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## **R4.2. BioS VLE Guide**

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**WP4: Development of the BioS Virtual Learning Environment (VLE)**

Responsible Partner: P4- Skybridge

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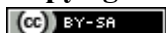
## Executive Summary

This report defines the technical and contextual requirements for the BioS Virtual Learning Environment (VLE), which will host the BioS Massive Open Online Course (MOOC).

Contextual requirements concern the key features of the BioS VLE, including building blocks of the BioS MOOC architecture, course structure, assessment and certification, collaborative mechanisms, users' communication, accessibility, roles and enrolment.

Technical requirements concern the software specifications of the VLE, including IT architecture, software components, installation prerequisites, software prerequisites, course content format and specifications.

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## INTRODUCTION

The objective of this report is to present the contextual and technical requirements for the design and development of the BioS Virtual Learning Environment (VLE). The BioS VLE follows the latest technology in virtual learning to allow for the collaborative interaction between its users through both learning and assessment activities. The BioS VLE is directly available through the weblink <https://mooc.bios-project.eu/>. It is also incorporated into the project website <https://www.bios-project.eu>.

## 1. BACKGROUND

### 1.1. BioS Objectives

The BioS project aims at advancing the digital skills of medical doctors and other healthcare professionals through the design, development and delivery of a new modular vocational curricula on Computational Biology & Bioinformatics. The purpose is to provide medical doctors and other healthcare professionals with knowledge, skills and competencies, which will allow them to tackle effectively concurrent challenges in EU healthcare systems, services, and policies, in benefit of the health of EU citizens.

### 1.2. Scope of the VLE

The scope of the BioS VLE is to create an accessible Vocational Open Online Course (VOOC) which integrates the latest advancements in the field of Computational Biology/Bioinformatics, that can be immediately applied in clinical environment. The main aim of the course is to provide learners with skills which will enable understanding and utilization of large biomedical data sets, especially genomic sequence data, to enhance patient care through improved diagnostic sensitivity and more precise therapeutic targeting.

The BioS VOOC will be a form of Massive Open Online Course (MOOC) but focused on Vocational training tacking into account the VET teaching and learning particularities.

It will offer the BioS training and assessment material developed in WP3 in all partners' language and English, freely and openly for educators, students and self-learners for use, reuse, adaptation and sharing. Constraints imposed will be regarding commercial reuse of the material as well as giving appropriate credit and license when reusing the material. Thus, the resources will be released under the [Creative Commons Attribution-NonCommercial 4.0 International Licence](#).

The BioS VLE will implement the BioS pedagogy, based upon collaborative learning approaches, allowing the collaborative interaction between learners and students. To this purpose, it will include a **Virtual Community**, where users can meet, exchange experiences, and participate in group activities through **Discussions Forums**.

Also, learners will have access to a 'practice area' in the BioS MOOC, where they will be able to access real working-life multimedia case studies.

### 1.3. Target groups

The direct users of the BioS VLE will be:

- Medical doctors
- Other healthcare professionals

### 1.4. Prerequisites

Specific admission requirements: A completed degree in health care professional training programme at the minimum of EQF level 6, such as medical doctor degree or B.Sc. in Health and Safety

Occupational competences of trainees with examples: Medical doctor; Veterinary doctor; Clinical geneticist.

**It is estimated that 800 learners will attend the BioS course. Additionally, massiveness [1] refers to the BioS partners' vision to scale up the course in terms of the number of learners.**

## 2. LEARNING MANAGEMENT SYSTEM (LMS)

### 2.1. Comparative analysis of Moodle & Open edX

A comparative analysis of the main characteristics of the most used open access learning platforms, Moodle & Open edX was performed and the main findings are presented below:

- Open edX is specifically designed for the MOOC world of online and self-paced learning and caters nicely to larger-scale audiences, wherein the platform can easily scale from a few learners to a very high number of learners (tens of thousands or even hundreds of thousands). On the flip side, Moodle is built for a more traditional online classroom model, where online classroom sizes would typically range between 5-30 students. Most instances of Moodle would not be able to manage Massive Online Courses.
- According to [2] students in the Open edX environment in comparison with Moodle LMS are more active. The MOOC-style setup of Open edX enables more interactive participation than a simple online classroom. Open edX technology allows instructors to create engaging learning sequences, which promote active participation as students alternate between learning concepts and solving simple exercises to check their understanding. The course content is presented through learning sequences: a set of interwoven videos, readings, discussions, wikis, collaborative and social media tools, exercises and materials with automatic assessments and instant feedback.

- Generally, both platforms are rich in multimedia features, but Open edX is superior because it offers more options for the video content and gives greater importance to interactive learning tools. The Open edX video player, which is based around YouTube's embeddable video player, is excellent: custom extensions to this player allow students to follow click-on transcripts to move along the video, adjust video speeds, download both the video and the transcripts, and even view transcripts in other languages.
- Open EdX is also superior in terms of evaluation techniques because of the automatic grading system for grading essays [3]. Overall it seems to also give a greater importance to the assessment process than Moodle, by developing new methods of giving feedback to students and tracking their performance.
- Both Moodle and Open edX offer decent communication tools such as discussion forums.

