools and resources. The ILDH has been used by the designers and developers of popular open educational resource tools and repositories such as OER Commons<sup>16</sup>, Pressbooks<sup>17</sup>, PhET<sup>18</sup>, and Lumen Learning<sup>19</sup>. The Handbook is implemented as a Markdown-based static web site that can be forked and contributed to on Github<sup>20</sup>.

One of the areas we identified where the Inclusive Learning Design Handbook could offer additional guidance—and which we emphasized within the Prosperity4All project—was in documenting the role that accessible technologies (such as those offered within the Developer Space) can play in supporting inclusive “constructionist” learning experiences. *Constructionism* is Seymour Papert’s term for learning that “happens felicitously in a context where the learner is consciously engaged in constructing a public entity.”<sup>21</sup> Papert emphasizes that learning happens most profoundly when it is social, embodied, and experiential. To this end, FLOE has organized a series of “hackathon” events in which the OER community and members of the FLOE team were able to learn about and collaborate on projects that use Prosperity4All and GPII-related technologies in a hands-on way. We then

<sup>10</sup> <http://handbook.floeproject.org/InclusiveEPUB3.html>

<sup>11</sup> <http://handbook.floeproject.org/AccessibleStandardizedTesting.html>

<sup>12</sup> <http://handbook.floeproject.org/WebGamesAndSimulations.html>

<sup>13</sup> <http://handbook.floeproject.org/SVGAndAccessibility.html>

<sup>14</sup> <http://handbook.floeproject.org/Sonification.html>

<sup>15</sup> <http://handbook.floeproject.org/CognitiveConsiderations.html>

<sup>16</sup> OER Commons is “a dynamic digital library and network” of open educational resources. <https://www.oercommons.org/>

<sup>17</sup> Pressbooks is “a book content management system that exports in multiple formats.” <https://pressbooks.org/>

<sup>18</sup> PhET “creates free interactive math and science simulations.” <https://phet.colorado.edu/>

<sup>19</sup> Lumen Learning helps educational institutions adopt open educational resources. <http://lumenlearning.com/>

<sup>20</sup> <https://github.com/fluid-project/docs-inclusive-learning/>

<sup>21</sup> Cited in Blikstein, Paul. “Seymour Papert’s Legacy: Thinking about learning, and learning about thinking.” *Seymour Papert Tribute at IDC 2013* (2013).

documented these events—and the techniques we used to organize them and ensure they were fully inclusive—within the Inclusive Learning Design Handbook.

Figure 2: A screenshot of the *Inclusive Making and Hacking* entry in the Inclusive Learning Design Handbook.

The screenshot shows the 'Inclusive Learning Design Handbook' interface. At the top, there is a dark teal header with the 'floe' logo and the text 'The Inclusive Learning Design Handbook'. A '+ show display preferences' button is in the top right. Below the header is a navigation bar with links for 'Introduction', 'Methods', 'Accessible Standardized Testing', and 'Inclusive EPUB 3'. The 'Methods' section is active, and a 'Hide Topics' button is visible. The main content area features the title 'Inclusive Making and Hacking' in a large, bold font. Below the title, there are two paragraphs of text. The first paragraph discusses the popularity of hackathons and makeathons in various contexts. The second paragraph discusses the benefits of hacking and making in education. The text is partially cut off at the bottom.

**Methods**

- [Inclusive Learning](#)
- [Accessibility Principles](#)
- [Techniques](#)
- [Metadata](#)
- [Access for All](#)
- [Schema.org Accessibility Properties](#)
- [Learner Needs and Preferences](#)
- [Video Content and Learning](#)
- [Audio Content and Learning](#)
- [Web Games and Simulations](#)

## Inclusive Making and Hacking

Hackathons, makeathons and similar community-oriented participatory technology events have become very popular in recent years, both in traditional learning contexts such as schools, colleges and universities, and in the broader world. Ideas of "hacking" and "making" have also been popularized as approaches to creatively and collaboratively solve problems in society, business and government.

