

# Open Virtual Mobility

## O2 Virtual Mobility Learning Hub

### Activity 1: Virtual Mobility Learning Hub Concept

### Activity 2: Virtual Mobility Learning Hub Technical Implementation

### Activity 3: Usability Evaluation

## Final Report

Output O2	
Partner information	
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*The creation of these resources has been (partially) funded by the ERASMUS+ grant program of the European Union under grant no. 2017-1-DE01-KA203-003494. Neither the European Commission nor the project's national funding agency DAAD are responsible for the content or liable for any losses or damage resulting of the use of these resources.*

## 1. What were the aims in the application?

Despite numerous projects on Virtual Mobility, there is no single European Learning Environment acting as a central hub for learning about Virtual Mobility and developing virtual mobility skills in higher education (Buchem, 2018). This Output O2 is dedicated to designing, implementing and usability testing of an integrated **Open Virtual Mobility Learning Hub** for developing VM Skills using online, open & flexible higher education approaches and practices.

The technical concept and the architecture of the Virtual Mobility Learning Hub, as designed in **O2-A1 Technical Concept** incorporates the core components or services as described in O3, O4, O5 and O6:

- (1) VM Skills - a semantic, machine-readable description of virtual mobility skills including alignment to existing competency frameworks in a competency directory (O3);
- (2) VM Assessment - different forms of digital self-/assessment including digital evidence (such as testimonials, digital assets, e-portfolios, crowd evidencing) applied as elements of open credentials and supporting open, evidence-based assessment (O4);
- (3) VM Credentials - digital recognition of VM skills based on current forms of open digital credentials such as Open Badges and Blockcerts (O5);
- (4) VM Content - User Generated Content, Open Educational Resources and other forms of Open Content to support learning about VM and developing VM Skills (O6);
- (5) VM Activities - Open Learning Activities including learning in and through MOOCs, peer-to-peer activities, virtual/blended collaborations (O6);
- (6) VM Connections - finding cooperation partners for VM activities supported by such tools as the Matching Tool including an algorithm and interface for learning group formation and matching for collaboration of groups (O3);
- (7) VM Data - data about learning pathways and learning outcomes captured by xAPI and feeding into E-Assessment, Open Credentials and recommendations for learning.



### Aims of Output 2:

- To create a European VM Learning Hub for achievement, assessment and recognition of VM Skills as a central reference point.
- To propose the design of the Virtual Mobility Learning Hub from the technical point of view.
- Outlining a possible implementation at the level of different technical components of the hub.
- To provide details regarding the technical implementation of the Virtual Mobility Learning Hub - VMLH.

The development of Virtual Mobility Learning Hub as a Personal Learning Environment (PLE) furthermore focuses on (a) the development of a responsive interoperable interface, (b) implementation of social software, (c) integration of tools for mobile learning, (d) development of a common working/collaboration space, (e) inclusion of adaptable and semantic features and learning analytics, (f) integrated self-assessment, and (g) validation of open digital credentials.

The development of the Virtual Mobility Learning Hub (VMLH) implies an interdisciplinary approach from web technologies, mobile technologies, Web 2.0, interactive media and audio-video technologies, open access and tools to semantic technology, user interfaces and web usability. It exists now in **all partners' languages (EN, DE, IT, NL, FR, ES, RO)** with a possible extension to other languages which will allow communication at European, national and regional levels.

The Virtual Mobility Learning Hub is an innovative multilingual ICT-based environment unique in Europe (as a directory of virtual mobility attributes) which promotes collaborative learning, connectivist social networking as an instructional method, OERs as the main content, open digital credentials as recognition and validation of VM skills which can be applied to all ages and levels of digital education.

The user-friendly interface as well as the mobile interface encourages everyone to access it, engage in different open learning activities, connect with others and develop their VM competencies.

The concept which laid the foundation of VMLH can be applied into other developments in education, especially in higher education, as an interplay between the 21st century skills or the future skills, education and information and communication technologies (Andone 2018).