In conclusion, Open edX is a modern approach which can handle massive concurrent participants while Moodle provides more traditional classroom teaching approach. This is in alignment with the BioS partners' lecturers' experience of delivering massive open online courses.

**Thus, the most appropriate LMS to be used for the purposes of the BioS MOOCs is Open edX.**

### 3. CONTEXTUAL REQUIREMENTS

The BioS VLE will be tailored to the training needs of the BioS target groups. It will take advantage of the Open edX platform capabilities. Since Open edX is an open-source LMS, it will be modified to meet any specifications necessary. The core features of the BioS VLE are presented below.

#### 3.1. Modularity

One of the big differences 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 will be as modular or stand-alone as possible, since modularity has many benefits. Learners can more 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 will be organised so that learning material (e.g. video modules/reading material/PowerPoint presentations) alternate with exercises. This will also allow to easier change, reorganise, replace or improve a modular course content or exercise because it minimizes the impact on adjacent material.

Modularity will also facilitate the sharing of content by virtue of being easier to link to.

In this context, the BioS MOOC architecture includes the following building blocks:



1. The **course outline** is the container for all the course content. The outline contains one or more sections.
2. **Course sections (Modules/Weeks)** are at the top level of the course and typically represent a time period. A section contains one or more subsections.

2.1. **Course subsections (Lessons)** are parts of a section, and usually represent a topic or other organizing principle. Subsections are sometimes called “lessons” or “learning sequences”. A subsection contains one or more units.

2.2. **Course units** are lessons in a subsection that students view as single pages. A unit contains one or more components.

2.3. **Course components** are objects within units that contain the actual course content: Videos, reading material, problems/quizzes and discussion forums.

The template for developing the BioS building blocks is presented in Appendix 1.

### 3.2. Getting the word out

#### *About Page*

To get the word out about the BioS MOOCs an About page will be initially created. The About page will be the site where students come to register and will be an advertisement of the BioS courses. It will include texts and short videos (no longer than 3-5 minutes) describing the course content, introducing the course staff and stating the learning objectives of the BioS courses in a general and succinct way.

This page will be published several months before the BioS courses begin.

The set of introductory materials that learners can view when they first enter a course are presented in Appendix 2.

### 3.3. Learning sequence

BioS training content includes a variety of material, from BioS syllabus and schedule to BioS course handouts. Most of the BioS training content consists of courseware and the teaching and assessment material developed throughout the project. Courseware will include videos, readings, exercises, exams and case studies. This content will live in the Course tab of the BioS VLE.

Courseware will be organized in sections. When the learner selects a section, he/she can drill down further into subsections. When the learner selects a subsection, he/she will see a learning sequence, a sequential list of course units across the top of the screen in the Course ribbon.

Learners will engage with content as they move through the units in the learning sequence.

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

A typical learning sequence has a video lecture with accompanying reading material followed by a quick exercise, then another video lecture with accompanying reading material, and another exercise, and so on.

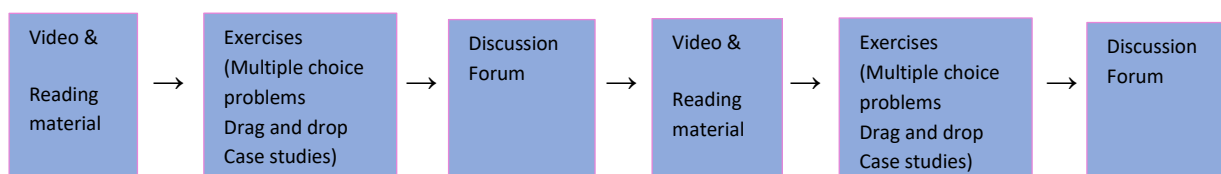


Figure 1. BioS MOOC learning sequence

This active-learning method enables learners to apply what they've learned from the videos and the reading material before moving on to new material. The videos and reading material included in the learning sequence will cover the important ideas, questions, issues, and problems that are at the heart of the BioS training material. In order to make the learning sequence engaging the video content will be split into small, bite-sized elements and interweaving meaningful exercises, or other interactive experiences, to follow them. The videos will be 5 minutes to 10 minutes in length and as modular or standalone as possible.

A discussion topic will be inserted after each module (video, reading material and exercise) so that learners can discuss the material with other who have also recently gone through this material. This “local” discussion topic, embedded in the learning sequence, will also appear in the **course discussion forum**.

The BioS VLE will offer a variety of exercises and problem types from basic multiple-choice problems - reminiscent of a paper-based classroom - to drag and drop exercises that are especially geared towards an online audience. The platform will even offer advanced exercise environments like real case studies. All these problems will be automatically graded and will have customizable features. For example, learners will be allowed to have multiple attempts before they submit their responses or will be shown the answer, or a hint, after several attempts.