In education, hacking and making can offer students greater autonomy, choice and personalization opportunities than the traditional classroom. Students can be encouraged to collaborate on challenges that interest them, to develop context-specific problem-solving strategies, and to engage with the wider world beyond the classroom.

Where does Inclusive Design fit into these approaches? How do we maximize their reach and

## 3 Integrating Prosperity4All with the FLOE Project

### 3.1 Hackathons and Design Events for the OER Community

In addition to developing generalized tools and strategies that help developers and designers to create more accessible software, regardless of context or domain, it's also important to engage with communities in order to help them understand how these tools can be applied to their unique situation. Hackathons, co-design workshops, design jams, and other practice-based community events are particularly useful for fostering hands-on learning about accessibility and inclusion, in a more interactive form that documentation or tutorials alone cannot easily replicate. The *Inclusive Learning Design Handbook* describes such events as being primarily participatory and social in nature:

*“We use the term ‘hackathon’ expansively... to refer to events that emphasize intensive short-term collaboration between small groups. The groups typically conceptualize, design, and implement prototypes related to social, cultural, or political issues that are relevant to them (for example, art, open data, or STEM education)... In learning settings, hackathons might be held as part of course curriculum or as an extracurricular activity for interested students.”<sup>22</sup>*

To fully engage the open educational resource community in designing and developing inclusively using Prosperity4All-related tools, the FLOE Project has, so far, held three community events. These hackathons and co-design workshops provided an opportunity for participants to:

- Meet and collaborate with contributors to FLOE and Prosperity4All
- Learn about and try new design methods such as SP1's *User States and Contexts*<sup>23</sup>
- Discover technologies such as Prosperity4All's Nexus<sup>24</sup> and AsTeRICS<sup>25</sup>
- Prototype new OER or improvements to existing resources using these resources and technologies

The three key Prosperity4All-related events held by the FLOE Project were:

<sup>22</sup> FLOE Project. “Inclusive Making and Hacking.” *Inclusive Learning Design Handbook*. <http://handbook.floeproject.org/InclusiveMakingAndHacking.html>

<sup>23</sup> User States and Contexts are described in D102.1 Map of Models and Approach, and is posted to the *Inclusive Design Guide*, available at <https://guide.inclusivedesign.ca/tools/UserStatesAndContexts.html>

<sup>24</sup> GPII Project, “The Nexus.” *GPII Wiki*. [https://wiki.gpii.net/w/The\\_Nexus](https://wiki.gpii.net/w/The_Nexus)

<sup>25</sup> AsTeRICS Project. “Assistive Technology Rapid Integration and Construction Set.” *AsTeRICS Homepage*. <http://www.asterics.eu/index.php?id=88>

1. The OER Accessibility Sprint, held in Toronto on February 25-27, 2015,<sup>26</sup> which was attended by over 60 people who were interested in open education and accessibility<sup>27</sup>.
2. A Nexus Musical Instrument Co-Design Workshop, held July 15, 2016, a small, invite-only session that provided an opportunity to perform with and provide feedback on the Nexus music instrument, designed by FLOE.
3. The PhET/Nexus Hackathon, held in Toronto on July 22, 2016, which included developers from the PhET interactive simulation OER project.

### 3.1.1 OER Accessibility Sprint

On February 25-27, 2015, the FLOE Project held an OER Accessibility Sprint at OCAD University in Toronto. The goal of the sprint was to explore the new strategies for designing and developing accessible:

- Simulations, games, and interactive content
- Video and timed media
- Mobile and responsive web sites
- OER authoring and delivery platforms

There were approximately 60 designers, developers, and accessibility experts in attendance who were interested in working with open educational resources. Attendees identified their personal areas of interest and were clustered into four thematic groups: *sonification, math and simulations, authoring and transformation, and literacy, learning, and self-assessment*. Notes and links to the ideas and prototypes created during the sprint were published openly on the web<sup>28</sup>. We invited the groups to try out and share their feedback on early versions of the SP1 design methods, practices, and activities—personas<sup>29</sup>, user states and contexts<sup>30</sup>, the matching game<sup>31</sup>, and inclusive facilitation<sup>32</sup> were all employed by the groups during the conceptualization phase of the hackathon. Technologies hosted in the P4A Developer Space such as the *Flocking* sonification framework and User Interface Options<sup>33</sup> were also used during the event.

