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REWIRE - Cybersecurity Skills Alliance
A New Vision for Europe

Technical Specifications for the REWIRE VLE

WP4 – R4.4.1

Title	Technical Specifications for the REWIRE VLE
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CONTENTS

REWIRE - CYBERSECURITY SKILLS ALLIANCE
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REWIRE
AGREEMENT NO.
621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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EXECUTIVE SUMMARY

The REWIRE VLE will act as the main point for delivering the project's training activities in the form of VOOCs. It will be based on the already deployed WordPress technology and will expand the REWIRE website with LMS functionalities.

The first section of the deliverable describes the main functionalities and features that will be deployed covering content structure topics and several back-end functionalities including:

- Modularity. Structure of the content and main elements.
- Content accessibility. A set of guidelines to be in line with accessibility standards
- Mobile learning support.
- Reporting and analytics. A set of potential indicators and metrics to be tracked.
- Notification system. Description of automatic notification mechanism based on user's interaction with the platform.
- Course Authoring tool. Description if the Course builder environment and how content can be populated online.

The second section provides an overview of the REWIRE LMS from a user perspective. It describes:

- Course access and registration. Description of the sign up / sign in process.
- Navigation. Description of the landing page and main layout of the contents with the respective menu options.
- Assessments. A short description of the available types of online problems.
- Certificates. When and how certificates can be issued.
- Custom front-end navigation integrating a lean layout (focus mode).

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A NEW VISION FOR EUROPE
REWIRE
AGREEMENT NO.
621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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1. INTRODUCTION

The purpose of this report is to provide the main set of features of the REWIRE Virtual Learning Environment (VLE). The VLE will host the REWIRE Vocational Open Online Courses (VOOCs) consisting of several learning modules and will be the main medium to offer an engaging online learning experience.

The REWIRE VOOCs are targeting individuals under four occupational profiles which are: Cyber Incident Responder, Cybersecurity Architect, Cybersecurity implementer and Penetration Tester.

The REWIRE VLE will offer the relative training and learning resources freely and openly for educators, learners and self-learners for use, reuse, adaptation and sharing. Thus, the resources will be released under the Creative Commons licenses[1]. The REWIRE consortium will define the exact configuration (NonCommercial, ShareAlike, etc.). Most of the resources will be made available in downloadable and editable formats so the user can store them locally and access them offline, e.g. presentations. The quality of these open educational resources will be assured based on OER commons recommendations[2] and the EU Open Education 2030 vision on lifelong learning[3].

The consortium will explore the exploitation potential after the project's lifetime, which will turn the REWIRE course into a commercially viable value in order to enhance the long-term sustainability of the project. This may be considered on the basis of a commercial and IPR agreement between all interested partners, thus safeguarding the coverage of the costs after the project end and ensuring our project's long-term sustainability.

The REWIRE VLE is connected to the R4.1.2 REWIRE Cyber Range as part of the online training activities will be done on the Cyber Range platform. The REWIRE VLE will be populated based on the work described in R4.2.2 Training courses material and R4.2.3 Training courses material suitable for VOOC delivery.

[1] https://creativecommons.org/licenses/

[2] https://www.oercommons.org/

[3] https://espas.secure.europarl.europa.eu/orbis/document/open-education-2030-vision-papers-part-i-lifelong-learning

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REWIRE Cybersecurity Skills Alliance
AGREEMENT NO. 621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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2. VIRTUAL LEARNING ENVIRONMENT MAIN FEATURES

The REWIRE VLE will be tailored to the training needs of the project's target groups. It will take advantage of the LearnDash[4] technology capabilities and will be modified to meet any specifications necessary. LearnDash Learning Management System (LMS) comes as an add-on any WordPress installation making it an appropriate choice for the REWIRE project since the REWIRE website was developed with the specific technology. The LearnDash solution extends the already deployed capabilities to encompass eLearning under the same look & feel offering a consistent and smooth user experience. In addition, LearnDash will be freely installed exploiting ReadLab's current technical infrastructure. The REWIRE VLE will be accessible under the same domain with a different subdomain which will be defined on a consortium level during the deployment process.

The core features or functionalities are presented below.