### 3.4. Discussion forums

Course discussions will be an integral part of the BioS online courses. Through course discussions, learners will share their opinions and ideas, engage in conversations with other learners, ask questions of the course staff and their peers, and comment on the various components of the course. The vision for the learning community in the BioS MOOC is to bring together medical doctors, healthcare professionals, researchers and experts in bioinformatics from all partners' countries and beyond and to be sustained long after the end of the project.

It will possess a diversity of perspectives, interests, and background knowledge and will allow learners to tap into this tremendous diversity, enriching the BioS course experience for everyone.

Discussion components will be added directly into a unit, allowing learners to respond to the content introduced in the unit. Learners will be able to view and access all the course discussions in the "Discussion" tab in the navigation bar.

Discussions will be moderated by the BioS consortium. Each partner should appoint one person as discussion moderator, who will be responsible for the active upkeep, for example keeping an eye on discussions in order to alert professors of particularly interesting conversations.

When using course discussions, learners will be able to:

- create new discussion posts, reply to existing posts, comment on existing responses, and upvote posts and responses;
- filter and sort posts by various criteria, including posts with the most votes or with the greatest level of activity;
- search on discussion forums by keyword;
- receive an email message each day that summarizes discussion activity for the posts they are following.

Discussion moderators can perform the same tasks as learners, but in addition they can:

- edit, delete or close posts;
- pin posts so they appear at the top of the discussion;
- add more discussion moderators to the course team.

### 3.5. Problems

The BioS VLE will provide many different problem types and feedback options that can be used when designing the exercises and assignments for the BioS courses:

- Multiple choice/Checkbox/Dropdown problems: They have a limited number of possible answers and can allow learners to quickly check their understanding in the middle of a learning sequence.
- Image mapped input/Drag and drop problems: Assessments with graphical components can link learners more closely to the material while still allowing them to choose from a finite set of possible answers. Image mapped input (pointing on a picture) and drag and drop problem types allow learners to interact directly with a graph or picture.
- Problem types that prevent random guessing are a powerful tool combined with automatic grading. Text input (fill-in-the-blank) and numerical input (enter a number) problems can allow an unlimited number of tries without guaranteeing a correct answer.

- Math expression input problems prompt learners to understand the relationship between values instead of focusing on calculating the final result.
- Open Response Assessment (ORA) problems allow instructors to assign questions that may not have definite answers or may be too lengthy for instructors to grade at scale. ORA's can be designed in three ways: as a Peer Assessment, Self-Assessment, or for Staff Assessment. Learners submit a response to the driving question, and then that learner and the learner's peers compare the response to a rubric that you create. Learners can submit text responses, or you can allow them to upload an image to accompany the text.
- Peer instruction provides students with in class opportunities to discuss questions and to achieve a deeper understanding of concepts. The peer instruction tool emulates this classroom experience for the learners in an online course.

All these exercises will be auto-graded on the BioS VLE, so as to allow learners to receive instant feedback. Also, they will give learners multiple attempts, including hints, and writing detailed solutions so as to increase the effectiveness of feedback. Studies have shown that this kind of rapid feedback has significant and positive effects on learner performance when compared to assessments without instant feedback.

### 3.6. Accessible Content

The BioS VLE will make the BioS courses available to students from diverse backgrounds with varying levels of skills and abilities, including students with disabilities that prevent them from completing traditional or on-campus courses. In this context accessibility refers to the degree to which information and activities are available to all students equally regardless of physical or other disabilities. The BioS VLE will create accessible digital learning content, which conforms to level AA of the World Wide Web Consortium's Web Content Accessibility Guidelines (WCAG) 2.0.

The following best practices will be followed:

- To help students who use screen readers, BioS will use descriptive titles for the course content and the content will be structured with HTML elements.
- When using images, charts or diagrams, colour will not be used as a distinguishing element in the image, chart or diagram.
- BioS will use high resolution images that accommodate zooming and always include descriptive, alternative text.
- All BioS courses will use videos with interactive accessible transcripts.
- Any external content or content that requires plug-ins, will be accessible.

### 3.7. Textbooks and PDF Accessibility guidelines

Portable Document Format (PDF) is a common format for course materials, including textbooks. However, converting materials to PDF documents can create accessibility barriers,

particularly for learners with visual impairments. Accessibility issues are very common in PDF files that were scanned from printed sources or exported from a non-PDF document format. Scanned documents are simply images of text. To make scanned documents accessible, Optical Character Recognition (OCR) should be performed on these documents and proofread the resulting text for accuracy before embedding it within the PDF file. Also, semantic structure and other metadata (headings, links, alternative content for images, and so on) should be added to the embedded text. When exporting documents to PDF from other formats, it is important to ensure that the source document contains all the required semantic structure and metadata before exporting.