<sup>26</sup> FLOE Project, <http://floeproject.org/accessibilitySprint2015.html>

<sup>27</sup> Attendee bios:

[https://docs.google.com/document/d/1ZUxNyguMxJzlpAF66g\\_pRfPSomVkEsHdxTLFqrghPhU/edit](https://docs.google.com/document/d/1ZUxNyguMxJzlpAF66g_pRfPSomVkEsHdxTLFqrghPhU/edit)

<sup>28</sup> Each group's collaborative "notebook" is available at:

<https://docs.google.com/document/d/1EPdECgqM7BxDmfh5CHJ7ZYr00ldxUqkcJJOddaMvXTE>

<sup>29</sup> <https://guide.inclusivedesign.ca/tools/Personas.html>

<sup>30</sup> <https://guide.inclusivedesign.ca/tools/UserStatesAndContexts.html>

<sup>31</sup> <https://guide.inclusivedesign.ca/activities/MatchingGame.html>

<sup>32</sup> <https://guide.inclusivedesign.ca/practices/FacilitateInclusively.html>

<sup>33</sup> <http://testing.developerspace.gpii.net/content/user-interface-options>

The result was one of the largest accessibility-focused participatory events ever held for the OER community. It provided significant learning and capacity-building opportunities for the attendees, many of whom were exposed to inclusive design and one-size-fits-one design methods for the first time, and who were then able to apply this new knowledge—as well as their greater awareness of the Prosperity4All project and its potential to help make accessible development easier, faster, and cheaper—in their own projects.

### 3.1.2 Nexus Musical Instrument Co-Design Workshop

The Nexus Musical Instrument is a demonstration technology for the Prosperity4All Nexus that was co-developed by FLOE and the lead developer of the Nexus. It is intended to serve as an exemplar for the open education resource community that illustrates how hands-on, experiential learning in the arts can be made more accessible to learners with mobility impairments.

In July 2016, FLOE held a small co-design workshop in which we experimented with group improvisation as a generative design method for evaluating the initial Nexus musical instrument prototype. Via the process of reflectively and critically improvising, we were able to elicit tangible ideas for improvements to the prototype, and to brainstorm new alternative musical control interfaces. This workshop was documented, and the footage was used to produce a video that describes how the Nexus works<sup>34</sup>.

### 3.1.3 PhET/Nexus Hackathon

The PhET project at the University of Colorado Boulder “creates free interactive math and science simulations. PhET sims are based on extensive education research and engage students through an intuitive, game-like environment where students learn through exploration and discovery.”<sup>35</sup> As a result of an ongoing collaboration between FLOE and the PhET Project, accessibility features are being added to PhET's online library of physics simulations. The *John Travoltage* simulation is an example of how web-based accessibility techniques such as keyboard navigation, ARIA, text to speech, and sonification can be leveraged to enable multimodal access to a rich learning experience<sup>36</sup>.

<sup>34</sup> Johnny Taylor, Michelle D'Souza, Simon Bates, Colin Clark. “A Musical Introduction to the Nexus.” *YouTube*. [https://www.youtube.com/watch?v=7R\\_pz2Fz4qE](https://www.youtube.com/watch?v=7R_pz2Fz4qE)

<sup>35</sup> The PhET Project. “PhET: Interactive Simulations for Science and Math.” *PhET: Free online physics, chemistry, biology, earth science and math simulations*. <https://phet.colorado.edu/>

