Blueprint "New Skills Agenda Steel": Industry-driven sustainable European Steel Skills Agenda and Strategy (ESSA)

Training Framework

Development of training courses, measures, arrangements, tools and activities for integration within VET, company and association training programme

Deliverable D5.1

First Framework (Version 1)

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Content

1 Executive Summary

A first version of the infrastructure for sharing learning resources between stakeholders of the ESSA Online Training Eco-system (ESSA OTS) from a central repository, steelHub, was developed and successfully implemented. To test the flexibility of the infrastructure and develop an innovative training experience, ESSA took advantage of the learning competition program "steelChallenge" of worldsteel already in place to implement a blended learning experience.

The learning objective of the course cover some of the technical competences of Metal Processing Plant Operators Job position. The scope of the training comprises learners from VET System and Industry. The training path includes the support of Faculty Members from the academy, research and industry for coaching and mentoring the learners involved in this program. The training path includes several innovative training resources like Interactive 3D models, HTML5 interactive exercises and simulation as well as conventional training resources like pdf files, videos and e-Learning courses. The content has been successfully connected into the Learning Management System (LMS) in some of the companies. Therefore, we were able to complement the Blended Training Path with custom modules and the learners could access the learning experience from the company system.

The Blended Training Path have been delivered to 633 learners from 50 companies and 608 learners from 90 educational institutions. While 99% of the learners will recommend this kind of trainings, this underlines that they are not only of growing importance but also have a high acceptance.

Although the specific technical and professional skills development are in the forehand of the training, also related transversal skills (e.g. work autonomously, critical thinking and decision making, data input and processing, complex information processing and interpretation, green skills, process analysis, complex problem solving, entrepreneurship) are appearing and trained (and assessed in the end of the course).

After the successful implementation of the first version of steelHub infrastructure and the development of a methodology to deliver a highly accepted Blended Training Path, the next step is the integration of the ESSA Job Profile and Occupational Matrix in steelHub. Furthermore, we will start working with training providers to analyse technical and economic barriers to increase the integration of new content into the system to cover the knowledge and skills gaps defined by the ESSA Skills Assessment Checklist and Survey recently started.

2 Introduction

This report summarises the foreseen Training Framework based on the progress of the European Steel Skills Alliance and Agenda (ESSA) and its implementation strategies of its first cycle:

- **Phase 1:** Identifying skills requirements and foundations for establishing the Blueprint (WP 2, 3, and 4), first contours of the Blueprint (WP5)
- **Phase 2:** Reflecting the first research results and network development with policy, social partner, European and national representatives (WP6, 7)
- **Phase 3:** Upgrade of the research results of phase 1 (WP 2, 3, 4), implementing a Blueprint Prototype of the European Steel Skills Agenda and strategy (WP5).

This report comprises the description of the methodology, implementation and results of the Phase 3 for the development of training activities and modules, including training the trainers, to be integrated into VET provision at European national and sector level (incl. interrelation to existing EU tools like EQF, ECVET, ESCO, etc.). Main elements of the Blueprint for this integration are (a) up to now the *Online Training Eco-system (ESSA OTS)* and (b) for further development during the implementation and roll-out phase of the ESSA Blueprint the *Regional Training Eco-systems (ESSA RTS)* in the dedicated steel regions (for further information see ESSA Deliverables D5.2 Blueprint Prototype and D1.4 Midterm-Report).

The Training Framework as a central Blueprint task for the ESSA OTS and ESSA RTS ecosystems includes the development of:

1. Training courses for up- and reskilling existing profiles
2. New occupational profiles or parts of it
3. New Leadership and Work 4.0
4. Train the trainer, improve the training providers
5. New training methods and arrangements, considering
    a. New possibilities of digital learning and support (social media, moodle, virtual labs, online learning, …) and
    b. Workers participation (e.g. workplace innovation, but also by using digital tools like tablets, augmented reality glasses, etc.).

While first tests already done for the ESSA Online Training System, the VET system perspective will come more in-depth into play when it comes to the first implementation phase 2021. In this next phase (within the Regional Training Ecosystem development) the different VET systems of the Member States come into play, checking support and improvement possibilities for the regional steel industry. The work performed in this first phase have been focussed on the **Online Training Eco-system (ESSA OTS)** and its following deliverables:

1. Developing a centralised repository and omnichannel dissemination tool to connect all the relevant and willing stakeholders. This connection allows the exchange of valuable and standard information to continuously integrate and update job profiles and competences; connected with a learner's profile database (human resources databases) and content/assessment

2. Developing a technology-based assessment for Continuous Casting Operation to be used online and at the regional level by trainers, teachers and instructors. This development includes a digital tool to audit the results of the learners. The assessment has been integrated into a steelHub, which is the central element of the ESSA Online Training Eco-system.
3. Developing digital contents which include videos, simulation, webinars and e-learning courses to be used online and in the classroom setup for usage on the regional level by teachers and trainers. These contents have been integrated into the steelHub.
4. Developing a Dashboard with the data collected from the interaction of the learners.

The deliverables consider the topics, the expected level of the audience (basic to advanced) and language issues (translation is important esp. relevant for lower skills levels). Courses are described in a comparable way and customer-oriented. The modules need to be self-contained and small in order to be used in the process to create a custom curricula and individual learning paths.

During the ESSA Blueprint implementation and test phase 2021 the online training framework will be translated into an onsite training environment at the level of steel regions, developing complementary Regional Training Eco-systems (ESSA RTS).

Because ESSA is focusing on the incremental upskilling of the existing workforce (continuous vocational education and training) this reports starts with the detailed outline of the Learning Arrangement focusing on the ESSA Online Training Ecosystem approach, methodology, content, and assessment possibilities. In a second chapter the pilot measures and tests so far are described in respect to the training paths, digital tools, assessment, evaluation and audit measures.