1.1. Modularity

The main difference between an online course and a campus class is that instead of hour-long lectures, online classes are built up of many bite-sized components, such as, three to seven videos or individual exercises. These components are modular or stand-alone since modularity has many benefits. Learners can quickly find compactly organized reference information about a specific topic without having to scroll through a bunch of texts or scrub through an hour-long video to find the one piece of information they were looking for.

Learning modules are organized so that learning material (e.g. video modules / reading material / PowerPoint presentations) alternate with exercises or other types of assessments. This will also allow editing, reorganizing, replacing or improving the modular course content or exercises because it minimizes the impact on adjacent material.

In this context, the content structure includes the following building blocks:

- Course sections are at the top level of the course and typically represent a time period e.g. week. A section contains one or more subsections.
- Each section can be organised in subsections usually representing a specific learning objective or other organizing principle. Subsections are sometimes called "lessons" or "learning sequences". A subsection contains one or more Topics.
- Topics contain the actual material as a sequence of web pages. The content or training material inside the topic can be structured in several learning components depending on its type.
- Course components are objects within topics that contain the actual course content: Videos, reading material, problems/quizzes and discussion forums, interactive resources such as H5P or SCORM packaging, etc.
- The following picture summarizes the content display flow. When published, the content is available online. Graded assignments and problems are located in the subsection level while quizzes can be inserted in different structural elements (a

[4] https://www.learndash.com/

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A NEW VISION FOR EUROPE
REWIRE
AGREEMENT NO.
621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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quiz for the whole course, a quiz at lesson level or a quiz (short assessment) at topics level.

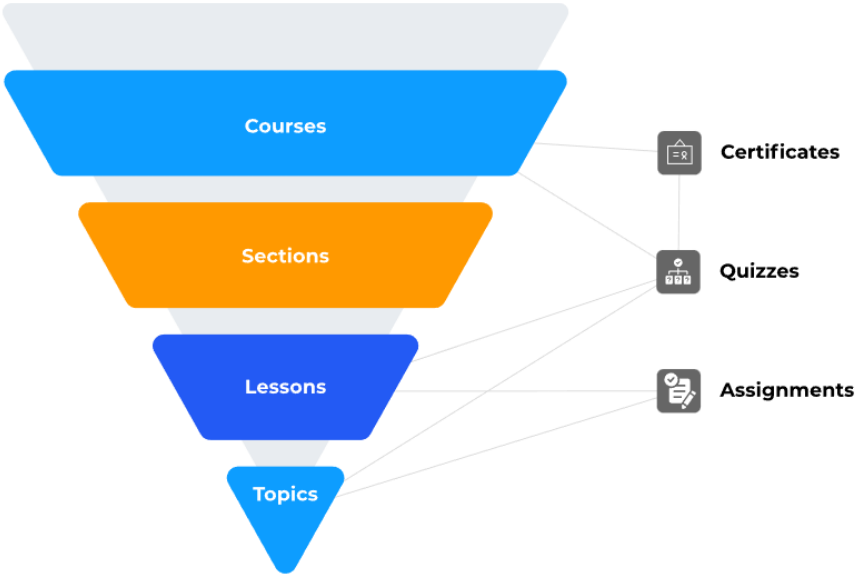

Figure 1 REWIRE VOOC structure (Learndash.com)

1.2. Accessible Content

The landing page of the VLE will be customized to display general information about the REWIRE courses including among others, the expectations and how the courses are going to be delivered. The REWIRE courses will be displayed on the landing page under the REWIRE course catalogue. Each one of courses will have a unique URL, facilitating sharing of specific course locations among the instructors, participants or any interested party. In addition, each REWIRE course can be exported as a collection of .JSON files in a zip folder. The export can be applied to the course as a whole or to parts of the courses (lessons, topics, quizzes, etc.). The extracted course (or part of the course) can easily be imported in a clean LearnDash environment. In general, data migration can be a time-consuming process depending on the volume of the contents of each course. Latest updates by the developers' community (Dec 2022), offer the option to migrate also the user's progress to a new website if needed going beyond the classical content re-use.