The following Best Practices for Authoring Accessible PDF Documents will be followed:

- Explicitly define the language of the document so that screen readers know what language they should use to parse the document.
- Explicitly set the document title. When you export a file to PDF format, the document title usually defaults to the file name, not a human readable title.
- Verify that all images have alternative content defined or are marked as decorative only.
- Verify that the PDF file is “tagged”. Make sure the semantic structure from the source document has been correctly imported to the PDF file.
- Verify that a logical reading order is defined. This is especially important for documents that have atypical page layouts or structure.
- If the document includes tables, verify that table headers for rows and columns are properly defined.

#### *Evaluating PDF Files for Accessibility*

Adobe Acrobat Pro has tools (for example, “Accessibility Checker”) that can be used to evaluate PDF files for accessibility. Adobe Acrobat Pro also includes tools (for example, “Make Accessible”) for fixing most common accessibility issues.

### **3.8. Open Access**

BioS MOOCs will include lectures and assessments that are especially created for the BioS project. The project’s educational resources will be offered freely and openly for educators, students and self-learners for use, reuse, adaptation and sharing through the BioS Virtual Learning Environment. Constraints imposed will be regarding commercial reuse of the material as well as giving appropriate credit and license when reusing the material. Thus, the resources will be released under the [Creative Commons Attribution-NonCommercial 4.0 International Licence](#). All resources will be made available in downloadable and editable formats so that the user can store them locally and access them when offline (such as text documents, presentations and videos). The quality of these open educational resources will be assured

based on OER commons recommendations, as well as the EU Open Education 2030 vision on lifelong learning.

Additionally, pre-existing resources can be included, such as published textbooks or articles. These educational materials can be incorporated into the BioS MOOC, provided that copyright laws and regulations are respected.

### 3.9. Grades and assignments

Any of the out of the box problems, such as multiple-choice problems, can be graded or ungraded. The BioS course team will have complete control of what type of graded exercises the BioS courses will have, how much exercises count towards the final grade, and when they are due. The instructor dashboard will provide a source for tracking students' progress.

Concerning the grading policy, the BioS VLE will give instructors considerable control over the exact nature of the grading policy. Instructors will be able to adjust grade ranges, change the names of grades, and decide on the number of possible grades. It is important to note though that any student earning a grade over the "F", or "Fail," threshold will qualify for a certificate. This will be true regardless of how many grade levels will be add in the grade range. Thus, when establishing the BioS grading policy it is important to consider where to set the bar for receiving a certificate.

### 3.10. Instructor Dashboard

The Instructor Dashboard of the BioS VLE will be a special staff-only tab in the navigation bar. Learners will not see the Instructor Dashboard listed in their course navigation. This tab has two main purposes: to show instructors information about student grades and enrolment, and to help them manage the course team. To put it simply, anything administrative that an instructor would do for a normal in-classroom course, can be performed on the Instructor Dashboard.

Using the Instructor Dashboard, instructors, and other course staff can perform many different administrative tasks including the following:

- Access learner grades and records.
- Correct grades and perform other grading tasks. For example, download a spreadsheet (.csv) file that contains a breakdown of all of the grades for BioS enrolled learners.
- Access learner enrolment data.
- Enrol and un-enrol learners, or close course enrolment.
- Email every enrolled learner in the BioS course.
- Assign specific roles to course team members including discussion administrators and beta testers.

### 3.11. Progress Page

While the Instructor Dashboard is the course staff's tool for managing and viewing grades, the Progress tab is the equivalent tool for learners.

The Progress tab will contain a bar chart that lists all graded content in the course, such as homework assignments, quizzes, and tests, as well as the percentage that learners have earned on each assignment that they've completed. The tab also will contain a detailed breakdown of their score on every graded question in the course.

### *Passing a Course and Verified Certificates*

Each course will have its own percentage cut-off for passing. Learners can see where those cut-offs are by looking at the vertical description in the Progress tab. Learners will receive a certificate once they have achieved the passing score. They will be able to download their certificate from the Progress page, or their dashboard on BioS VLE. Every verified certificate will come with a unique URL, which students can include on their resume or LinkedIn profile to confirm that they passed the course.

## 3.12. Roles

- **Staff (Instructor)**  
Team members with the Staff role can complete the following tasks:
  - ✓ View the course before the Course Start Date.
  - ✓ Enroll and unenroll students.
  - ✓ Access student grades.
  - ✓ Reset student attempts to answer a question correctly.
  - ✓ See course HTML errors.
  - ✓ Send email messages to course participants.
- **Admin**  
Team members with the Admin role have access to all of the same options for running the course as team members with the Staff role. They can also complete the following tasks:
  - ✓ Add and remove Staff.
  - ✓ Add and remove other Admins.
  - ✓ Add and remove Beta Testers.
  - ✓ Add and remove Discussion Admins, Discussion Moderators and community Teaching Assistants (TAs-see below)
- **Discussion moderator**  
While course discussions can contribute tremendously to the student experience, there are numerous reasons why it is important that the BioS course team maintain a constant presence in the discussions throughout the duration of the course.
  - ✓ First, moderators should enforce the Discussion Guidelines and edit or remove offensive or inappropriate content, ensuring that the discussions provide a positive and respectful environment for learner interaction.