## 2. How did we achieve the aims?



### Workflow and methodology:

- O2-A1 Virtual Mobility Learning Hub Concept (3 milestones)
- O2-A2 Virtual Mobility Learning Hub Technical Implementation (6 milestones)
- O2-A3 Usability Evaluation (5 milestones)

Work in O2 was divided into three key activities (1) O2-A1 Virtual Mobility Learning Hub Concept, (2) O2-A2 Virtual Mobility Learning Hub Technical Implementation and (3) O2-A3 Usability Evaluation. In order to achieve the aims related to O2-A1, O2-A2 and O2-A3, we worked in an extremely collaborative and agile way as it was specified in the project application. The design for the Hub took into account the quality assurance from O7 in all the states of its development. We applied an agile design and development methodology where we designed a prototype, we user-tested and evaluated its implementation and the results we obtained were used to improve the Learning Hub. At

the end of each milestone, written detailed reports in a scientific matter were created (Diana Andone, Vlad Mihaescu, Andrei Ternauciuc, Silviu Vert, Politehnica University of Timisoara), peer-reviewed (Johannes Konert, Beuth University) and after revision published in the project website, section “Outputs”. Like for all outputs and events, the publication was communicated on social media including Twitter [https://twitter.com/openVM\\_erasmus](https://twitter.com/openVM_erasmus), Facebook and LinkedIn.

## O2-A1 Virtual Mobility Learning Hub Concept

The Open VM Learning Hub Concept incorporates several components, services and technologies. The applied methodology for the concept and implementation of the Virtual Mobility Learning Hub (VMLH) follows the principles of agile development (Beck, 2001), and socio-cognitive engineering method (Sharples, 2002; Andone, 2009), with focus on frequent technical and user cases iterations and then, user tests to improve user experience as it was included in (Ternauciuc, 2019). The design of the VMLH starts with the desired functionalities previously discussed in partner meetings and conferences, as well as with the existing IT and e-learning infrastructures of the partners, and their desired connections with the Hub.

Several solutions were investigated, most of them in the area of open-source Personal Learning Environments (PLE). Based on the adopted concept, we propose to use the open-source learning management system Moodle as the basis for the VM Learning component, as well as, to some degree, for most of the other components.

The Open VM LH Structure comprises: VM Skills, VM e-Assessment, VM Open Credentials, VM Content, VM Activities, VM Market / Connections and VM Data.



**Highlight: Andone, D., & Ternauciuc, A. (2018) O2-A1: Virtual Reality Learning Hub Concept. Timisoara, Romania:**

[https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-O2A1\\_VMLH\\_Concept\\_Description\\_FINAL\\_QG1.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-O2A1_VMLH_Concept_Description_FINAL_QG1.pdf)

The milestones were reached according to the original plan or earlier:

- ✪1: O2-A1.1: VM Learning Hub concept
- ✪2: O2-A1.2: VMLH Design, User, Functional and Technical Specifications
- ✪3: O2-A1.3: VMLH Design Guidelines based on the validation

## O2-A2 Virtual Mobility Learning Hub Technical Implementation

The **Open VM Learning Hub** Concept incorporates several components, services and technologies. The O2-A2 report details the then current configuration of the VMLH development environment, which later became the production environment. This was based on the State of the Art analysis, part of the O2-A1 Learning Hub Concept.

The Virtual Mobility Learning Hub design and implementation focuses on the integration of open online and mobile components with tools and modules from O3, O4, O5, O6. The technical implementation combined smart digital information, data and resources from other outputs to provide Personal Learning Experiences: Competency Directory and Matching Tools (O3), E-Assessment (O4), Open Credentials (O5), OER, MOOCs and other elements of Open Education (O6). The implementation followed agile principles of iterative, user-driven development applying such methods as personas and user stories.



**Highlight: Andone, D., & Ternauciuc, A. (2018) O2-A2: Virtual Mobility Learning Hub Technical Implementation. Timisoara, Romania:**

[https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-DRAFT\\_O2A2\\_VMLH\\_Technical\\_Implementation\\_QG1.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-DRAFT_O2A2_VMLH_Technical_Implementation_QG1.pdf)

**Andone, D., Ternauciuc, A., Vert, S. (2020) O2-A2: Virtual Mobility Learning Hub Technical Implementation. Timisoara, Romania:**

[https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A2.3\\_VMLH\\_with\\_integrated\\_OERs\\_MOOCs\\_QC3-final.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A2.3_VMLH_with_integrated_OERs_MOOCs_QC3-final.pdf)

**Andone, D., Mihaescu V., Vert S., Ternauciuc A. (2020) O2-A2.4: VMLH Mobile App. Timisoara, Romania:**

[https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A2\\_4\\_VMLH\\_mobile\\_appQC3\\_final.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A2_4_VMLH_mobile_appQC3_final.pdf)