<sup>36</sup> An accessible development build of *John Travoltage* is available on the PhET website: [http://www.colorado.edu/physics/phet/dev/html/john-travoltage/1.3.0-dev.12/john-travoltage\\_en.html?sonification=2&accessibility](http://www.colorado.edu/physics/phet/dev/html/john-travoltage/1.3.0-dev.12/john-travoltage_en.html?sonification=2&accessibility)

To explore the potential of Prosperity4All's Nexus integration technology within PhET's simulations, we invited their development team to a hackathon in Toronto in July 2016. The goal was to design new physical interactions using external control interfaces, exploring the potential for learners to engage kinetically and proprioceptively with the simulations. Using the GPII Nexus as an integration bus, two different alternative input devices were connected to two PhET simulations during the hackathon:

1. A grid interface, based on the components that were originally designed for the Nexus musical instrument, was used to control the leg and arm movements of John Travoltage.<sup>37</sup>
2. An iPad accelerometer was used to remotely control the Waves on a String PhET simulation.<sup>38</sup>

The outcome of this hackathon was a significantly greater awareness of Prosperity4All and its technologies for the PhET team. They have, as a result, developed an ongoing interest in creating physical, connected PhET user interfaces with the Nexus and AsTeRICS, which may offer new possibilities for designing tangible learning experiences optimized for students with disabilities who are often otherwise excluded from hands-on lab and experimental activities.

## 3.2 Components and Learning Resources

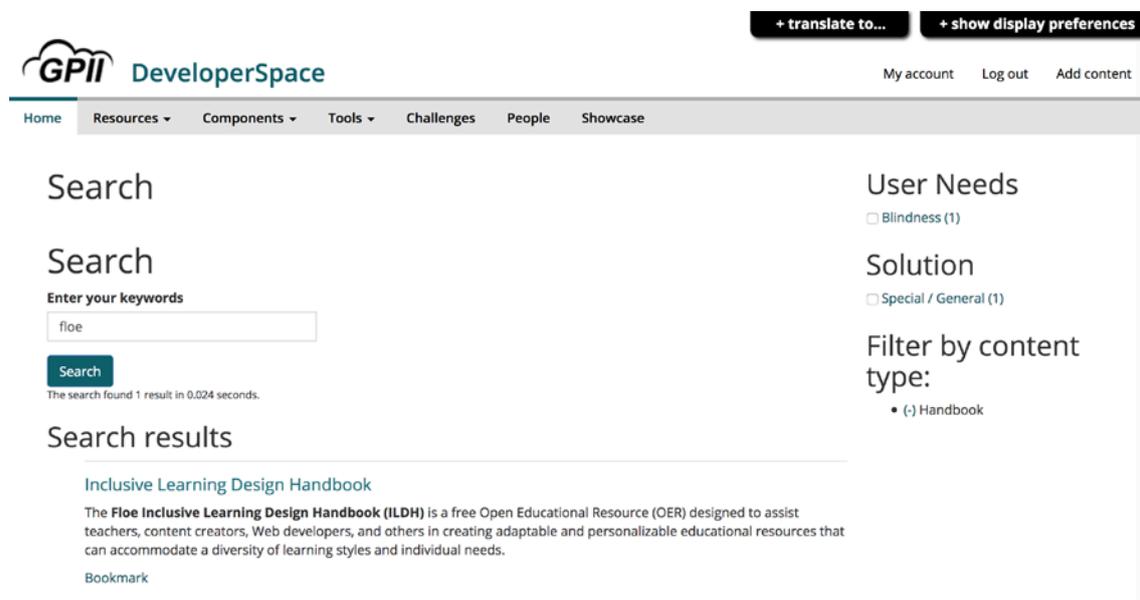
One of FLOE's goals is to establish a complementary and iterative relationship between our primary activities: organizing events with the OER community, designing resources in the Inclusive Learning Design Handbook, and developing technical components that are contributed to the Developer Space. This helps to ensure that each activity informs the others, and that our activities relate to the needs and goals of OER creators. For example, new tools will often generate topics for workshops or co-design sessions, while the lessons we learn from organizing inclusive events or developing components end up as new resources within the ILDH.