3 Eco-system Learning Arrangement

The ESSA Foresight Observatory as a continuous monitoring and exchange platform for the skills demands side will inform the Online and Regional Training Eco-systems (ESSA OTS and RTS Learning Arrangements) as the supply side. As information and exchange platform for training development and offers the related Training Framework designs (updated or new) training courses and (digital and "analogue") on the job learning. New skills demands have to be aligned to the job profiles of different production areas of the steel companies and VET system occupations. Any subsequent impact on VET systems for those occupations effected must be identified and necessary changes made to the curricula and training offers.

The steelHub as a core element of the Online Training System will serve new ways to incorporate new skill demands related to job profiles within company training provision in more immediate ways to meet pressing needs. However, this will also be a starting point to find new avenues of VET system support online and/or in the steel regions (Member States) for industry needs in the short-term, especially when it comes to the higher basic skills of new generations (including pre-VET education) and increasing the attraction for process industries like steel.

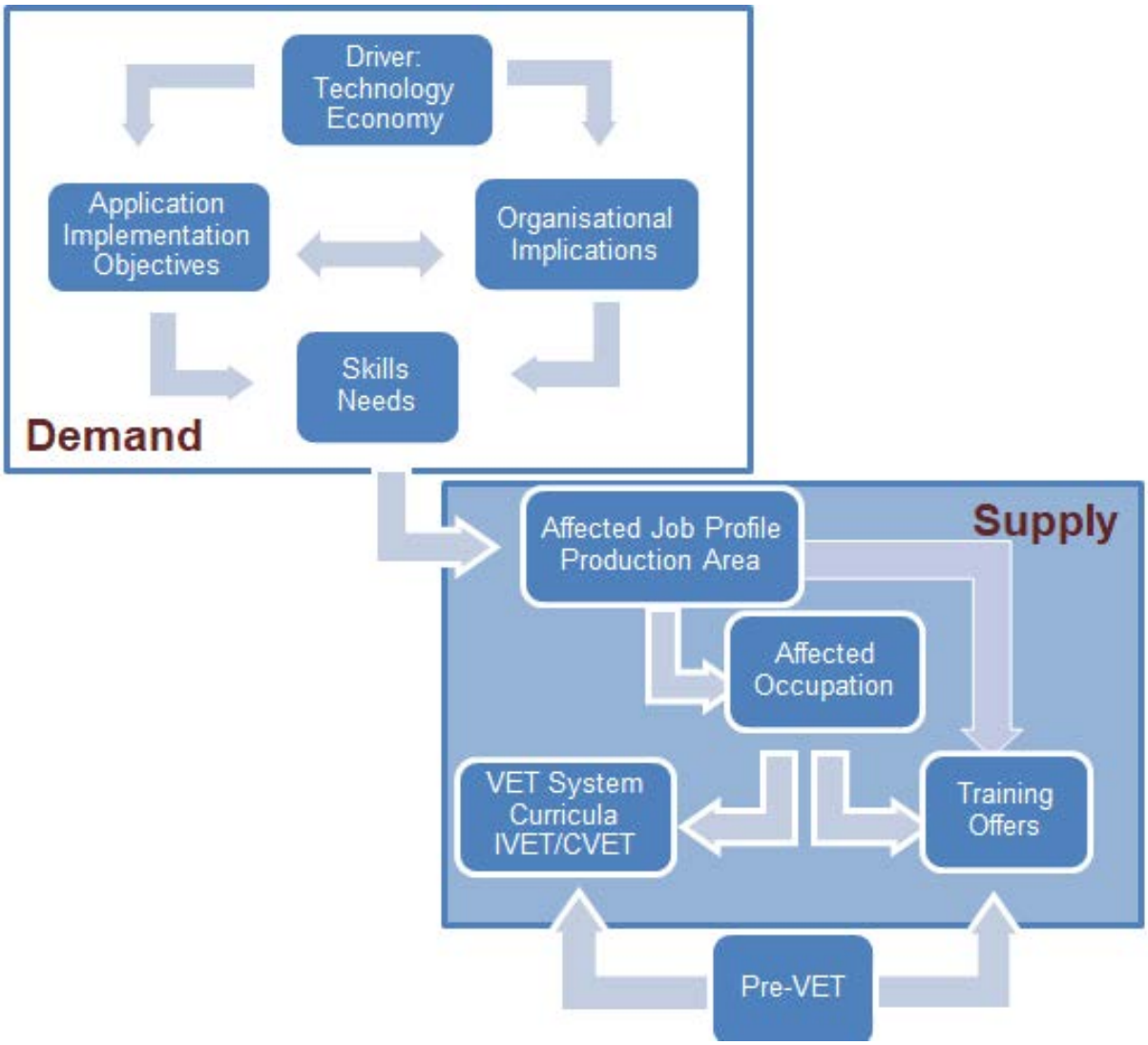


Figure 1: Vocational Education and Training as an answer to skills demands - the supply side

ESSA stresses both virtual and on-the-job learning, which are best way combined with each other. Therefore, the European perspective of ESSA intends to focus on the European level by an **Online Training Eco-system** (digital platform) and on the level of steel regions by national/regional specific **Regional Training Eco-Systems** (networking). Both systems are complementary and could be combined by adding specific advantages to each other (such as combining online and regional on-site training modules that could be integrated in a broader training program of the companies and VET providers):

- virtual / online: independence of time and space, integration of relevant modules in company and individual learning paths, selecting tailor-made individual learning paths and assessment tools, etc.
- analogue / workplace related: real working experience, interactive learning, workplace/project-based learning, mutual learning of peers and trainers, technology developers, etc.