**Andone, D., Mihaescu V., Vert S., Ternauciuc A. (2020) O2-A2.6: VM Learning Hub in all partner languages. Timisoara, Romania:**

<https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A2.6-VM-Learning-Hub-in-all-partner-languages.pdf>

The technical implementation combining Smart Tools (O3), E-Assessment (O4), Open Credentials (O5), OER & MOOC (O6) took the following course:

1. Standardised development of the integrated VM Learning Hub: server-based installation, module adaptation, integration of partner languages.
2. Code development and review for integration of smart tools (O3).
3. First prototype test and results determined performance against the O2 requirements.
4. Implementation and code development for the assessment (O4), Open Credentials (O5).
5. Development of the OER and MOOC tools and courseware (O6).
6. Implementation of social software, semantic and adaptable features.

7. Development of VM Learning Hub Mobile Application and its validation.
8. Quality Assurance - Functional validation of the Virtual Mobility Learning Hub online and mobile version (integration, system and acceptance tests).
9. Continuous delivery and adaptation based on the testing, in all partner languages.

Integration of **MOOCs and OERs** in Virtual Learning Systems and, generally, web platforms, is a common problem, although technically it's still a challenge for beginners and experts alike, because of the multiple standards and software fragmentation that exists nowadays. The integration of MOOCs and OERs in Open VM Learning Hub incorporates several components and technologies as it was described in the **O2A1 LH Concept** and in the **O2-A2.3: VMLH with integrated OERs & MOOCs**.

The **OpenVM mobile application** was created by integrating the open-source Moodle Mobile application and it has been configured to work with the Open Virtual Mobility Learning Hub (VMLH), as it was described in the **O2A1 LH Concept** and in the **O2-A2.4: VMLH mobile app**.

The milestones were reached according to the original plan:

- ✦1: O2-A2.1: VMLH first prototype
- ✦2: O2-A2.2: VMLH with smart tools, assessment, credentials
- ✦3: O2-A2.3: VMLH with integrated OERs & MOOCs
- ✦4: O2-A2.4: VMLH mobile app
- ✦5: O2-A2.5: VMLH validation report
- ✦6: O2-A2.6: VM Learning Hub in all partner languages

## O2-A3 Usability Evaluation

Usability evaluation and continuous update of the VM Learning Hub was performed to ensure the best possible user experience. User experience was designed for and evaluated at different levels as proposed by Garrett (2012), i. e. strategy, scope, structure, skeleton and surface. The validation of the technical concept and usability testing of each tool/feature and of the entire VM Learning Hub used current user experience testing methods such as in-person and remote feedback from live users, gathering and analyzing data from samples of participants, tree-testing to improve the navigation or taxonomy of content, and heuristic tests of the entire VM Learning Hub (Andone, 2020).

Specifically, the usability evaluation of the VM Learning Hub applied these 3 methods: (1) learning analytics validation and analysis, (2) end-user experience and application performance monitoring, and (3) user guides development and feedback as interactive support. This activity also provided periodical monitoring and update of tools based on updated standards, security requirements and new software releases to ensure the sustainability of the VM Learning Hub.



**Highlight: O2-A3 Andone, D., Mihaescu V., Vert S. & Ternauciuc A. (2020) O2-A3.1: VMLH Usability Report (Online and Mobile). Timisoara, Romania.**

[https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A3\\_1\\_VMLH-usability-report-online-and-mobile\\_final.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A3_1_VMLH-usability-report-online-and-mobile_final.pdf)

**Andone, D., Mihaescu V., Vert S., Ternauciuc A. (2020) O2-A3.2: VMLH Update Report. Timisoara, Romania.**

[https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A3\\_2\\_VMLH-update-report.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A3_2_VMLH-update-report.pdf)

**Andone, D., Mihaescu V., Vert S., Ternauciuc A. (2020) O2-A3.3: VMLH User Guides. Timisoara, Romania**

[https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A3\\_3\\_VMLH-user-guides\\_final.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A3_3_VMLH-user-guides_final.pdf)

**Andone, D., Mihaescu V., Vert S., Ternauciuc A. (2020)**

**O2-O2-A3.4: VMLH analytics report. Timisoara, Romania**

[https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A3.4\\_-VMLH-analytics-report.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A3.4_-VMLH-analytics-report.pdf)

**Andone, D., Mihaescu V., Vert S., Ternauciuc A. (2020)**

**O2-A3.5: VMLH Final prototype and report. Timisoara, Romania**

[https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A3.5\\_-VMLH-Final-prototype-and-report.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A3.5_-VMLH-Final-prototype-and-report.pdf)

The **usability evaluation** was performed in several stages – April-May 2019, September- November 2019, February-April 2020 by integrating several usability evaluation methods. The results are used to constantly improve the user experience in the Virtual Mobility Learning Hub – VMLH.

