

# Interactive EPUB3 vs. Web Publication for Screen Reading Users: the Case of ‘Pinocchio’ Book

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## ABSTRACT

In this paper, accessibility in the EPUB3 and the draft version of Web Publication formats is studied, with particular reference to interaction features. EPUB3 and Web Publication were chosen primarily because they are based on Open Web Platform technologies. Using an eBook prototype designed in EPUB3 and Web Publication, we investigated whether both reading applications and screen reading assistive technology are sufficiently mature to support accessibility. The results revealed that they do not yet fully support these formats.

## CCS Concepts

• Human-centered computing~Accessibility • Human-centered computing~Human computer interaction (HCI) • Applied computing~Hypertext / hypermedia creation

## Keywords

Accessible publishing; EPUB 3.0; ebook; Web Publication.

## 1. INTRODUCTION

Electronic books (eBooks) are particularly useful for people with print disabilities as they enable them to read books and contents autonomously. However, they must be designed with accessibility in mind. Many methods and tools have been proposed to make a document or eBook accessible to everyone [5], [7].

In this work, accessibility in the interactive and multimedia eBooks is investigated, especially for users of screen readers. Interactive eBooks have been investigated in various studies in the literature, such as [1], [2], [4]. While these studies introduce the usefulness of interactivity in an eBook, they do not consider accessibility in the interaction features, especially for screen reader users.

Not all eBook formats and reading solutions are equally suitable for use via screen reader. Many formats are based on Open Web technologies, which allow content producers to create born accessible publications. These include the EPUB and the (new) Web Publication formats. In 2011, EPUB3 (DAISY 4 distribution format) which uses HTML 5, CSS and JavaScripts was approved

as a final Recommended Specification by IDPF (International Digital Publishing Forum<sup>1</sup>). Consequently, the publishers' standard and accessibility format were integrated to achieve accessibility in the mainstream eBook industry. The Web Publication is the combination of International Digital Publishing Forum (IDPF) and World Wide Web Consortium (W3C) standards: it is a candidate to become a new standard, currently under development [6], for designing publications usable both online and offline. Web Publications will be read natively by Web browsers.

The aim of our study is to investigate whether reading applications as well as assistive technology are sufficiently mature to effectively support users of EPUB3 and Web Publication with special attention to interaction tasks. We particularly refer to visually-impaired people who use screen reading software as assistive technology. The research questions we formulated can be summarized as: (1) Are the reading applications suitable for supporting an interactive EPUB3 and Web Publication? (2) Is the screen reader assistive technology mature enough to support interactive EPUB3 and Web Publication? (3) Are EPUB3 and Web Publication equally usable via assistive technology? For the first question we study whether popular reading applications are able to perform properly interaction tasks, such as (a) selection of User Interface control elements (e.g. text fields, radio buttons, links, etc.), (b) run specific scripts like those used for handling quizzes or customization directly in the eBook, and (c) reproduction of audio descriptions and sounds. The second research question is focused on evaluating how screen reader assistive technology works with (a) interaction UI components (e.g. text fields and buttons), (b) “live content” which is dynamically updated based on user actions (e.g. different table views), and (c) multimedia audio contents activated by the user. The third question is to compare the two formats in terms of their usage via screen reader. To this end, some inspection tests were conducted based on an interactive and multimedia eBook prototype. This work extends the results of a previous study [3], by testing additional aspects.

## 2. METHOD

Firstly, an interactive EPUB3 prototype was developed. An existing textbook was used as a source content to be enriched with interaction features and multimedia contents. We refer to an ‘interactive eBook’ in terms of an eBook whose content changes based on how the user engages with it. The latest version of

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<sup>1</sup> EPUB 3 specification, Recommended Specification 26 June 2014 <http://www.idpf.org/EPUB/301/spec/EPUB-overview.html>

EPUB (version 3) allows authors to develop highly interactive eBooks. To the best of our knowledge, no eBooks in EPUB3 which include interaction features like radio buttons, checkboxes, text fields, alternative audio descriptions for figures, etc., are currently available on the Web or on the market at the time of writing. Secondly, the Web publication version was developed for the same eBook.

To design and develop the eBook in the EPUB3 format, we used (1) the InDesign software to develop the eBook core, (2) the Sigil software to manipulate the document<sup>2</sup>, (3) the HTML5, CSS and JavaScript to add accessibility features and interaction functions which were not directly supported by the software, and (4) WAI-ARIA techniques<sup>3</sup> to address some accessibility features.