As the result of this mutually reinforcing process, FLOE has contributed several new components to the Developer Space and has authored four new entries in the Inclusive Learning Design Handbook (see subsections 3.2.1-3.2.4).

<sup>37</sup> A video demonstration from the hackathon of this interface is available on YouTube: [https://youtu.be/gStu\\_fuXM](https://youtu.be/gStu_fuXM) and <https://www.youtube.com/watch?v=-cW6TR4ln2E>

<sup>38</sup> This demonstration of this UI from the hackathon is also available on YouTube: [https://www.youtube.com/watch?v=GX\\_6rLWw2Cc](https://www.youtube.com/watch?v=GX_6rLWw2Cc)

Figure 3: A screenshot of searching for the Inclusive Learning Design Handbook in the Developer Space



In general, the ILDH tutorials provide the higher-level, more generally applicable background knowledge that we discovered while developing the technical components. This ensures that even when a particular technical solution is not appropriate for a given context or application, the background knowledge and experience is still available if the OER community wants to design or develop their own alternatives. The following sections provide a brief description of the components and related ILDH resources that FLOE created for WP302.1.

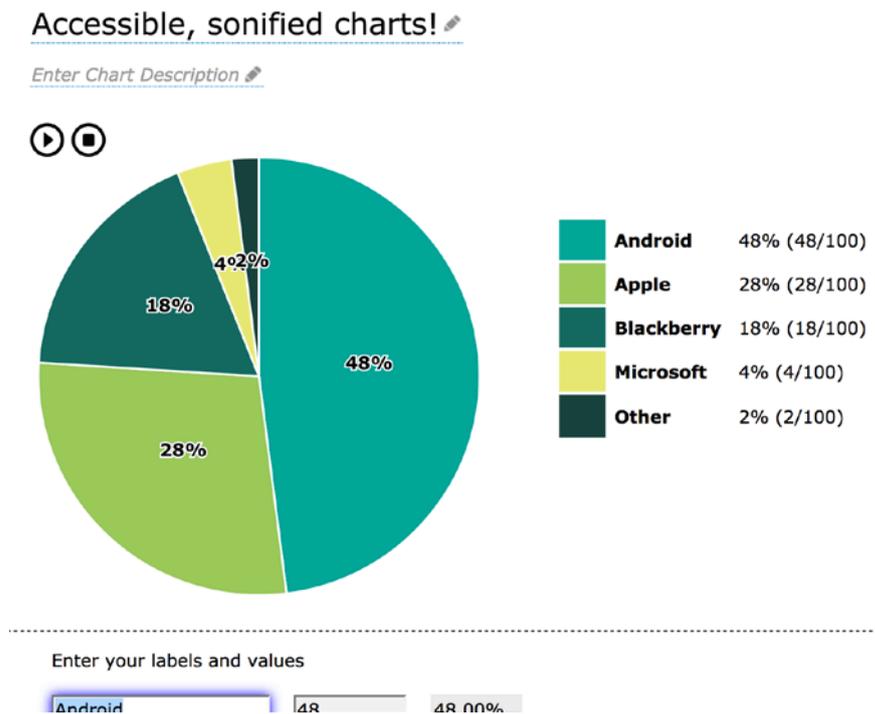
### 3.2.1 Chart Visualization and Sonification

The FLOE Chart Authoring Tool supports the authoring and sharing of highly accessible charts and visualizations<sup>39</sup>. This includes providing text to speech-based descriptions as well as a sonified audio representation of the data set. The current version supports creating pie charts and transforming the data into sonified form via a pattern where long notes represent 10% of the pie chart and short tones represent 1%. Future development will include support for other kinds of charts, pluggable data sonification strategies, and export functionality<sup>40</sup>.

<sup>39</sup> The source code for the Chart Authoring Tool is available on Github: <https://github.com/fluid-project/chartAuthoring/>

<sup>40</sup> A demonstration of the Chart Authoring Tool is available at <http://build.fluidproject.org/chartAuthoring/demos/>

Figure 4: The FLOE Chart Authoring components.