- ✓ Secondly, moderators answer questions posed by students regarding course content or structure and reply to suggestions or complaints about the course. No issues should go completely unaddressed—even a simple acknowledgement that an issue can only be fixed the next time the course is offered is better than no reply. Learners want to be heard and to understand why things are done the way they are; they always appreciate when the course staff is responsive to their needs and suggestions.
- ✓ Third, moderators can help foster vibrant and active discussions by replying to interesting posts, thanking or congratulating particularly active or insightful discussion participants, posing thought-provoking questions, and pinning or highlighting insightful discussion threads.
- ✓ Lastly, moderators can identify learners who are especially active in the discussions and invite them to become community Teaching Assistants (TA). As community TAs, these learners are very helpful to their peers and find the experience very rewarding.

In brief, the BioS course team will spend a significant amount of time in the course discussions, as this is a great place to communicate with learners and ensure they have an excellent experience.

- **Beta Tester**

Beta testers have early access to the course. Beta testers are not members of the course team: they do not have information about “how it is supposed to work”. They use their own computers and Internet connections to view videos, follow links, and complete problems. They interact with the course as learners will to find, and make, mistakes.

However, beta testers are not the same as other learners in the course, either. They have privileged access to the course and have more time to review and complete the course materials than the enrolled learners do. Course discussions are not open before the course start date, so beta testers cannot participate in community conversations. As a result of these differences, beta testers do not receive certificates when they complete a course.

*Using Course Team Members as Beta Testers*

The BioS course team can provide valuable feedback about the BioS courses. However, they are typically stakeholders in the success of the courses and have a significant amount of knowledge about it. As a result, they can be too close to the course to interact with it in the same way as learners will.

If a team member will be a beta tester, it should be noted that the privileges of the Staff or Admin role override those of a beta tester. The team member must use a different, second email address to create an additional edX account and enroll in the course, and



the course team must assign only the beta tester role to that edX account. The course team member experiences the course as a learner only when she signs in to edX using the beta tester account.

### 3.13. Analytics: BioS Insights Dashboard

The BioS VLE will provide information about courses available to course team members who have the Course Staff or Instructor role. The BioS VLE will provide these course team members with data about learner backgrounds and activities throughout the course. The BioS VLE will provide intelligent, learner-centric analytics to help instructors understand how learners engage with course material.

### 3.14. Enrollment and Engagement

The Insights Dashboard will track learner enrolment and student engagement.

#### *Enrolment*

The Enrollment tab will include the total number of learners enrolled in the course, the number of new learners who enrolled in the previous week, a demographic breakdown of learner age, gender and education level, and a geographic breakdown of the learners enrolled in the BioS course.

#### *Engagement*

The Engagement tab will report the total number of active learners in the past week, as well as the number of learners who viewed videos and attempted to answer problems in the BioS course.

### 3.15. The BioS MOOC Development Checklist

An important tool for the BioS MOOC team is the BioS MOOC Development Checklist (BioS MDC), which is available in Appendix 3. BioS course teams will use the BioS MDC to guide their course planning and creation efforts as well as to determine if their course is ready to be offered on the BioS VLE as a MOOC. The BioS MDC includes a list of minimal requirements that a course must meet before being launched, as well as a list of optional best practices. The BioS MDC addresses the following areas:

- ✓ Course announcement and introduction
- ✓ Course structure
- ✓ Instructional materials and assessments
- ✓ Course administration and learner engagement
- ✓ The checklist is also available as a course handout.

While the BioS MDC can be viewed as a final checkpoint for the BioS course before it is launched, it should be consulted throughout the process of designing and creating a course.

## 4. TECHNICAL SPECIFICATIONS

### 4.1. BioS VLE Architecture

The centerpiece of the BioS VLE is the Open edX platform (<https://github.com/edx/edx-platform>), which contains the learning management and course authoring applications (LMS and Studio, respectively). This service is supported by a collection of other autonomous web services called independently deployed applications (IDAs).

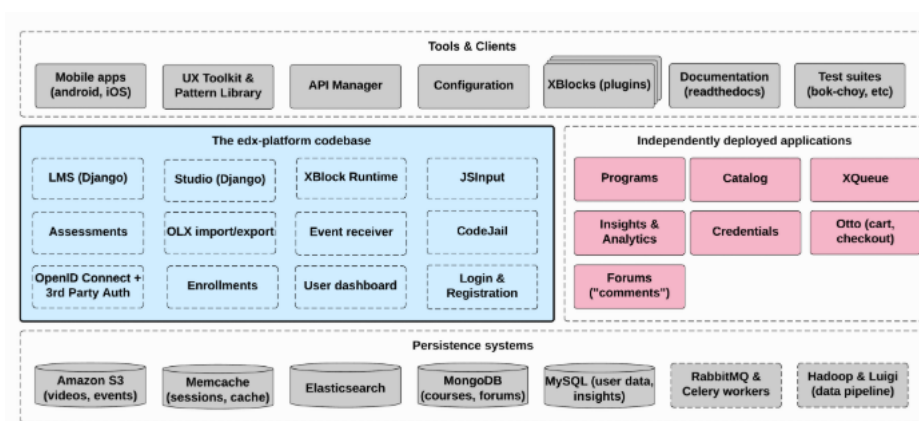


Figure 2. BioS VLE architecture

Almost all of the server-side code in the Open edX project is in Python, with Django as the web application framework. A number of other repositories are also included, that can be used off the platform to integrate machine learning and analytics.