Concerning VET system integration such a complementarity could be seen as follows:

1. Online ecosystem could provide guidance on how to better navigate and make use of national VET (especially CVET and recognition of non-formal and informal learning procedures) and EU frameworks; also, the online ecosystem can build micro-credentials on top of VET systems

to fill gaps and complement them with more customised training (e.g. the continuous casting simulation described below).

2. Regional/national ecosystem could address recommendation to the states and VET systems (especially IVET and the integration in formal occupations) where gaps emerge and provide relevant and up-to-date information on sectoral trends and skills gaps on the basis of which the key actors can act to change the VET system from within (e.g. improve curricula, take into account different learning arrangements); also, providing policy-makers with models and examples of effective regional VET-business configurations.

Based on the ESSA approach and partnership (integrating stakeholders from companies, associations and social partners, training providers, research and development organisations) the Online Training Eco-System conceptualised as a "**steelHub**" is implementing and transfer human resources and training relevant contents and issues *from and to* all the relevant stakeholders:

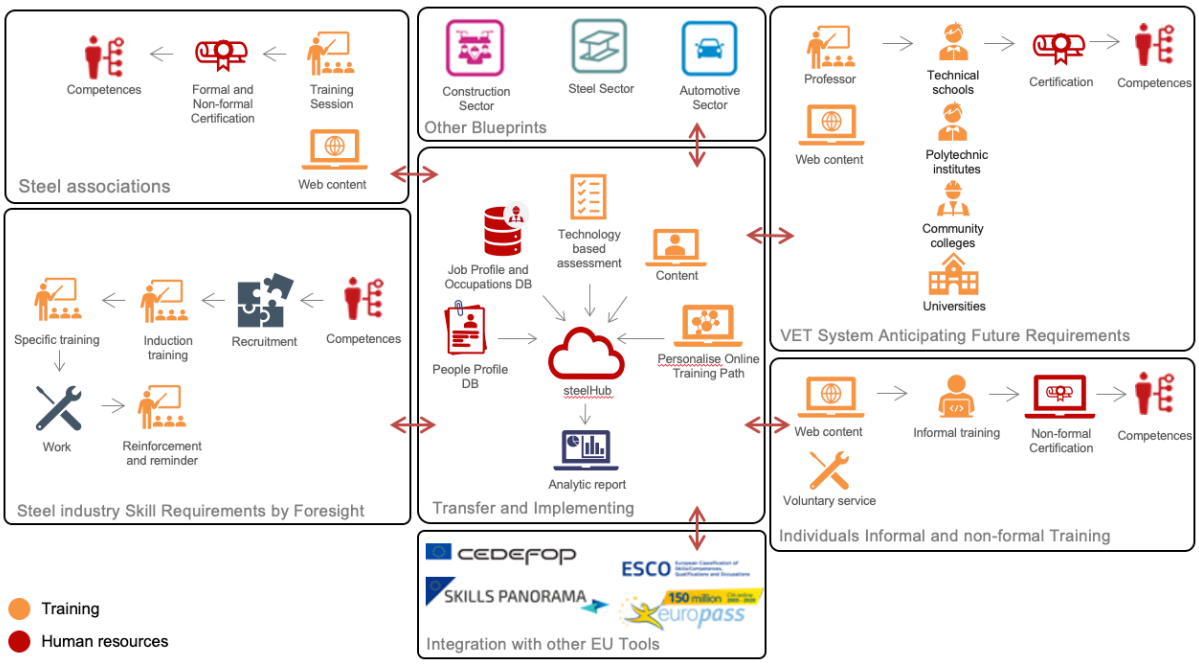


Figure 2: Online Training Eco-System (ESSA OTS)

The **steelHub** as centre of the online eco-system is engaging all the relevant and willing stakeholders and will continuously integrate and update job profiles and competences as well as a people/learner profile database (human resources databases). Technology based assessment, different contents and personalised learning paths / curricula will feed the steelHub and give a basis for analytical reports. The systematisation considers the topics, the expected level of the audience (basic to advanced) and the language issues (translation is important esp. relevant for lower skills levels). Courses are described in a comparable way and customer-oriented. General training courses but also modules for specific technology demands are developed.

The table below describes the up to now six relevant stakeholder areas and their relation to VET in general - feeding in inputs to the steelHub and taking back outcomes or training results in an interrelated way.

Stakeholder	Description
Individuals	Given the improvements in delivery methods, online learning environments provide a greater degree of flexibility than traditional classroom settings (Giesbers et. al., 2014, Douglas Business School, 2017). Online platforms can also offer more diverse representations of student populations as learners prepare for working in the twenty-first century (Stewart et. al., 2017). The diversity comes from interacting with students outside of one's geographical location, possibly offering a variety of perspectives on course content (Stewart et al., 2017). Courses offered completely online are primarily delivered in an asynchronous learning or synchronous learning format. This generate that the training providers platform starts concentrating on courses and certificate programs from individual experts, professors, VET System players, steel equipment providers, association, etc. Normally this programme is part of non-formal and informal education and allows individuals worldwide to access skills and knowledge on demand. Examples of these platform are Degreed[1], Coursera[2] and Linkedin[3]. These platforms can take courses already curated and aligned with the needs of the steel industry, uploaded in steelHub improving the offer to their users. On the other hand, training providers (experts, professors, VET System, etc) will be able to reach a broad audience with their content.
Learning and development in the steel industry	Learning and development (L&D) aims to improve group and individual performance into an organization by increasing and honing skills and knowledge. L&D is designed to align group and individual goals and performance with the organisation's overall vision and goals. On a practical level, the organisation must identify skills gaps among groups and teams and then finding suitable training to fill these gaps. The identification of the training is not an easy task due to the amount of possible options. Usually, the training that represents the core of the business is delivered by internal instructors. Despite the fact that normally the internal instructors do not have the pedagogic skills, they generate high level of knowledge transfer and motivation, due to their deep understanding of processes and add values with specific example and cases. On the other hand, generic training is usually delivered by external instructors or using online resources from supply chain (like Danieli Academy[4] and SandVik Coromant[5]), private training providers (like ToolingU[6] and Vector Solution[7]), research center (like Material Processing Institute[8]) and also through other steel companies like Tata Steel[9]. Due to the digitalisation of contents, it is possible to integrate them into steelHub. The content is curated with standard competences in order to *easily identify* the training for the particular skill gap required by the company. Besides, cost-sharing is given for development and maintenance of high-quality content like simulators and videos. Furthermore, having a