An anticipated usage scenario for the FLOE Chart Authoring Tool is described in the SP1 use model scenario “Making it easier, faster and cheaper to build, improve, assemble AT or integrate AT features in other products,”<sup>41</sup> in which developer persona James Olsen<sup>42</sup> finds the component when searching in the Developer Space for a suitable for charting tool for a contract development job. It is clear from this scenario that technology tools alone are not enough; resources and guidelines for understanding relevant accessibility requirements and technical constraints are also required. To this end, FLOE also created additional resources that provide conceptual information to developers such as James Olsen as well as stakeholders and clients such as Filipe Castilo Porras<sup>43</sup>.

In combination with the Chart Authoring Tool, two new entries were added to the Inclusive Learning Design Handbook. The first, *SVG and Accessibility*, provides technical general guidance on web image accessibility and how to use SVG and its associated alternatives to create accessible charts, graphs, and other forms of data materialization<sup>44</sup>. The second, *Authoring of Content*, describes strategies for how to design more inclusive

<sup>41</sup>[https://wiki.gpii.net/w/Use\\_model#Making\\_it\\_easier.2C\\_faster\\_and\\_cheaper\\_to\\_build.2C\\_improve.2C\\_assemble\\_AT\\_or\\_integrate\\_AT\\_features\\_in\\_other\\_products](https://wiki.gpii.net/w/Use_model#Making_it_easier.2C_faster_and_cheaper_to_build.2C_improve.2C_assemble_AT_or_integrate_AT_features_in_other_products)

<sup>42</sup> [https://wiki.gpii.net/w/Use\\_model#AT\\_Developer](https://wiki.gpii.net/w/Use_model#AT_Developer)

<sup>43</sup> [https://wiki.gpii.net/w/Use\\_model#Obligated\\_Main\\_Stream\\_Organization](https://wiki.gpii.net/w/Use_model#Obligated_Main_Stream_Organization)

<sup>44</sup> FLOE Project. “SVG and Accessibility.” *Inclusive Learning Design Handbook*. <http://handbook.floeproject.org/SVGAndAccessibility.html>

content authoring UIs, using the several OER components (including the Chart Authoring Tool) as case studies<sup>45</sup>.

In order to generate audio for the sonifications in the Chart Authoring Tool, PhET simulations, Nexus Musical Instrument, and other OER-based projects, FLOE has developed a sonification framework that supports browser-based audio synthesis, scheduling, and transformation<sup>46</sup>. A portion of this framework, called *Flocking*, has been contributed to the Developer Space<sup>47</sup>. An effort is underway by FLOE, the PhET team, and Bruce Walker’s Georgia Tech Sonification Lab to develop a small “sonification core” based on *Flocking*, called *Signaletic*, which is suitable for use on low-powered devices<sup>48</sup>.

Based on this work with the Chart Authoring Tool, PhET, and *Flocking*, a new *Sonification* section of the Inclusive Learning Design Handbook was created as a guide to the emerging best practices for using sonification in learning resources<sup>49</sup>.

### 3.2.2 Making and Hacking

Based on the experience we gained while organizing the sprints, hackathons, and co-design sessions, a new *Inclusive Making and Hacking* guide was added to the Inclusive Learning Design Handbook<sup>50</sup>. It describes ways to improve the inclusivity of maker events and hackathons, and places particular emphasis on the role that Prosperity4All technologies such as the Nexus, Developer Space, and AsTeRICS can play in helping to engage learners with disabilities in the assistive technology-creation process.

This resource is intended to support educators, students, and developers when organizing events related to the design and development of new forms of AT development—people such as the SP1 persona Nora Lindberg, who is a researcher who works with students on assistive technology projects, and who would benefit from new strategies for engaging her students and the broader community in her research projects<sup>51</sup>.