### 4.2. Key components

#### 4.2.1. Learning Management System (LMS)

The LMS is the most visible part of the BioS Open edX VLE. Learners take courses using the LMS. The LMS also provides an instructor dashboard that users who have the Admin or Staff role can access by selecting Instructor.

The LMS uses several data stores. Courses are stored in MongoDB, with videos served from YouTube or Amazon S3. Per-learner data is stored in MySQL.

As learners move through courses and interact with them, events are published to the analytics pipeline for collection, analysis, and reporting.

#### 4.2.2. Front End

The Django server-side code in the LMS and elsewhere uses Mako for front-end template generation. The browser-side code is written primarily in JavaScript with some CoffeeScript as well (edX is working to replace that code with JavaScript). Parts of the client-side code use

the Backbone.js framework, and edX is moving more of the code base to use that framework. The BioS VLE uses Sass and the Bourbon framework for CSS code.

### 4.2.3. Course Browsing

The BioS VLE provides a simple front page for browsing courses.

### 4.2.4. Course Structure

BioS Open edX courses are composed of units called XBlocks. Anyone can write new XBlocks, allowing educators and technologists to extend the set of components for their courses.

In addition to XBlocks, there are a few ways to extend course behavior:

- The LMS is an LTI tool consumer. Course authors can embed LTI tools to integrate other learning tools into an Open edX course.
- Problems can use embedded Python code to either present the problem or assess the learner's response. Instructor-written Python code is executed in a secure environment called CodeJail.
- JavaScript components can be integrated using JS Input.
- Courses can be exported and imported using OLX (open learning XML), an XML- based format for courses.

### 4.2.5. Studio

Studio is the course authoring environment. Course teams use it to create and update courses. Studio writes its courses to the same Mongo database that the LMS uses.

### 4.2.6. Discussions

Course discussions are managed by an IDA called comments (also called forums). Comments is one of the few non-Python components, written in Ruby using the Sinatra framework. The LMS uses an API provided by the comments service to integrate discussions into the learners' course experience.

The comments service includes a notifier process that sends learners notifications about updates in topics of interest.

### 4.2.7. Mobile Apps

The BioS VLE includes a mobile application, available for iOS and Android, that allows learners to watch course videos and more.

### 4.2.8. Analytics

Events describing learner behavior are captured by the Open edX analytics pipeline. The events are stored as JSON in S3, processed using Hadoop, and then digested, aggregated results are published to MySQL. Results are made available via a REST API to Insights, an IDA that

instructors and administrators use to explore data that lets them know what their learners are doing and how their courses are being used.

### 4.3. Installing the BioS VLE

There are two development environment installation options for the BioS VLE, which install the Open edX software using Docker:

- Install the Open edX developer stack (**Devstack**): Devstack is a set of Docker containers designed for local development.
- Install the Open edX analytics developer stack (**Analytics Devstack**). Analytics Devstack is a modified version of the Devstack installation that allows to run Open edX Analytics.

#### *Software Components*

A Devstack installation includes the following Open edX components:

- The Learning Management System (LMS)
- Open edX Studio
- Discussion Forums
- Open Response Assessments (ORA)
- E-Commerce
- Credentials
- Notes
- Course Discovery
- XQueue
- Open edX Search
- A demonstration Open edX course

Analytics Devstack also includes the following Open edX components:

- Open edX Analytics Data API
- Open edX Insights
- The components needed to run the Open edX Analytics Pipeline. This is the primary extract, transform, and load (ETL) tool that extracts and analyzes data from the other Open edX services.

#### 4.3.1. Installation prerequisites

The hosting server of the BioS VLE should have a minimum of 2 CPUs and 6GB of memory.

### 4.3.2. Software prerequisites

Devstack and Analytics Devstack require the following software.

- make (<https://www.gnu.org/software/make/>)
- Docker 17.06 CE or later (<https://www.gnu.org/software/make/>)

### 4.4. Technical specification of the course content

The actual course content of the BioS courses consists of Videos and HTML components (problems/quizzes, reading material).

#### 4.4.1. HTML Components

HTML, or HyperText Markup Language, is the standard markup language used to create web pages. Web browsers present HTML code in a more readable format.

HTML components are the basic building blocks of the BioS course content. BioS team will use HTML components to add and format text, links, images, and more.