Furthermore, the REWIRE VLE will support accessible digital learning content conforming to level AA of the World Wide Web Consortium's Web Content Accessibility Guidelines (WCAG) 2.0[5]. The REWIRE VOOC will be available to representatives from diverse backgrounds with varying skills and abilities. In this context, accessibility refers to the degree to which information and activities are available to all learners equally regardless of physical or other disabilities. For example, visually impaired users may use screen readers and in order to fully rip the benefits of such functionality, the following best practices should be taken into account:

[5] https://www.w3.org/WAI/standards-guidelines/wcag/

- Help the participants who use screen readers through the use of descriptive titles in the course content.
- The content will be structured with HTML elements or textbooks that should follow the basic accessibility guidelines: appropriate use of headings, presence of alt text in case of images, links should contain unique and descriptive names, use of semantic elements as much as possible that clearly defines the content to which they are referring (e.g. <form>, <table>, <article>, etc.).
- When using images, charts or diagrams, color will not be used as a distinguishing element in the image, chart or diagram.
- Anchor text for links should be descriptive and specific (where this link goes to).
- REWIRE will use efficient resolution images that always include descriptive, alternative text.
- In the case of video, interactive accessible transcripts will be embedded.
- Any external content or content that requires plugins, will be accessible.

Textbooks and PDF Accessibility guidelines

Portable Document Format (PDF) is a standard format for course materials, including textbooks. Accessibility is an essential issue for PDF files. For example, scanned PDF files are not accessible to visually impaired learners who may use screen readers. In addition, it is also essential to ensure that the source file (e.g. Word) contains all the required semantic structure and metadata before exporting to PDF.

An excellent example of best practices for Authoring Accessible PDF Documents can be found in the case of the Open edX LMS. However, these best practices are transferable in any LMS that hosts educational material in the form of PDFs[6].

1.3. Mobile Learning

In general, the percentage of learners who access online courses through smartphones is constantly rising. It is expected that an important percentage of the REWIRE registered users will perform part of their learning activities through their smartwatches or mobile devices. Having this in mind the following best practices will be employed:

- Implementation of a custom theme (branding, colors, fonts, buttons) to support registering, enrolling and performing learning activities. The theme must be responsive and able to display content in displays of different sizes.
- Keep display names of sections and labels concise.
- Avoid, if possible, learning material in Flash since mobile platforms do not support it efficiently.
- When needed, components in HTML will use relative rather than explicit sizes for objects so that they scale appropriately when viewed on displays of different sizes.
- In case of including content in the form of tables, verify that table headers for rows and columns are properly defined.

[6] https://edx.readthedocs.io/projects/edx-partner-course-staff/en/latest/accessibility/best_practices_course_content_dev.html

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REWIRE
AGREEMENT NO. 621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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1.4. Reporting and analytics

The REWIRE database will be able to store data that the user is creating when interacting online with the VLE. By design, the basic metrics or indicators that can be defined are enrollments per course, course completion and performance data based on quizzes or assessments. However, the reporting functionality can be extended since one of the biggest advantages of using LearnDash is the supporting community developments in the form of add-ons or plugins. Potential enhanced metrics include time spent on the course, time spent on specific quizzes or assessments and number of retries (depending on the type of the problem), completion percentage per course per participant and passing rates (applies to quizzes as a whole). Pass rate of quizzes can act as an alternative indicator of evaluating the quality of the teaching, e.g. a low pass rate usually means that the participants are not able to acquire the knowledge offered.

1.5. Automatic notifications

Automatic notifications are a useful functionality that can be configured to send automatic emails to participants based on specific triggering events. This feature needs to be carefully designed in order to send the right amount of emails to the end-user with a view to boosting participation in case of low attendance. Since these notifications are going to be sent automatically in order to avoid delays, a custom cron job might be added in the server that hosts the REWIRE platform. The available triggers can be:

- User enrollment
- User completion (course, lesson, topic, quiz)
- “Number of Days” before the course expires
- “Number of Days” that the user has not logged into the platform

Some basic shortcodes can be deployed too for including dynamic content (user’s first and last name, email, course title, course URL, etc.).

1.6. Course Authoring tool

Most of the back-end procedures including configurations, customizations and content creation are accessible through an admin panel in line with WordPress technology. Structure-wise, the process is done mainly through a course builder tool that offers a simplified functionality structuring each course (Sections, Lessons, Topics, quizzes). Restructuring the course’s main components is done again visually through drag and drop inside the main course structure.