The VMLH was used by different target groups since November 2018, several evaluation and usability tests have been performed, the results were integrated in the VMLH and now we are in the final integration after piloting phase.

By harmonizing the qualitative and quantitative evaluation performed on 139 participants in several usability evaluation periods and scenarios, using several usability testing methods in an extended period of time (8 months), we draw our conclusions on how a MOOC platform dedicated to virtual mobility should perform. Some of the issues, from the usability tests, were related to the usability of the OpenVMLH, others pertained to the actual creation and formatting of the learning materials but very few were of high severity. The **O2-A3.1: VMLH usability report (online and mobile)** included all these evaluations, issues raised and solutions, and it was constantly updated over a period of 8 months.

The improved version of the learning hub is now used by students and professors in 5 universities.

The user guides were proposed to be developed in several stages. The initial one performed between April and June 2019 was dedicated to the tutors of the VMLH and was used by the OpenVM project partners. For the final use of the Open VMLH several tutor/student guides are produced by the Politehnica University of Timisoara (UPT) team. They integrate different needs observed during the initial piloting phase and are integrated as guides in the Open VMLH.

The milestones were reached according to the original plan:

- ✦1: O2-A3.1: VMLH usability report (online and mobile)
- ✦2: O2-A3.2: VMLH update report
- ✦3: O2-A3.3: VMLH user guides
- ✦4: O2-A3.4: VMLH analytics report
- ✦5: O2-A3.5: VMLH Final prototype and report

### 3. What are the key outcomes?

The main result is the creation of the European **Open Virtual Mobility Learning Hub** for collaboration, achievement, assessment and recognition of VM Skills in HE, in this way enhancing recognition, transparency and certification of VM Skills, including digital competencies, through innovative Online, Open & Flexible HE approaches. The VM Learning Hub is available as a desktop and mobile solution, enabling Online, Open and Flexible Higher Education approach.



#### O2 key outcomes:

- One Virtual Mobility Learning Hub design and implementation
- One Virtual Mobility Learning Hub Mobile App design and implementation

#### Key outcomes for O2-A1 Virtual Mobility Learning Hub Concept

- Technical solution for the required functions of the Virtual Mobility Learning Hub.
- The functional diagram for the Virtual Mobility Learning Hub, containing most of the functionalities of the VMLH as envisioned.
- The Open Virtual Mobility Learning Hub structure.
- The VMLH functionalities
- Open VMLH User Case Scenarios

#### Key outcomes for O2-A2 Virtual Mobility Learning Hub Technical Implementation

- Technical implementation of the Open VMLH first prototype
- Technical implementation, tools development, apps integration, smart digital tools integration, adaptation and integration, and support for the Open VMLH integrated with smart tools, assessment, credentials



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- Technical integration, development and support for VM Learning Hub in all partner languages
  - Technical implementation and adaptation of several tools to integrate in the Open VMLH in the courses OERs and MOOCs
  - Technical implementation, development and validation of the Open VMLH mobile app

## Key outcomes for O2-A3 Usability and Evaluation

- Usability evaluation performed in different staged and the Open VMLH usability report (online and mobile)
- Continuing updates and integration of new tools in the Open VMLH
- Development and deployment of Open VMLH user guides and tutors and students support
- Digital analytics (web and learning analytics) for the Open VMLH, continuous and final report
- Deployment, integration and support of the Open VMLH Final prototype

## Further results in O2

The following academic papers related to Technical concept (O2-A1), Implementation (O2-A2) and Usability Evaluation (O2-A3) were written by researchers involved in the project and published in journals/proceedings:

- Andone D. Virtual Mobilities in Open Education in “Access to Knowledge in the 21st Century. The Interplay of Society, Education, ICT and Philosophy”, ISBN 978-3-9503983-5-9, following the 16th NETTIES Conference (Networking Entities) Reading Society, Corfu, Greece, May 3-4, 2018, under IAFES – International Association for eScience <https://www.iafes.net/publications>
- Andone, Diana, Andrei Ternauciu, Vlad Mihaescu, and Silviu Vert. "Developing the Open Virtual Mobility Learning Hub." In European MOOCs Stakeholders Summit, pp. 111-120. Springer, Cham, 2019.
- Andrei Ternauciu, Radu Vasiiu, Vlad Mihaescu, and Diana Andone. "Integrating Open Technologies in the Virtual Mobility Learning Hub." In 2019 IEEE 19th International Conference on Advanced Learning Technologies (ICALT), vol. 2161, pp. 24-28. IEEE, 2019.
- Iona Buchem, Francesca Amenduni, Antonella Poce, Diana Andone, Vlad Mihaescu, Gemma Tur, Santos Urbina, Branislav Smitek, "Integrating mini-MOOCs into Study Programs in Higher Education During COVID-19. Five Pilot Case Studies in Context of the Open Virtual Mobility Project", EDEN 2020
- Andone, Diana, Silviu Vert, Vlad Mihaescu, Daniela Stoica, and Andrei Ternauciu. "Evaluation of the Virtual Mobility Learning Hub." In International Conference on Human-Computer Interaction, pp. 20-33. Springer, Cham, 2020.

## 4. Where are the results documented?

**Published reports related to O2:**

<https://www.openvirtualmobility.eu/topics/outputs/o2-learning-hub/>

**Implementation of O2-A2:** <http://hub.openvirtualmobility.eu>

The published written outcomes from O2 can be accessed and downloaded from the project website, section “Outputs”, subsection “O2.”:

**List of O2 documents published on the project website (chronological order):**

- May 2018 - O2-A1 Virtual Mobility Learning Hub Concept (summary of Milestones 1, 2 & 3): [https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-O2A1\\_VMLH\\_Concept\\_Description\\_FINAL\\_QG1.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-O2A1_VMLH_Concept_Description_FINAL_QG1.pdf)
- Sep 2018 - O2-A2 Virtual Mobility Learning Hub Technical Implementation: [https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-DRAFT\\_O2A2\\_VMLH\\_Technical\\_Implementation\\_QG1.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-DRAFT_O2A2_VMLH_Technical_Implementation_QG1.pdf)
- Jan 2020 - O2-A2.3 Virtual Mobility Learning Hub with Integrated OERs and MOOCs: [https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A2.3\\_VMLH\\_with\\_integrated\\_OERs\\_MOOCs\\_QC3-final.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A2.3_VMLH_with_integrated_OERs_MOOCs_QC3-final.pdf)
- Jan 2020 - O2-A2.4 VMLH Mobile App Technical Implementation: [https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A2\\_4\\_VMLH\\_mobile\\_appQC3\\_final.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A2_4_VMLH_mobile_appQC3_final.pdf)
- Jan 2020 - O2-A3.1 VMLH Usability Report (Online and Mobile): [https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A3\\_1\\_VMLH-usability-report-online-and-mobile\\_final.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A3_1_VMLH-usability-report-online-and-mobile_final.pdf)
- Jan 2020 - O2-A3.2 VMLH Update Report: [https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A3\\_2\\_VMLH-update-report.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A3_2_VMLH-update-report.pdf)
- Jan 2020 - O2-A3.3 VMLH User Guides: [https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT\\_O2A3\\_3\\_VMLH-user-guides\\_final.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/08/openVM-DRAFT_O2A3_3_VMLH-user-guides_final.pdf)
- August 2020 - O2-A2.6: VM Learning Hub in all partner languages <https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A2.6-VM-Learning-Hub-in-all-partner-languages.pdf>
- August 2020 - O2-A3.4: VMLH analytics report [https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A3.4\\_-VMLH-analytics-report.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A3.4_-VMLH-analytics-report.pdf)
- August 2020 - O2-A3.5: VMLH Final prototype and report [https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A3.5\\_-VMLH-Final-prototype-and-report.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2020/09/O2-A3.5_-VMLH-Final-prototype-and-report.pdf)

## 5. What were the challenges and how did we overcome them?

### Challenges and solutions in O2-A1 (Technical Concept)

The main challenges that the technical concept posed were related to the design of the platform architecture, which needed to include all the different functionalities required by the projected outcomes. Some of those functionalities were provided by existing solutions, others needed to be developed by the technical teams in the project.