In the EPUB development life cycle, the two tools EPUBCheck<sup>4</sup> and ACE (Accessibility Checker for EPUB)<sup>5</sup> were used to check code accuracy and accessibility compliance.

### 3. THE EBOOK PROTOTYPE

#### 3.1 Interactive and Multimedia EPUB3

The ‘Pinocchio’ textbook was selected as basic contents to be enhanced through interaction and multimedia features. The textbook is available in the Gutenberg project, in several versions: EPUB, PDF, Kindle and plain text. The plain text version was selected for the eBook development. The images were selected from the EPUB version. Once the main contents (text and figures) were available, some interactive and multimedia features were added to enrich the resulting eBook. The main interaction features developed are summarized in Table 1.

Table 1 - Interactive features designed in the prototype

Feature	Design	Development
Personalization by name	Name input and reuse throughout the contents	Text field and Java Script code
Figure descriptions	Alternative text and Mp3 audio files	Alt attribute and link to MP3 file for audio descriptions
Quizzes	Form with quizzes	Radio buttons
Quizzes	Confirmation alert	Dialogue window and audio feedback
Dynamic table views	Simple and complex table	Table with 3 and 5 columns
Audio contents	Words linking to audio contents	Links to mp3 files
Notes and glossary	Words linking to a description	Links to text blocks
Table of contents	Chapter titles	Links to chapters

##### 3.1.1 Personalization by Name

By adding the reader’s name, the user experience becomes more engaging. The user is invited to input his/her name in an editable TextField at the beginning of the first chapter. The name will appear in the quiz pages. While reading, the user can perceive that

<sup>2</sup> Sigil editor, <https://sigil-ebook.com/>

<sup>3</sup> Accessible Rich Internet Applications (WAI-ARIA) 1.1, <http://www.w3.org/TR/wai-aria/>

<sup>4</sup> ePUB checker: <https://github.com/w3c/epubcheck/releases>

<sup>5</sup> ACE: <https://inclusivepublishing.org/toolbox/accessibility-checker>

the book is talking to him/her, thus enhancing his/her involvement in the story.

#### 3.1.2 Figure Descriptions

The figures have been described using short captions, longer alternative textual contents or audio descriptions. The user can thus explore different levels of detail. This can support the writer in providing both simple and more complex descriptions for the same image. The tags <figure> and <figcaption> and the alt attribute have been used for the purpose.

#### 3.1.3 Quizzes

The reader is invited to answer some comprehension questions at the end of each chapter. The quizzes have been developed through a set of multiple-choice questions arranged via radio buttons on a form. When clicking on a radio button associated to the selected answer, a dialogue message (an alert) and an audio feedback (mp3 file) are provided to indicate if the answer is correct. Different sounds have been used for the right and wrong answers. The user gets 1 mark for a correct answer, and loses 1 for an incorrect one. The total score is shown at the end of the quizzes (see Figure 1).

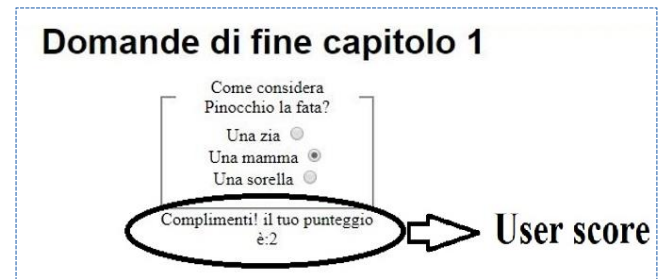


Figure 1 - Example of quizzes for chapter 1

#### 3.1.4 Table Views

Two different views for a data table were explored in the eBook. The aim was to understand if dynamic tables were well perceived via screen reader. For this purpose, a summary table of the characters was designed to be displayed in two different views: (1) simple, composed of 2 columns (name and role), and (2) complex, with 4 columns (name, role, description and relevant chapter). The user can switch between the two versions by clicking on the button “simple table” or “complex table” (see Figure 2).