Adding content (topic level) will be done through a customized built-in editor offering the possibility to include text, images, videos, or custom code for more advanced types of visualized material. The course editor functionalities can be extended beyond the default one, by integrating a custom page builder plugin or addon i.e. Elementor, Beaver Builder, Bakery, etc.). The criteria of selecting the appropriate page builder environment are:

- simplicity (re-edits, updates);

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REWIRE Cybersecurity Skills Alliance
AGREEMENT NO. 621701-EPP-1-2020-1-LT-EPPKA2-SA-B
Co-funded by the Erasmus+ Programme of the European Union

- supporting the types of the training material (fit in one web page multiple types of content like text, images audiovisual resources).

Even though the REWIRE platform will be enhanced with these custom tools to facilitate the course structure and content creation, a basic knowledge of the WordPress technology (admin panel) is needed for an individual to be able to locate and edit the training resources in the back-end.

2. USER FLOW

2.1. Course Access and registration

The REWIRE VOOC will be offered free (open) and can be accessed upon creating an account into the REWIRE VLE (registration). The account creation will allow tracking of user performance and how participants interact and progress throughout the course lifetime. There is also the possibility to manually enroll participants or restrict course access upon agreement with the REWIRE Consortium.

The VOOC access can also be restricted if there is a need to include some prerequisite training before entering the main REWIRE VOOC. If needed the course can be configured to be accessed by all enrolled users even after its end date.

The REWIRE platform supports the registration function. Each user needs to create an account and verify it through a confirmation email on the email address used. Upon verification, the user is able to log in /sign in to the REWIRE VLE. The registration / signing-in process will be supported by the classic “Lost Your Password?” functionality. It is a best practice to keep the registration page as much as possible simplified in an effort to not discourage participants from creating an account on the REWIRE VLE. In case more user data are needed these can be optionally acquired through an entrance survey.

All personal data will be processed according to GDPR rules. A detailed data privacy policy will address the following topics: what kind of personal data is processed, the rationale behind the data-tracking, data subject rights, retention policy, etc. The privacy policy will be available in the footer section.

When logged in, the participants are following two options through the REWIRE course catalog:

- Enroll in an open course through a “take this course” button or similar. After enrolling they can see the contents of the course organized in the structured described in section Modularity.
- If the user has already enrolled in a course (or more than one) a progress bar at the top of the course page will be displayed. Again, by selecting the course, the user can navigate through the course steps.

The following figure depicts the landing page of a fully customizable and responsive layout deployed in ReadLab’s test environment. It may consist of:

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AGREEMENT NO. 621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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- A tailor-made menu bar leading to different web pages if needed, e.g. Contact page or an About page, etc. By design a profile/account page will be designed for the registration/sign in / forgot password / change password functionalities.
- A general information section mainly acting as an advertisement to the REWIRE courses.
- The REWIRE course catalogue which can be customized in terms of layout (number of courses and columns) and content (display course tags, progress bar and number of participants.
- A section dedicated to instructors or content developers of the REWIRE training material.

Given the flexible nature of the front-end more sections can be embedded always on-line with the project's visual identity.