[1] https://degreed.com/
[2] https://www.coursera.org/
[3] https://www.linkedin.com/
[4] https://www.danieli.com/en/danieli-education/danieli-academy.htm
[5] https://www.sandvik.coromant.com/en-gb/services/education/pages/e-learning.aspx?Country=be
[6] https://www.toolingu.com/
[7] https://www.vectorsolutions.com/
[8] https://www.mpiuk.com/index.htm
[9] https://capabilitydevelopment.org/

	rating capability for each content, the evaluation of the students can be centralised in order to identify best practice and trends from pedagogic perspective.
Other Blueprints and EU Tools	Under the EU Erasmus+ program for sectoral cooperation on skills, stakeholders work together in sector-specific partnerships, called **alliances for sectoral cooperation for skills,** which develop and implement strategies to address skills gaps in these sectors. The idea of skilling for a job is central to blueprint alliances. They address skills shortages by: • gathering information for the European skills panorama[10] • developing a sector skills strategy • developing occupational profiles, vocational programmes and qualifications • designing a long-term action plan to be rolled out at the national and regional levels • promoting the use of EU tools such as - European qualifications framework (EQF)[11] - European skills, competences, qualifications and occupations (ESCO)[12] - Europass[13] - European credit system for vocational education and training (ECVET)[14] - European quality assurance in vocational education and training (EQAVET)[15] The standardization of specific and transversal skills proposed by this program make possible to integrate and curate all the content into a centralised platform to be accessed by different stakeholders of the ecosystem in each sector. In particular, for Automotive and Construction sectors, which sharing not only transversal skills but also some specific skills, are excellent candidates for content sharing with steel manufacturing sector. Besides, because many manufacture steels companies also have business downstream on the automotive and construction sector, they will find this centralised repository very useful to search for training offers and cost sharing development. Finally, having all the analysis received from the interaction with content and assessment of the student storage into the same database makes it possible to integrate with related individual learners and tools like European skills panorama[16] and Europass[17].
Steel Association	For the purpose of this document, we can define the "trade steel association" and "professional steel association". A **trade association**[18], also known as an **industry trade group**, **business association**, **sector association** or **industry body**, is an organization founded and funded by businesses that operate in a specific industry. An industry trade association participates in public relations activities such as advertising, *education*, publishing, lobbying, and political donations, but its focus is collaboration between companies. Associations may offer other services, such

[10] https://skillspanorama.cedefop.europa.eu/en/useful_resources/including-sectoral-skills-evidence-skills-panorama-practical-framework
[11] https://www.cedefop.europa.eu/en/events-and-projects/projects/european-qualifications-framework-eqf
[12] https://ec.europa.eu/social/main.jsp?catId=1326&langId=en
[13] https://ec.europa.eu/social/main.jsp?catId=1266&langId=en
[14] https://www.cedefop.europa.eu/en/events-and-projects/projects/european-credit-system-vocational-education-and-training-ecvet
[15] https://www.eqavet.eu/
[16] https://skillspanorama.cedefop.europa.eu/en/useful_resources/including-sectoral-skills-evidence-skills-panorama-practical-framework
[17] https://ec.europa.eu/social/main.jsp?catId=1266&langId=en
[18] https://en.wikipedia.org/wiki/Trade_association

	as producing conferences, holding networking or charitable events, or offering *classes or educational materials*. Regarding the service in education of associations, they normally focus on specific training to developed skills to do something rather than just know about something. Training can be specific for the needs, vocation or skills-gap of the people. The focus of those training is for people who want to implement a new system, improve a specific ability or further their ability in something. Those skills are normally identified by the industries, collected by the association and delivered by subject matter experts from the industry, supply chain or VET System. In many cases this training is delivered in a non-formal or informal way. The Professional Association[19] represents the interest of the professional practitioners. According to Science Council[20] in the UK, this association can be defined as, "an organisation with individual members practicing a profession or occupation in which the organisation maintains an oversight of the knowledge, skills, conduct and practice of that profession or occupation". Many professional bodies are involved in accrediting degrees, defining and examining the skills and competencies necessary to practice a person, and granting professional certifications[21] to indicate that a person is qualified in the subject area. Besides, there are some advanced professional certificates, which are a result of an educational process designed for individuals. Those certificates are designed for both newcomers to the industry as well as seasoned professionals. Certificates are awarded by an educational program[22] or academic institution[23]. In the both cases the need of a *strong communication channel* between VET System, Association and Industry to align the training offers and skills needed in order to offer a high quality and industry-oriented training program for individuals is identified, to be realised by the steelHub.
VET System	**Online learning**[24] involves courses offered by postsecondary institutions that are 100% virtual, excluding massively open online courses[25] (MOOCs). Online learning or virtual classes offered over the internet are contrasted to traditional courses taken in a brick-and-mortar school building. Learner experience is typically asynchronous, but may also incorporate synchronous elements. The vast majority of institutions utilise a Learning Management System for the administration of online courses. As theories of distance education evolve, digital technologies to support learning and pedagogy continue to transform as well. Most online learning occurs through a college's or university's learning management system[26] (LMS). A LMS is a software application for maintaining, delivering, and tracking educational resources. According to the Educause Center for Analysis and Research (ECAR) use of a LMS is nearly ubiquitous as 99% of colleges and universities report having one in place (Dahlstrom et al. 2014). Among faculty, 87% report using a LMS and find them useful for "enhancing teaching (74%) and student learning (71%)" (Dahlstrom et al. 2014, p. 10). Similarly, 83% of students use an LMS for their learning, with the majority (56%) using them in most or all courses.