Tabella Personaggi			
Clicca per una visione più semplice della Tabella		Tabella Semplice	Clicca per una visione più complessa della Tabella
		Tabella Complessa	
Personaggi	Ruolo	Descrizione	Capitolo
Fata	Aiutante	Fata che cerca di aiutare Pinocchio a diventa	1
Pinocchio	Protagonista	Burattino che magicamente ha una sua vita, guai	1
Lucignolo	Spalla del protagonista	Compagno di scuola biricchino di Pinocchio	1
Marmotta	Aiutante	Animale gentile che abita al paese dei Baloc	3
Omino	Antagonista	Conduttore del carro che porta i ragazzi al paese che tutti i ragazzini si trasformano in asini	2

Figure 2 - Character table (complex view)

### 3.1.5 Notes and Glossary

The source textbook is a 1902 edition, thus there are many archaic or difficult terms to understand. In order to fill this gap, a glossary with explanations has been added. Each difficult word has been linked to a description. The user can read a description by clicking a linked word and go back to the main text via a “go back” link.

## 3.2 Web Publication

Based on the specifications, the Web Publication is composed of:

**Contents:** HTML files, images, multimedia (audio, video), CSS, fonts, etc.

**Manifest:** file in JSON-LD format whose URL must be linked to each HTML page of the Web Publication; the manifest file includes:

- List of resources (HTML, fonts, images, etc.);
- Metadata (title, authors, identifier, etc.);
- Default reading order, i.e. the play order in which the content files are displayed to the user;

**Entry point:** page that refers to the manifest and gives the user information about the publication (e.g., cover, Table of Contents, etc.).



**Figure 3 - First page of the Web Publication prototype**

To develop the Web Publication eBook prototype, we started from the HTML files of the EPUB3 (i.e. the files included in the .epub file). After unpacking the EPUB3 file, the resources were mapped to the Web Publication components as reported in Table 2.

**Table 2 - Differences between the components of EPUB3 and Web Publication**

EPUB3	Web Publication	Conversions required
Contents (HTML, CSS, multimedia, etc.)	Contents (HTML, CSS, multimedia, etc.)	None
Metadata (OPF file)	Metadata (JSON-LD format)	Converting OPF (XML) in JSON-LD with the necessary adjustments required by the formats
-	Entry point webpage	To be generated (in case automatically from metadata)

The main work was focused on mapping the metadata from the OPF file to those in JSON-LD. Table 3 reports a portion of the mapping procedure. Figure 3 shows the first page of the resulting Web publication of the ‘Pinocchio’ book prototype.

**Table 3 - Matching of OPF-file and JSON-LD**

OPF file (EPUB3)	JSON-LD (Web Publication)
<metadata>	top-level properties
<manifest>	property resources

<spine>	property readingOrder
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To prepare the “entry point webpage”, an HTML page containing some metadata (cover, title, synopsis and authors), and the link to the first chapter and the table of contents was developed. This simple web page can be obtained automatically by using the information of the Manifest in JSON-LD.

To sum up, in order to develop a Web publication from an EPUB3, four steps are required: (1) EPUB file unpacking; (2) Conversion from OPF file to manifest JSON format; (3) Preparation of the entry point webpage; and (4) addition of the reference to the manifest in each HTML page.

## 4. EVALUATION

### 4.1 Methodology

An inspection evaluation was conducted to verify some accessibility and interaction aspects while using (a) the EPUB and (b) Web Publication prototypes via reading apps and the screen reader. The tests were conducted by three sighted experts and four blind technology-skilled users. They were selected by the authors as experts in eBook interaction as well as in desktop and mobile screen reader usage. The blind people were users of IOS Voice Over, Android talkback and Jaws for Windows so the corresponding operating systems were considered. Two PCs equipped with Windows 10 and Windows 7 were used for desktop tests. An iPhone X was used as mobile IOS device and a Huawei P10 lite for the Android Operating System. Some popular eBook reading apps and Internet Explorer and Google Chrome browsers were used to test the EPUB3 and Web Publication prototypes. This first inspection test was aimed at verifying that the designed prototypes were properly handled by (1) the applications and (2) the screen reading software. Thus, each test was firstly conducted with no assistive technology running, and then using the same app via screen reader.