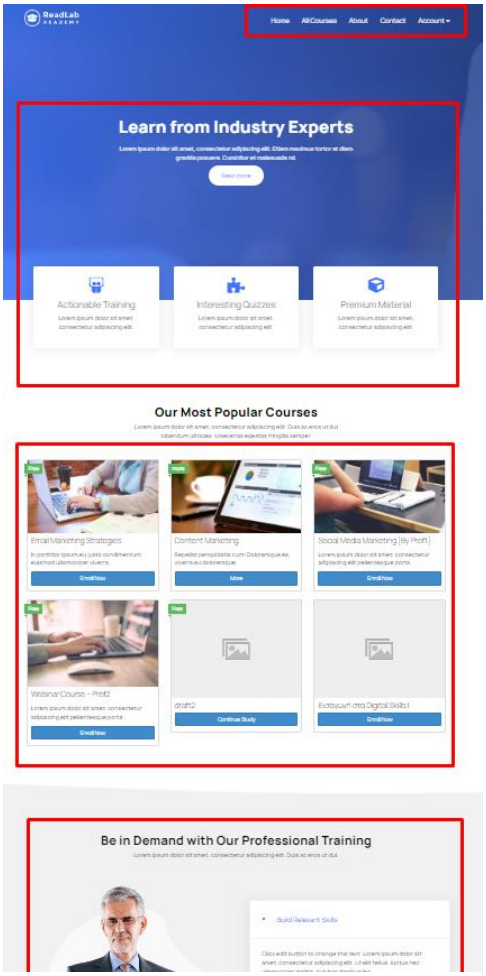

Figure 2 LearnDash deployment on test environment

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REWIRE
AGREEMENT NO. 621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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2.2. Navigation and learning sequence

REWIRE training content will include various learning components fitted to the online medium. It may consist of videos, slides, readings, exercises, quizzes/tests, podcasts and case studies and will be organized in sections (modules), lessons and topics. All video material can be streamed through an open common streaming platform (e.g. YouTube, vimeo, etc.).

When learners select a section, they will be able to drill down further into subsections. When learners select a subsection, they will see a learning sequence, a sequential list of course units, on the right-hand side of the screen (Figure 3).

The learning sequence will be designed to engage the learner by creating a modular experience to go through. Learning sequences promote active engagement as participants navigate between learning concepts and solving simple exercises to check their understanding.

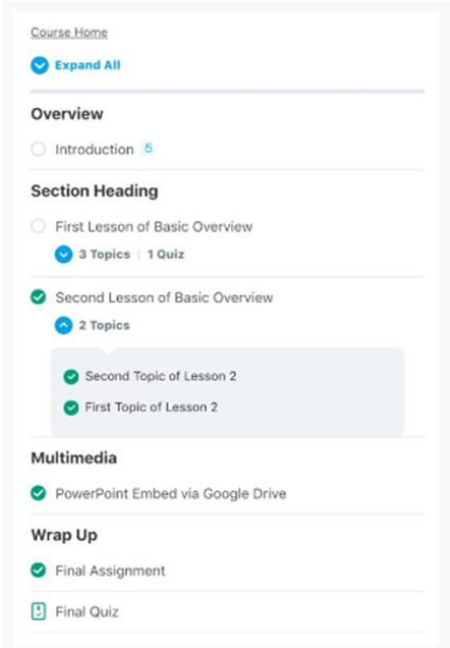

Figure 3. Hierarchical view and high level course structure example (learndash.com)

There are two ways to configure the navigational behavior:

- The *Linear* which is the default one. The linear navigational flow requires the user to progress through course steps in a specific order. Participants cannot jump around and skip lessons, topics or quizzes. This means a participant must finish the first lesson before taking the second one.
- The *Free* navigational flow allows the user to freely move through the course steps and view the content.

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A NEW VISION FOR EUROPE
REWIRE
AGREEMENT NO. 621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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A typical learning sequence has a video lecture with reading material followed by a quick exercise, another video lecture with reading material, another exercise or other self-reflective activity, and so on.

This active-learning method enables learners to apply what they've learned from the "theoretical" part and the reading material before moving on. The reading material in the learning sequence will cover important ideas, relevant questions, issues, and problems in line with the defined learning objectives. The hands-on part will be covered by linking to the REWIRE Cyber Range, powered by KYPO Cyber Range Platform. The objective is to provide a smooth learning experience performing activities in two different learning environments, with the REWIRE Cyber Range providing hands-on training exploiting scenario-based learning activities.

A discussion topic may be inserted after each module (video, reading material and exercise) so that learners/trainees can discuss the material with others who have also recently gone through this material.

The picture below depicts the classical layout of the course contents:

- The actual material on the right-hand side of the web page (the specific example displays an embedded YouTube video).
- The top section where the progress bar of the whole course is displayed along with an interactive navigation path.
- The left-hand side where the whole structure of the course is displayed. The user can browse through the contents and move easily to a different resource.
- The bottom section where the user can alternatively navigate to the next or the previous topic inside the lesson.