[19] https://en.wikipedia.org/wiki/Professional_association#:~:text=The%20roles%20of%20professional%20associations,represent%20the%20interest%20of%20the
[20] https://en.wikipedia.org/wiki/Science_Council
[21] https://en.wikipedia.org/wiki/Professional_certification
[22] https://en.wikipedia.org/wiki/Educational_program
[23] https://en.wikipedia.org/wiki/Academic_institution
[24] https://en.wikipedia.org/wiki/Online_learning_in_higher_education
[25] https://en.wikipedia.org/wiki/Massively_open_online_course
[26] https://en.wikipedia.org/wiki/Learning_management_system

	Access to online content hosted in steelHub allows the VET System to use content developed by other training resources like interactive models developed by steel industry equipment providers, industry experts delivering practical training, Virtual Reality and Augment Reality games for teaching that usually is economically difficult develop them into the VET System. On the other hand, VET System contribute with a high-level education material developed by academics that are useful for the development of the workers into the steel industry and its supply chain.

Table 1: Interrelation of stakeholder groups with the steelHub

ESSA is not starting at scratch to configure such a learning arrangement. The already in place training program of worldsteel will integrate and develop the web-based steelHub. It is a database and analytics system hosted in the cloud which can generate files to be shared with companies and education providers. The system is built in a flexible way to allow organisations also to use it although they do not have an own learning management system. Through the system and based on a standard database of competencies, one can gain a rapid overview of the strengths and weakness at the individual level, but also compare where a company stands among other companies and how people's competences are distributed within a company. Furthermore, individual learners can see which skills are needed for a specific position and see how their own level compares to the job requirements and to the industry standards. Based on this gap analysis, they can choose individually and company tailored specific training to build the needed competences due to the contents and evaluations are curated by means of the standard database of competences. Besides, the creation of an automatic and customised training path (personalize curricula) to close the skills gap for each individual is also possible.

In order to cover the demands of each stakeholder group in the eco-system the following table describes in detail the different modules that need to be included into the steelHub.

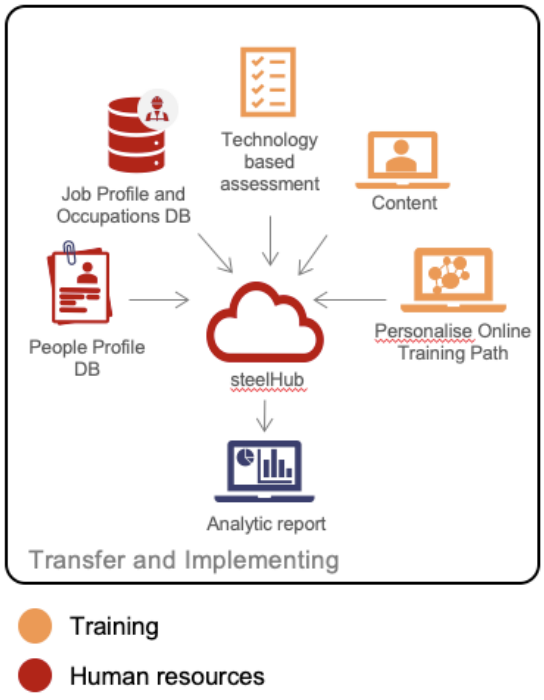


Figure 3: steelHub as centre of the ESSA Online Training System

	Online database of skills associated with current and future jobs in the steel sector. The database needs to be connected and updated according ESCO Database in order to assure alignment between all the stakeholders.
	Technical Based Assessment library that includes conventional assessment tools like multiple choice, surveys and audit forms. A new innovative digital tool to evaluate the students, like simulations, virtual reality scenarios, etc. is also included.
	Content Library for up- and reskilling existing profiles, new occupational profiles or parts of it, new leadership and work 4.0, train the trainer tools. This library will also include new training methods and arrangements, considering new possibilities of digital learning and support (such as social media, virtual labs, online learning, gamification, mobile apps, virtual reality) and workers participation (e.g. workplace innovation, but also by using digital tools)
	Due to all the information of competencies, content and assessment are connected and the data of learner experience and results are collected in the same environment and decision tool base on Machine Learning (Personalised Online Training Path). This will apply to guide the student/learner through the most efficient process to develop their skills.
	Within the People/Learners Profile Database the information of each user is consolidated in the users profile to report their skills and to track acquisition of new skills. This user profile could also be used to match learners to job openings in the sector helping in the mobility inside the companies, between region and between countries.
	Finally, the analytic report will aggregate data collected from multiple users, which will help organization, VET systems, industry, governments, etc. to evaluate the performance of their training programs with an Analytic Report program and offer.

Table 2: steelHub modules

The steelHub will be an **exchange platform for training offers (input and output)**. It will be a continuously updated inventory of training offers and modules curated with a standard competences data base. The development of training activities and modules, including training the trainers, will be done by the companies and training providers, coordinated by worldsteel as a platform coordinator. As an open platform, the steelHub training offers could be used by individuals, companies, VET providers (including VET institutions like vocational schools). Training could be integrated into VET provisions at company, national and sector level (incl. interrelation to existing EU tools like EQF, ECVET, ESCO, etc.). As described in the introduction, this central Blueprint platform will include the development of (a) training courses for up- and reskilling existing profiles, (b) new occupational profiles or parts of it, (c) new leadership and work 4.0, (d) train the trainer, (e) new training methods and arrangements. As an online platform ESSA OTS is considering new possibilities of digital learning and support and workers participation and empowerment (e.g. workplace innovation, but also by using digital tools). The further development and sustainable running of the steelHub will be coordinated by worldsteel, done collaboratively with divided responsibilities due to the expertise and preferences of the involved companies and training providers.