#### 4.4.2. Video Components

- Video length  
Videos should be kept as short as possible. Learners are more likely to finish watching a video if it is no more than 3-10 minutes long.
- Accessible Media  
Media-based course materials help to convey concepts and can bring course information to life. All videos in BioS courses are required to include timed text captions in SubRip (SRT) format. The edX media player displays caption files in an interactive sidebar that benefits a variety of learners, including learners who are hard of hearing or whose native language differs from the primary language of the media. This built-in universal design mechanism enhances course's accessibility.
- Recommended Compression Specifications  
The recommended specifications for the videos, which will be hosted to the BioS MOOC are the following:

Output	Publish to YouTube	Publish downloadable file to AWS S3
Codec	H.264 .mp4	H.264 .mp4
Resolution & Frame Rate (see note)	1920x1080, progressive, 29.97 fps	1280x720, progressive, 29.97 fps
Aspect	1.0	1.0
Bit Rate	VBR, 2 pass	VBR, 2 pass
Target VBR	5 mbps	1 mbps
Max VBR	7.5 mbps	1.5 mbps
Audio	AAC 44.1 / 192 kbps	AAC 44.1 / 192 kbps

- Supported Video Formats**

The BioS MOOC will support videos in .mp4, .mpeg, .webm, and .ogg format. However, to help make sure all standard browsers can play the videos, BioS course team will use the .mp4 format.
- Video Transcripts**

Transcripts will be included in all BioS videos. Transcripts help learners with hearing impairments understand audio content, and they are helpful for learners who speak other languages. The BioS VLE will allow learners to download transcripts so that they can read them offline. Transcripts will be associated with a video when the video component is created. Timed transcripts in the SubRip Text (.srt) format are strongly recommended.
- Posting the Video Online**

All course videos should be posted to YouTube. By default, the edX video player accesses the course YouTube videos.

In case YouTube is not available in all locations, however, BioS team will also post copies of the course videos on a third-party hosting site such as Amazon S3. When a learner views a video in the BioS MOOC, if YouTube is not available in that learner's location or if the YouTube video does not play, the video on the backup site will start playing automatically. Learners will be also allowed to download the video from the backup site.

## 5. CONCLUSIONS

BioS VLE will create an accessible Vocational Open Online Course (VOOC) which integrates the latest advancements in the field of Computational Biology/Bioinformatics, that can be immediately applied in clinical environment, based on the Open edX platform. It will allow the collaborative interaction between their users through interactive learning content, assessment activities and discussion forums. The VLE content will be monitored and kept up-to-date continuously.

In order to ensure user acceptance, the BioS VLE will be pilot tested by both the BioS team, the External Advisory Board and the Focus group.

## Appendix 1. BioS MOOC Architecture

<b>BIOS MOOC building blocks</b>	Title	Description
<b>Section/Module 1</b>		Is the top level of the course and typically represent a time period (week).
Subsection/Lesson 1		it represents a topic or other organizing principle and is also called "lesson"
Unit 1		A unit contains one or more components, which represent the actual course content.: Videos, problems/quizzes, reading material, discussion forums.
Unit 2		A unit contains one or more components, which represent the actual course content.: Videos, problems/quizzes, reading material, discussion forums.
Unit ...		A unit contains one or more components, which represent the actual course content.: Videos, problems/quizzes, reading material, discussion forums.
Subsection/Lesson 2		
Unit 1		
Unit 2		
Unit ...		
Subsection/Lesson ...		
Unit 1		
Unit 2		
Unit ...		
<b>Section/Module 2</b>		
Subsection/Lesson 1		
Unit 1		
Unit 2		
Unit ...		
Subsection/Lesson 2		
Unit 1		
Unit 2		
Unit ...		



Subsection/Lesson ...		
Unit 1		
Unit 2		
Unit ...		
<b>Section/Module ...</b>		
Subsection/Lesson 1		
Unit 1		
Unit 2		
Unit ...		
Subsection/Lesson 2		
Unit 1		
Unit 2		
Unit ...		
Subsection/Lesson ...		
Unit 1		
Unit 2		
Unit ...		

## Appendix 2. Preliminary course material

These are a set of introductory materials that learners view when they first enter a course. Preliminary course material can include:

- A syllabus:  
A syllabus is an outline and summary of topics to be covered in a course. As with an on-campus course, a syllabus may include:
  - ✓ Topics covered by the course.
  - ✓ Names of instructors and teaching assistants for the course.
  - ✓ A grading rubric.
  - ✓ Textbook information.
  - ✓ Assignments that the learners can expect.
  - ✓ Deadlines and important dates.
  - ✓ Exams and topic coverage for exams.
  - ✓ Any additional information, such as information about course discussion sessions.
- A course schedule:  
The course schedule lists course topics and when they are covered during the course. The course schedule is useful for both course planning and for the learner to get a bird's-eye view of the course. A course schedule can also be called a "course-at-a-glance" or a course calendar.  
MOOCs, after all, benefit from allowing learners to set their own schedule and manage their own time. The deadlines and due dates for specific assignments, discussion postings, or exams represent the synchronous portion of the MOOC, and must be clearly articulated to any student taking your course.  
A course schedule may include:
  - ✓ Topics to be covered by week
  - ✓ Issue dates and completion deadlines for various assignments
  - ✓ Dates for special assignments such as exams
  - ✓ Readings from the textbook
  - ✓ Expected outcomes by week can also be included in the course schedule.
- Any specific collaboration or course discussion guidelines.  
Topics to address include:
  - ✓ Working together versus sharing answers.
  - ✓ Acceptable versus unacceptable outside resources.
  - ✓ How and when to ask for help with a topic.
  - ✓ Different standards of collaboration for practice exercises, homework, and exams.
- A welcome announcement on the Home page and future announcements.