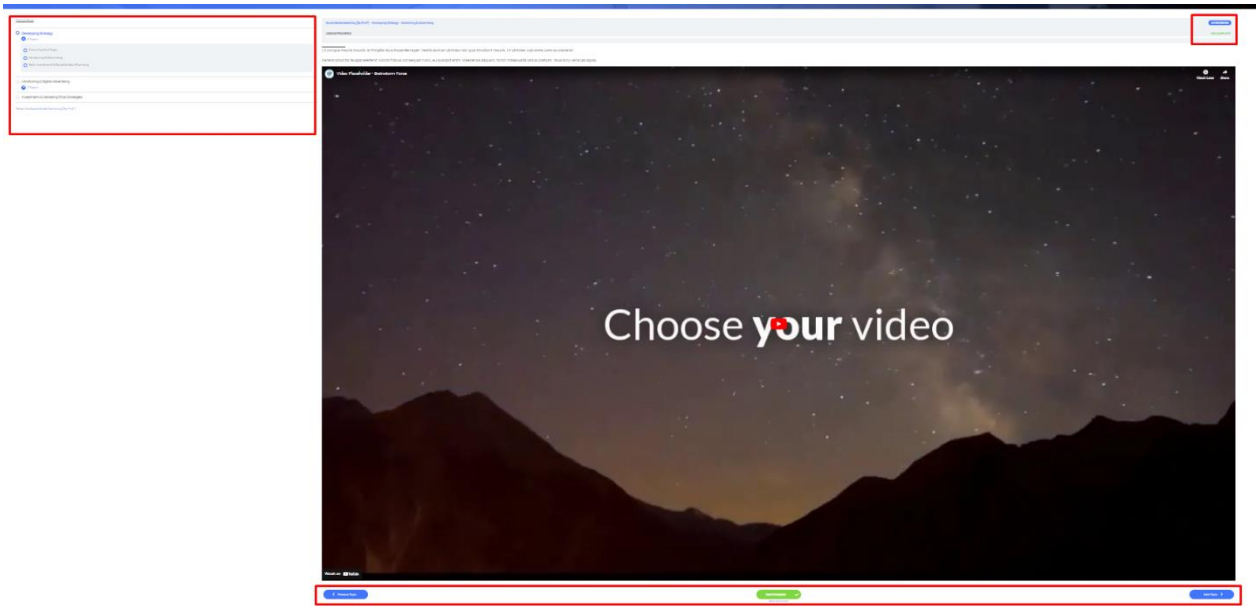

Figure 4 Main layout of the course contents

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2.3. Types of online assessments / problems

The REWIRE Online Training Platform can be customized to offer a variety of exercises or assessment types, from basic multiple-choice questions to drag-and-drop exercises that are especially geared towards an online audience. The following options can be configured and integrated in the REWIRE VOOC:

- Single Choice: This is the most common format, and it should be used for True or False questions. There is only one correct answer while there is no restriction to the number of incorrect answers.
- Multiple Choice: They support multiple correct answers. Users must select all the correct answers for the question to be marked correct. If they choose only some correct answers, the question is marked incorrect.
- Free Choice or text input questions: This assessment provides the users with an input field where they must type the correct answer. The answers may be one or multiple words, and the correct ones can be more than one. Capitalization does not matter.
- Sorting Choice (Drag & Drop): Sorting choice questions ask the user to place a series of answers correctly. When creating the question, the order of the answers in the backend will be considered the correct order.
- Matrix sorting: questions should be used when you want the user to match two items together. Two elements must be configured: a) Criterion and b) Sort elements or options. The latter is what users will drag & drop to the correct criterion. The options should be unique, and only one-to-one associations should be supported. The answer area will be set up like a table, with the criterion on the left and an open space to drag & drop sort elements on the right.
- Fill in the Blank: Users then type the correct answer into empty fields in the middle of a sentence or paragraph. All blanks must be answered correctly for the question to be marked correctly, while capitalization does not matter.
- Assessment (Survey): This question type is perfect for surveys or any time you're asking a user to rate something on a scale. It may include text/images before or after the scale, and only one answer can be selected. The maximum possible score is equal to the total number of options.
- Essay questions: Essay questions allow the user to enter a free-form answer. This type of question can be answered either from an online text box or by uploading a file. In both cases, the instructor has to assess the answer manually and optionally provide comments in the form of feedback.
- Hands-on exercises in the REWIRE Cyber Range: Cyber Range exercises simulate real-world cyber-attacks in a controlled, risk-free environment. These exercises can be tailored to specific learning objectives and scenarios, ranging from basic training to advanced persistent threat simulations. Participants are provided with tools such as virtual machines and attack scripts to develop practical skills in cybersecurity. Cyber Range exercises improve the ability to detect, respond to, and prevent cyberattacks, and provide a platform for testing and evaluating new technologies and