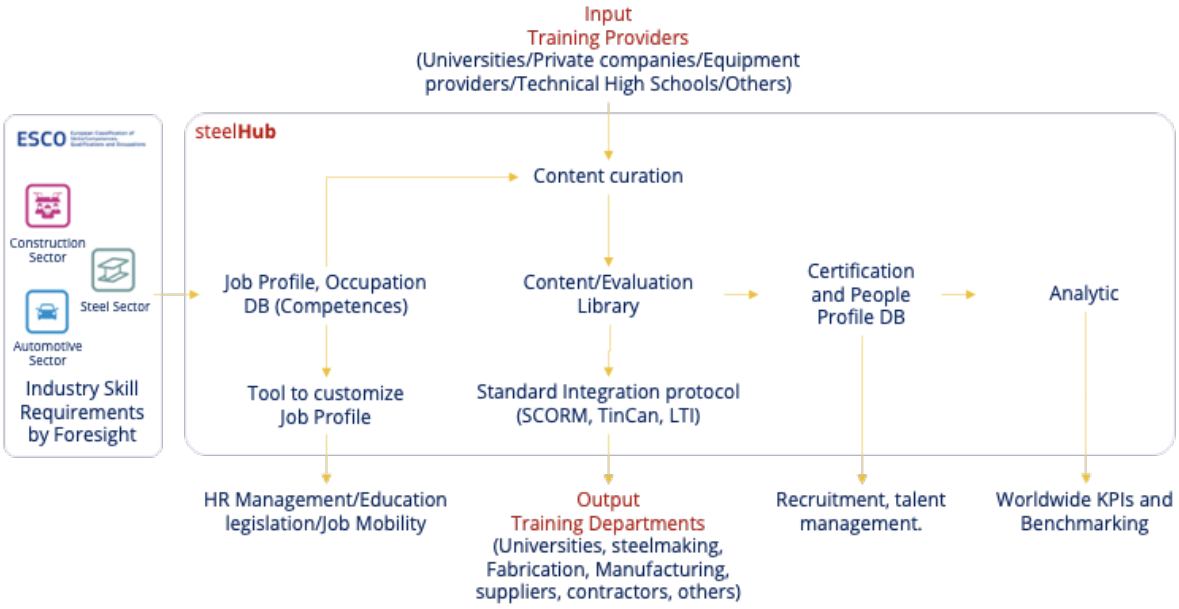


Figure 4: steelHub infrastructure

The steelHub and its infrastructure is composed to support the **Online and Regional Training Eco-Systems** (see Deliverable D5.2 Blueprint Prototype, chapter 3): Promoting new learning arrangements, expand and promote relevant digital and on-the-job training as lifelong learning and improve the image of the steel sector and careers by fostering recruitment and talent management. With the steelHub activities and tools (e.g. the Steel Challenge, see next chapter) job contents and opportunities in the sector could be spread to candidates of varied disciplines (incl. a new diversity by women, migrants, etc.) and VET system institutions (promoting contents of the steel sector to vocational schools but also primary and secondary schools (pre-VET)).

The **delivery method and protocols** of the training platform have been tested in a full scale over five multinational industries, where steeluniversity works as a "training provider" delivering more than 90 courses in three different languages into the Learning Management System (LMS) of the companies compatible with SCORM2004. The LMS included in this pilot test were Success Factor and SumTotal, which are the main system in the steelindustry. Courses include different assets, like videos, simulations and 3D model; which prove the flexibility of the system. It is necessary to expand the communication protocols to Tin Can API (xAPI)[27] and LTI in order to cover all the possible options. VET system players have access through steeluniversity.org[28] composing a training group for each company, association or VET institution.

The **Job Profile and Occupation Database** (Skills, Competences, Occupations) of the steelHub is fed by the **Industry Skills Requirements and Foresight** defined by the ESSA Observatory Roadmap and Foresight Panel (monitoring and anticipating current and future skills demands), being aligned with (parts of) the ESCO database and integrating relevant skills related inputs from other sectoral Blueprints (related to steel, such as Construction and Automotive as steel using manufacturing). The database module will have a web service interface with authentication access for the administrator to edit and change the skills and competences description and add additional competences to keep the

[27] https://en.wikipedia.org/wiki/Experience_API
[28] http://steeluniversity.org/

Database up to date with the evolution of the industry. It will provide and promote T-shaped skills of the main job profiles concerned.

The **Content/Evaluation Library Module** is storing all the assets, which includes videos, pdf files, HTML or web-GL simulations/games and SCORM Packages. They are stored within Amazon S3 for distribution. Regarding video, any kind of format can be uploaded into the current version of steelHub, which include MPEG-4[29], Ogg[30] and webm[31]. Under development is the implementation of AWS service for streaming, this service will add the ability to have a flexible and scalable video processing for highly distributed and personalized access to video. Also, pdf format allows the dissemination of reports, research papers, pdf format books, articles, and others controlling and measuring the access to those. Games and Simulation can be uploaded into web-GL, HTML or wrapped into SCORM Package. These simulations are a very good complement for classroom training at regional level because they can be used as virtual labs, case study or homework to be solved by students. All assets described can be organize into steelHub in Training Paths to cover multiple learning objectives at different cognitive levels. One important aspect of this module is the connection with People/Learners Profile DB, the results of pre-assessment and assessment are recorded into this module to generate certificates.