<sup>45</sup> FLOE Project. “Authoring of Content.” *Inclusive Learning Design Handbook*.  
<http://handbook.floeproject.org/AuthoringOfContent.html>

<sup>46</sup> Colin Clark. “FLOE Sonification Framework.” *Fluid Project Wiki*.  
<https://wiki.fluidproject.org/display/fluid/Floe+Sonification+Framework>

<sup>47</sup> <http://testing.developerspace.gpii.net/content/flocking-audio-synthesis-framework>

<sup>48</sup> Colin Clark. “Web Audio Core Sonification Library – FLOE Sonification Framework.” *Fluid Project Wiki*.  
<https://wiki.fluidproject.org/display/fluid/Web+Audio+Core+Sonification+Library>

<sup>49</sup> FLOE Project. “Sonification.” *Inclusive Learning Design Handbook*.  
<http://handbook.floeproject.org/Sonification.html>

<sup>50</sup> FLOE Project. “Inclusive Making and Hacking.” *Inclusive Learning Design Handbook*.  
<http://handbook.floeproject.org/InclusiveMakingAndHacking.html>

<sup>51</sup> [https://wiki.gpii.net/w/Use\\_model#AT\\_Researcher.2FEducator](https://wiki.gpii.net/w/Use_model#AT_Researcher.2FEducator)

### 3.2.3 Interactive Games and Simulations

Driven by our experience working with PhET and Lumen Learning on interactive simulation OER, the *Accessible Web Games and Interactive Simulations* guide within the Inclusive Learning Design Handbook provides insights and techniques for creating accessible interactive content<sup>52</sup>. Topics include orienting a screen reader user, communicating events, and cognitive load.

### 3.2.4 Accessible Modal Dialogs

A common challenge that designers and developers often ask us about is how to create web-based model dialogs and overlays in a way that is accessible to assistive technology such as screen readers. The *Accessible Modal Dialogs* section of the Inclusive Learning Design Handbook provides practical advice to developers and examples for when and how to use modal dialogs<sup>53</sup>, and is intended to complement some of the components for creating accessible modal dialogs that are listed in the Developer Space.

<sup>52</sup> FLOE Project. "Web Games and Simulations." *Inclusive Learning Design Handbook*. <http://handbook.floeproject.org/WebGamesAndSimulations.html>

<sup>53</sup> FLOE Project. "Accessible Modal Dialogs." *Inclusive Learning Design Handbook*. <http://handbook.floeproject.org/ModalDialogs.html>

## 4 Conclusion

The FLOE Project continues to work with the Open Educational Resource community to design and implement the educational materials, technical infrastructure, and human capacity required to build an inclusive design for learning ecosystem. To this end, FLOE has introduced Prosperity4All's tools, resources, and design strategies to the OER community by organizing collaborative learning events and publishing guides in the Inclusive Learning Design Handbook. FLOE has shared its accessible user interface components, such as the Chart Authoring Tool, Sonification Framework, Learning Options, and other tools within the Prosperity4All Developer Space, and has highlighted the usefulness of other Prosperity4All components to OER developers. As a result of these efforts, a number of OER developers integrated Prosperity4All technologies into the applications as prototypes, and there is a growing enthusiasm for the use of Prosperity4All tools—and one-size-fits-one inclusive design strategies more generally—within the context of open learning.

## Annex I: Glossary

Abbreviation	Full form
<b>AsteRICS</b>	Assistive Technology Rapid Integration & Construction Set
<b>D</b>	Deliverable
<b>DSpace</b>	DeveloperSpace
<b>FLOE</b>	Flexible Learning for Open Education
<b>GPII</b>	Global Public Inclusive Infrastructure
<b>Hackathon</b>	A participatory, informal, hands-on learning event
<b>ILDH</b>	Inclusive Learning Design Handbook
<b>Nexus</b>	An integration technology that is part of the P4A architecture
<b>OER</b>	Open Educational Resources
<b>P4A</b>	Prosperity4all
<b>Sonification</b>	The use of audio to convey information
<b>SP</b>	Sub-Project
<b>UI</b>	User Interface
<b>WP</b>	Work Package