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REWIRE Cybersecurity Skills Alliance
AGREEMENT NO. 621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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methodologies. They help organizations and professionals better prepare for the evolving threat landscape.

In addition, hints or automatic feedback can be included for all questions to direct the participants in the right direction.

2.4. Certificates

Certificates of completion offer the participants the opportunity to prove their competence in a tangible way. The certificates can be configured to be issued upon:

- Successful completion of a course
- Passing a quiz/assessment

The visual design of the REWIRE certificates will be designed and developed in custom html format following the visual identity of the project. The visual design will be finalized on a consortium level and based on initial mockups provided by ReadLab. Each Certificate will be available to users from the online environment in a downloadable format (PDF).

Dynamic information can be also integrated using specific *Shortcodes*, mainly addressing User data (first name, last name) and Course data (course title, date, percentage or actual score of the course if valid, etc.).

In addition, the REWIRE platform can be customized to offer the possibility to participants to share their Certificate(s) to social media platforms to enhance the dissemination of the REWIRE project results and training activities. Potential candidates are LinkedIn, Facebook, and Twitter and each one of them needs to be individually investigated. For example, in the case of sharing through LinkedIn, the partnership has to define which is the *Issuing Organization* (through the integration of the unique LinkedIn ID of the Issuing Organization).

Finally, since each generated Certificate has a unique ID, a verification page could be implemented targeting learners and other interested parties, e.g. potential employers that can search if a learner has indeed the specific qualification. Again, this is a decision to be made on a partnership level.

2.5. Custom theming

The front-end page will be based on a responsive theme fully supporting mobile users. The built-in v3.0 template will be used which can be customized to fit to the look & feel of the project's visual identity (custom CSS to update specific template elements). In general, three basic color types can be customized – *main* referring to buttons, action items or other callouts, *progress* referring to completed items, progress bars or certificates and notifications including warnings or other messages.

An interesting feature is the *focus mode* where the main navigation and sidebar menus can be removed (hidden) from the main view enabling a distraction-free learning experience.

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A NEW VISION FOR EUROPE
REWIRE
AGREEMENT NO.
621701-EPP-1-2020-1-LT-EPPKA2-SA-B
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However, this feature is not recommended for highly structured courses where parent and child items (menus and submenus items) are usually present.

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REWIRE
AGREEMENT NO.
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3. CONCLUSIONS

This document provides a general description of the technology that is going be deployed for delivering the REWIRE VOOCs.

The core element will be the LearnDash technology which can be enhanced with add-ons coming from the developers' community[7]. Section 2 provided the main foreseen functionalities that are going to be used in the REWIRE project. Section 3 presented the main features from a user perspective describing the navigational flow and front-end options (UX design).

The VLE specs will be updated when the platform will be deployed and piloted with the actual training material. Updates may be considered regarding:

- assessment methods integrated into the environment,
- the user flow for connecting to the Cyber Range environment as part of the VOOC online learning experience and visual designs
- any custom visual design that will be developed during the population of the learning environment with the training material.

[7] https://developers.learndash.com/

4. LIST OF ABBREVIATIONS AND ACRONYMS

Abbreviation	Explanation/ Definition
LMS	Learning Management System
VOOC	Vocational Open Online Course
MOOC	Massive Open Online Course
CRP	Cyber Range Platform
VLE	Virtual Learning Environment
CSS	Cascading Style Sheets
WCAG	Web Content Accessibility Guidelines
HTML	HyperText Markup Language
UX	User Experience

List of abbreviations and acronyms

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REWIRE
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5. LIST OF FIGURES

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