Multiple existing (mainly) open-source solutions were considered, and the final proposal for the technical concept was based on the Moodle learning management system (LMS). However, aside from several third-party plugins readily available on the official extensions' repository (employed mainly in the gamification efforts), there were specific functionalities that needed to be developed and customized in order to fulfill the aims of the project, such as the badge issuing mechanism coming from Bestr, the e-assessment tool, the group formation tool, or the competency directory.

Also, the open-source portfolio system Mahara was initially considered and ultimately accepted as a desired add-on for the Virtual Mobility Learning Hub in an auxiliary role.

All these different aspects of the platform needed to communicate and integrate harmoniously into a coherent application, transparent to the end-users.

Ultimately, the final technical concept included the aforementioned elements, as well as the way they communicate (see Figure 1 in **O2-A2 Virtual Mobility Learning Hub Technical Implementation<sup>1</sup>**).

## Challenges and solutions in O2-A2 (Implementation)

The implementation of the architecture described in the technical concept posed many of the familiar challenges associated with the development of a complex system composed of heterogeneous elements, by a multinational team of developers with different technical backgrounds.

Fortunately, thanks to constant communication and the efforts of all the partners involved, the final implementation of the Virtual Mobility Learning Hub was completed in a timely fashion, and met most of the initial requirements, as well as some which arose from subsequent testing phases.

The technical team from the Politehnica University of Timisoara (UPT) partner provided the management of the hosting environment, the development, installation and management of the Moodle based main platform, the Mahara auxiliary platform (as well as the unidirectional single sign-on mechanism from Moodle to Mahara), the testing and deployment of multiple third-party plugins, as well as the integration of the different applications developed by the other partners.

The badge issuing system is one of the main contributions the project aimed to provide, and the Italian partner Cineca provided this service by facilitating the integration with the Bestr platform. Badges are automatically issued by Bestr according to course completion events emitted by the Virtual Learning Mobility Learning Hub via the xAPI plugin, while badges that are individually obtained (or can be obtained) are presented inside the Hub via an API that was developed jointly by the UPT and the Cineca technical teams.

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<sup>1</sup>  
[https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-DRAFT\\_O2A2\\_VMLH\\_Technical\\_Implementation\\_QG1.pdf](https://www.openvirtualmobility.eu/wp-content/uploads/2018/09/openVM-DRAFT_O2A2_VMLH_Technical_Implementation_QG1.pdf)

The e-Assessment tool was developed by the Aunege partner as a Moodle native activity for easy integration. It aims to provide users with an electronic assessment experience, customized to the 8 different MOOCs developed inside the Hub.

The group formation tool aims to provide an automated method of creating groups of learners according to responses to a short questionnaire highlighting self-assessed personality traits. Developed by the Beuth University of Applied Sciences team as a Moodle activity, it was easily integrated into the Hub via the usual installation method.

One of the biggest challenges of the implementation was to ensure a balance between keeping the open-source tools – Moodle, Mahara, other third party plugins – at their latest stable versions (thus ensuring the latest security patches are applied), and preserving the proper functioning of the essential tools, especially those developed specifically for the Hub (and which were initially tested with a specific version and combination of environment variables). This makes any major update endeavor a carefully planned and potentially risky operation, which can only be solved with proper backups and redundancy checks.

## Challenges and solutions in O2-A3 (Usability Evaluation)

The usability evaluation of the Open Virtual Mobility Learning Hub extended from April 2019 until November 2019 and involved 139 participants (136 master students and 3 eLearning experts), all from the Politehnica University of Timisoara, Romania:

- 2nd year students from the Multimedia Technologies Master – 21 persons
- 2nd year students from the Communication, Public Relations and Digital Media Master – 17 persons
- eLearning Experts (university professors) – 3 persons
- 1st year students from various technical Master Programs - 98 persons

To evaluate the Virtual Mobility Learning Hub, we identified three main questions:

- Q1. Can a Moodle LMS sustain fully open, online, not tutorized courses?
- Q2. What are the experiences that real students might have as learners in the VMLH?
- Q3. Are the OpenVM MOOCs error-free and ready to become available for the HEI market?

This study combined several usability testing methods:

1. Focus Group – to answer Q1 and Q2
2. User Observation Sessions (as a combination of direct observation, think-aloud protocol, video-recorded observation, screen-logging observation and questionnaires) – to answer Q2 and Q3
3. Error Testing– to answer Q3
4. Survey (together with a written report) – to answer Q1, Q2 and Q3
5. Expert Review– to answer Q1 and Q3

Some usability methods, such as the focus group, were done in one day, in the usability lab that was set up at the university, while others, such as the error testing, were done over a period of 2 months, from the participants' home or office.