The amount of expected content is very large, which require a powerful tool to search into the content and assessment library. Therefore, the **Content Curation Module** is included into the infrastructure**.** This module is under development and the first curation proposed for the content is against the "Job Profile and Occupation DB". Following the methodology of ECD described before, it is possible to connect job profiles with competences and then with Learning Objectives to finally associate them with the content and assessments storage into the Content/Assessment Library. For example, if student A wants to develop skills to become a Continuous Casting Operator, steelHub will filter and offer the learner the relevant content and assessment to accomplish this goal. Other taxonomies are also planned to be integrated into this module, which uses data of the learner, collected by the "People Profile DB" and "Job Profile DB". For example, we know that learner "A" takes several modules from the content/assessment library to develop a Continuous Casting Operator competence, so the system learns about this experience of learner "A" and offers to learner "B" the same training path. Finally, the evaluation of the experience of learner A and B will curate the best training path offer to the students. The system will be more and more effective if the volume of learners increases.

The **Certification and People Profile Module** stores the experience of the learners and is used as a prove of completion and achievement for the learner. From this DB the report of achievement, CV or Learner profile is created that can be connected with European tool, like EuroPass. These data can also be used for recruitment and job posting.

Analytics Module is the last one in this process because it is the one in charge of consolidating all the information generating from the previous modules. This module helps to analyse the experience of the learners, follow up the completion rate of each training content, the evaluation of the content from learners to define best practice, recording the training hours. The Analytics Module will be used by the training providers to understand the use of their content and assessment uploaded into steelHub.

[29] https://en.wikipedia.org/wiki/MPEG-4
[30] https://en.wikipedia.org/wiki/Ogg
[31] https://en.wikipedia.org/wiki/WebM

3.1 Methodology

The ESSA Training Framework methodology is focusing very much on the upskilling of the existing workforce and therefore continuous vocational education and learning of adults: **adult learning as self-directed learning** (learning to learn as an increasing important soft skill). Therefore, some main elements considered for the Training Ecosystems are briefly described. However, the ESSA training modules are also relevant for apprentices and students of vocational schools and an integration in Initial Vocational Education and Training Programs, but "voluntary" lifelong adult learning of workers has to be treated different than compulsory education. On the other side the **connection of competences with learning content** is a main challenge for combining industry skills demands with occupational profiles and how industry demands fit with occupational profiles and thus IVET systems (as said above, this will be in the centre of the ESSA RTS development on the member state and regional level).

3.1.1 Adult Learning

The design, development, and implementation of an adult learning or professional learning initiative can be a complex task. To be successful, organizers are required to account for a multitude of considerations, from learning content to adult psychology to applicable technologies Jimi Gipple (n.d.), ICS Learning Group. Therefore, to understand the full breadth of the learning ecosystem and to comprehend its relevance in an effective educational strategy, we need to start with a fundamental component of adult learning.

Adults are self-directed learners, which is a concept introduced by Malcolm Knowles' (1975) theory of adult learning. Garrison (1997) added elements of self-management to the model. The model proposed included three overlapping dimensions: Self-management (task control), Self-monitoring (cognitive responsibility), and Motivation (entering and task). The self-directed learning model attempts to integrate contextual, cognitive, and motivational dimensions of the educational experience. The fundamental argument for understanding and facilitating self-direction is its potential to improve the quality of learning outcomes in both the short and long term. The self-directed learning can be understood as a process where individuals take the initiative to *diagnose learning needs*, form learning goals, identify resources, implement a learning plan, and assess their own results.

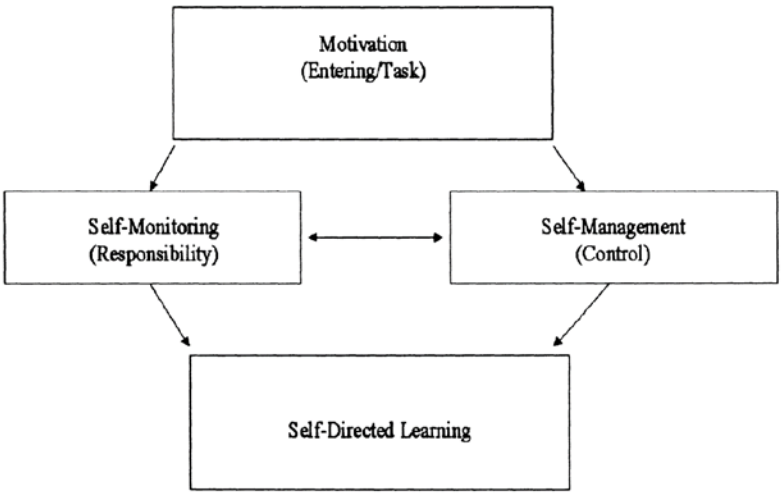


Figure 5: Dimensions of Self-Directed Learning (Garrison, 1997)

Therefore, the learning experience needs to include the following elements:

1. Connection between **up to date** Job Profiles and Learning Outcomes to motivate and make sense of the training content to the learner.
2. **Self-Assessment** of the Learning Outcomes to allow the learner to identify gaps.
3. Identify the relevant learning resources and implement a personalised training path. In order to help the learner, the content need to be curated and associated with Job Profiles, content and assessment.
4. **Final Assessment** to assure the quality of learning outcomes obtained and recorded, the results have to prove the achievement obtained.

These four points are integrated into the Eco-system Learning Arrangement and digitally inter-connected into an online platform to allow the massive access and self-management of the learning experience.