The Home page is the first page that learners see when they access BioS courses. A welcome announcement will be created on the Home page to serve as a landing pad for new learners and to provide guidance and instructions about the first steps learners should take. The welcome announcement should encourage learners to check out the syllabus, inform them about course discussions, and tell them what is available for viewing. Some instructors have also pointed to a self-diagnostic quiz and material to help learners make sure they're prepared for the course.

In addition to the welcome announcement at the beginning of the BioS courses, a regular stream of announcements will be posted on the Home page throughout the course. For example, the BioS course team will provide words of encouragement, inquire about how things are going, suggest a discussion on the discussion forum, provide answers to common questions, announce impending deadlines or exams, provide topic coverage for exams as they approach, or point learners to particularly interesting posts on the course discussion or to specific items like videos or exercises that the learners should look at.

- A welcome email and future email communications.

While BioS VLE Home page will serve as home base for disseminating information directly to BioS learners, also crafted e-mails will be sent before and during the course. To ensure that BioS learners are engaged and responsive, the e-mail communications will be brief and to the point. Usage may vary, but the emails will be sent to learners two months, one month, one week, and one day before the BioS course begins.

The welcome e-mail is of particular importance, and will be sent to all the learners registered in the BioS class just before the class begins. Many learners will have signed up to take the class months in advance, so this e-mail serves as a useful reminder for them that the course is starting.

## Appendix 3. BioS MOOC Development Checklist

2		
3	Welcome message	Yes
4	Demo of the platform if required	Not Applicable
5	Detailed explanation of how the student can get help if needed	Yes
6	<b>Course program</b>	
7	PDF of the program	Yes
8	prerequisites of the course	No
9	duration of the course	No
10	course deadlines and dates	No
11	Clear qualification policy	No
12	Learning objectives, goals and results	No
13	Accademic policy	No
14	guidelines for discussion forums	No
15	Instructor roles	No
16	Course launch date	No
17	Any unexpected change to the published content will be clearly communicated to the students	No
18	<b>Structure and design of the Course</b>	
19	Course design intersperses instructional content, such as videos and text with exercises	No
20	Course design is clear and consistent from week to week	No
21	<b>Evaluations</b>	
22	The course includes tasks, for example, exercises / tasks / questionnaires "	No
23	The questions and guidelines on allocation problems are clearly articulated	No
24	the deadline for the tasks is clear	No
25	<b>Course videos</b>	
26	The course includes original videos	No
27	Video quality and consistent and adequate audio levels	No
28	Scheduled subtitles for all videos and audio content	No
29	<b>Other Instructional Materials</b>	
30	All the images used in the course are of constant and adequate quality "	No
31	All content from third-party sources is integrated into the course material instead of being linked to another site, if applicable.	No
32	The content outside the platform is optional and it is clear that the link will take the students to a site outside the course and the platform	No
33	<b>Student's Commitment</b>	
34	A welcome message will be sent to the students about the start date of the course.	No
35	The emails will be sent to the students to communicate the launch of new content, provide updates on the course events, and so on at regular intervals throughout the course (recommended once a week)	No
36	A closing email will be sent to the students with the final details of the course near the end date of the course.	No
37	Students are encouraged to use the discussion forum to present themselves "	No
38	<b>Preparation of the certificate</b>	
39	All the certificate information is correct and has been loaded	No
40	The certificate templates have been reviewed by the course team and are approved to activate "	No
41	<b>Reuse</b>	
42	All IP problems are deleted for the course and are clearly documented	No

## References

[1] Weller et al, 2012

[2] Zagorskis, V. and Kapenieks, A. Impact of LMS Selection on Students' Activity - Students' Activity Evaluation Problems in Moodle and Open edX Learning Management Systems. In Proceedings of the 10th International Conference on Computer Supported Education (CSEDU 2018) - Volume 1, pages 505-512 ISBN: 978-989-758-291-2

[3] Lidia Mihaela FUNIERU, Florin LĂZĂROIU Bucharest University of Economic Studies, Romania, Massive Open Online Courses (MOOCs): A Comparative Analysis of the Main Platforms, Informatica Economică vol. 20, no. 2/2016

## Weblinks

<https://open.edx.org/>

<http://docs.edx.org/openedx.html>

<https://edx.readthedocs.io/projects/edx-installing-configuring-and-running/en/latest/index.html>

<https://edx.readthedocs.io/projects/open-edx-building-and-running-a-course/en/named-release-cypress/index.html>

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