Regarding the results of the evaluation, on the one hand, most of the participants consider that MOOCs could easily replace some of the faculty courses and it's easier for them to learn from MOOCs because they can have access anytime, using a device that has Internet connection.

On the other hand, the students were not so pleased with the experience they had using the platform because they encountered many issues that had a negative impact on their journey trying to get the badges for the courses. Some of them did not receive the badges even if they finished the course, and other students could not finish the courses because some of the quizzes were not implemented right and many of the "correct" answers were in fact wrong.

The participants proposed some improvements for both platform and courses. They believe that the experience of using the platform would improve if the videos and PDF documents would be integrated better because, at the moment of the evaluation, their implementation was defective. Also, the links should be more readable, visible and clear, and the quizzes should be revised and corrected, especially the checkboxes functionality. Another important aspect they mentioned is about the tasks and activities of each course, because they need to be revised and displayed correctly. The participants believe that for some of the courses, the structure should be modified in order to be more user friendly because they had some issues understanding exactly what they are supposed to do.

In summary, the major categories of usability problems that came out of the process are: problems pertaining to the platform itself (social media accounts login is hardly visible, platform flow is not user friendly and intuitive, links are not intuitive and hardly visible, the integration of YouTube videos and PDF documents is defective etc.) and problems pertaining to the actual creation and formatting of the learning materials (not everything is written in English / translated, some test answers are wrong, the courses' names are confusing and not specific, the tasks and activities weren't displayed correctly etc.).

A lot of suggestions for improvements were derived from the applied usability methods and most of them have already been implemented.

The usability evaluation allowed us to answer the three main questions as follows:

A1. The evaluation showed that, indeed, a Moodle-based Learning Management System has all the functionalities required and offers the right user experience for sustaining fully open, online, not tutorized courses. However, this also depends on the actual content of the courses and how the teachers set up the learning resources and interactions in the environment.

A2. The students generally reported that their experience in the VMLH was a good one. They rated the courses as better than their faculty ones and they found the VMLH courses to have the right amount of activities and that these activities are of good quality. However, they often stumbled upon small to medium annoyances, such as hidden social media login, page headers too big, defective integration of some multimedia learning materials etc.

A3. The OpenVM MOOCs are not error-free and many - though small - improvements need to be done in order for the courses to be made available to the HEI market. Most of the improvements are in the area of the content of the courses, so the tutors should be in charge with implementing them.

All the major and minor issues which were related to the Open VMLH were integrated as well as some others related to course design or educational resources integration.

## 6. What is the value added of our outcome for VM/HE in Europe?



### European value of O2:

- A European Open Virtual Mobility Hub in 7 languages with 24 courses and hundreds of OERs
- A validated, with usability evaluation, methodology, design, prototype and implementation of an open online and mobile learning environment dedicated to virtual mobility in Europe

<https://hub.openvirtualmobility.eu/>

The VM Learning Hub was created as a Personal Learning Environment with smart technologies, innovative forms of skill recognition with Open Credentials (e. g. Open Badges, Blockcerts) and innovative forms of collaboration (e. g. algorithm-based matching of learning groups with the Matching Tool), captivating and engaging learning experience (e. g. using meaningful gamification), and flexible forms of learning and collaborating (e. g. VM Mobile App).

Despite numerous projects on Virtual Mobility there is no single European Learning Environment acting as a central hub for learning about Virtual Mobility and developing VM Skills in HE. The Virtual Mobility Learning Hub and Mobile Application, as end results of the OpenVM project, offer a unique place where learners, teachers and higher education policy makers can reunite and find Virtual Mobility courses and projects. The Hub offers all interested parties the possibility of networking and exchanging ideas for further improving the field.

Until this project, there were no examples of VM implementation, and the Hub offers through its courses such practical examples. Also, there was a lack of scenarios for VM implementation, also solved through O2-A1.

One of the expected impacts of the openVM project on the participants and participating organisations is the use and extension of the VM Learning Hub tools and content created in the project beyond the project's lifetime. The VMLH helps target groups to develop, assess and recognize one's own VM skills.

Another important aspect of the VMLH is that it provides the technological infrastructure bringing different stakeholder groups together.

We believe we managed to provide a sustainable VM Learning Hub for the continuous development, assessment and recognition of VM Skills in HE in Europe.

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