To evaluate the interaction features, the following aspects were tested: 1) eBook contents could be read properly; 2) interactive components (e.g. links, buttons and text fields) could be clearly identified in terms of user interface; 3) interactive components could be properly activated via keyboard and gestures, and the related action could be perceived; 4) multimedia content could be perceived; 5) dynamic table could be managed and perceived; 6) the Table of contents could be accessed. The tester was asked to carry out a number of activities related to four areas: (1) accessing the table of contents; (2) selecting links and radio buttons; (3) listening to the additional multimedia descriptions and (4) activating and editing a text field. To this end, in addition to a free reading of the EPUB, some specific tasks like “Go to chapter x”, “Answer the quizzes at the end of chapter X”, and “Listen to the audio description for figure x” were assigned to the testers. They were asked to note down any problems which occurred.

### 4.2 EPUB3 Tests

#### 4.2.1 Adobe Digital Edition

Most major publishers use Adobe Digital Editions (ADE) to proof-read their books<sup>6</sup>. We tested ADE both on PC and mobile platforms. ADE for PC (release 4.5) did not work at all on various PCs with Windows 10 and 7 operating systems. When running without screen reader support, ADE worked properly with all

<sup>6</sup>Adobe Digital Edition (ADE):

<https://www.adobe.com/it/solutions/ebook/digital-editions.html>

content and interactive features. With screen reader support, several accessibility issues arose particularly relating to interactive elements that were (1) only detected as textual contents, and (2) not usable via keyboard. ADE on Android systems did not open the interactive EPUB3. ADE on IOS, instead, without screen reader support worked appropriately with all the contents. With screen reader support, the personalization by name and audio contents did not work. The button to activate the “table of contents” was difficult to detect via screen reader.

#### 4.2.2 Books

Apple Books is an e-book reading and store application pre-loaded onto IOS and macOS operating systems and devices. It is able to read the contents, but some issues were encountered with the interaction features. Without the screen reader, the feature “personalization by name” did not work because the edit field was not editable. With the screen reader, the content was read, but the interactive features were not operable via VoiceOver gestures. The content was read as a single chunk and the reading worked only in a sequential way. For the user it was impossible to locate and select the interactive elements. Moreover, they were identified just as simple text: i.e. the user was not aware that a word or a longer text were indeed a link or a radio button.

#### 4.2.3 Lithium

Lithium is an eBook reading application for Android System. We used the release 0.21.2 for our tests. We tested EPUB3 with and without the screen reader talkBack and the results were remarkable. Lithium supported all interactive features except the personalization by name: it was possible to edit the TextField, but the name did not appear in the quizzes.

### 4.3 Web Publication Tests

At the time of writing, the Web Publication could be accessed only via Web browser. Because the Web publication is a draft version, the browsers were not able to support all the reading functions. Since the webpages were developed to comply with WCAG accessibility guidelines<sup>7</sup>, and the screen readers were consolidated to properly interact with HTML contents, the Web Publication was found to be fully operable even via screen reader. Some issues in handling the table of Contents were observed due to the new format. Basically, the Web Publication was handled as common HTML pages.

### 4.4 Results

Despite the few cases (Lithium mobile version), we observed that the Screen reader had several problems to interpret the interaction features included in the EPUB 3. Table 4 shows the results of the tests conducted. The feature “personalization by name” was the most difficult for many apps, and some applications did not support the interaction features related to the audio contents. The screen reader behavior was completely different for the Web Publication, which was revealed to be fully accessible via screen reader for Windows. The main issues were just related to the browser limitations in handling the Web Publications.

**Table 4 - Summary of the tested features: + indicates a positive response, x indicates that the feature is not supported; SR stands for “screen reader” and M- for “mobile”**

App	p. by name	figure description	Quizzes	tables view	Audio content
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ADE	+	+	+	+	+
ADE-SR	x	x	x	x	x
ADE-IOS	x	+	+	+	+
ADE-IOS-SR	x	+	+	+	x
Lithium-M	x	+	+	+	+
Lithium-M-SR	x	+	+	+	+
Books-IOS	x	+	+	+	+
Books-IOS-SR	x	x	x	x	x

## 5. CONCLUSIONS

In this work, an interactive and multimedia eBook prototype developed in EPUB3 and Web publication has been tested via the most common reading applications and screen reader assistive technology. The evaluation revealed that for EPUB3 there are still many accessibility issues with regard to the interaction features, especially via screen reader (e.g. The elements are read as simple text and the user is unable to activate the desired element). In summary, the interactive EPUB3 format is not yet fully supported by apps and screen reader. On the other hand, the Web publication format is more widely supported. Most limitations relate to common functions used in eBook reading.

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