3.1.2 Connecting Competences, Skills and Knowledge with Training Content

It is crucial that the range of knowledge, skills and competences identified are translated into standardised, recognisable and acknowledged outcomes. Therefore, it is necessary to have a methodology to connect them. This connection allows for the construction of assessments to measure the level of knowledge, skills and competences in relation to the individual learners. John T. Behrens et al. (2012) address this problem with the implemented Evidence Centred Design (ECD) (Mislevy, Steinberg, & Almond, 2003) as a conceptual framework for assessment. They have been using this approach for over 10 years to undergird the delivery of 100 million exams in over 160 countries, along with development of innovative simulation-based curricular and assessment tools (e.g., Frezzo, Behrens & Mislevy, 2010). For each of the major sections of the ECD framework, they offered thoughts about how emerging technologies will influence the future of assessment and the alignment of those with training tools.

A quotation from Messick (1994) neatly summarizes the core idea of an assessment argument:

> *A construct-centered approach would begin by asking what complex of knowledge, skills, or other attributes should be assessed, presumably because they are tied to explicit or implicit objectives of instruction or are otherwise valued by society. Next, what behaviors or performances should reveal those constructs, and what tasks or situations should elicit those behaviors? Thus, the nature of the construct guides the selection or construction of relevant tasks as well as the rational development of construct-based scoring criteria and rubrics. (p. 17)*

The following image describes key parts of the ECD framework as end-to-end processes in several conceptual layers (Mislevy, 1994; Mislevy, Steinberg, & Almond, 2002, 2003). The first step in starting the assessment process is considering those aspects relevant to the assessment one wishes to construct. This is represented by the top layers of the ECD model, as illustrated in the following Figure (adapted from Mislevy & Riconscente, 2006). The first layer is marshalling facts and theory about the domain and are defined by the Industry Skills Requirements of ESSA, regularly updated by the planned ESSA Observatory. The second is organizing the information in the form of assessment arguments. The middle layer, the Conceptual Assessment Framework (CAF), specifies more technical models for task creation, evaluation procedures, measurement models, and the like - in essence, blue-

prints for the pieces and activities that instantiate the argument in the real world. The next layer concerns the manufacturing of the assessment artefacts and the specifics for their usage. The lower layer describes a four-process architecture for understanding assessment delivery.

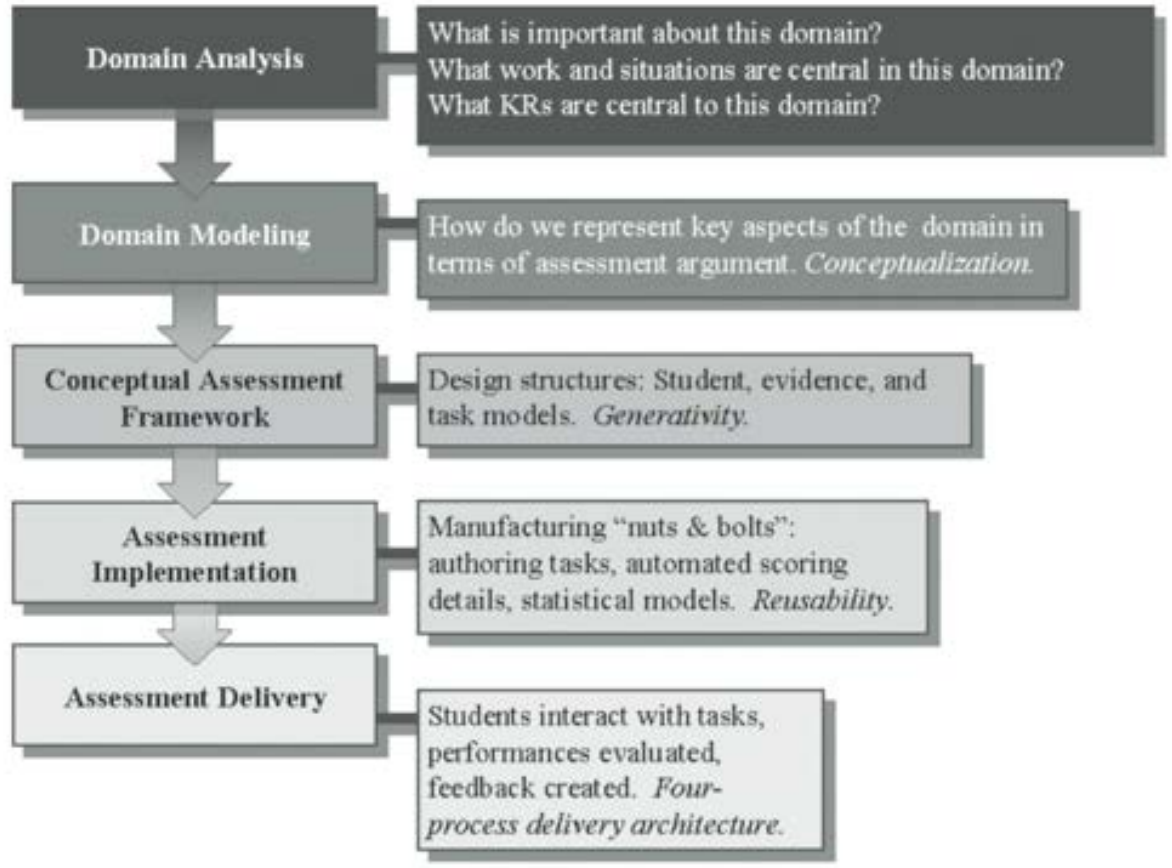


Figure 6: Layers in Evidence-Centered Design. KR = Knowledge Representations (adapted from Mislevy & Riconscente, 2006)

As an example, Shute et al. (2010) describes an approach for modelling key competencies and developing valid assessments embedded within an immersive game. In their work, they used a consolidate version of this flow chart which has three particular steps: (1) define the claims to be made about students' competencies, (2) establish what constitutes valid evidence of the claims, and (3) determine the nature and form of tasks or situations that will elicit that evidence.

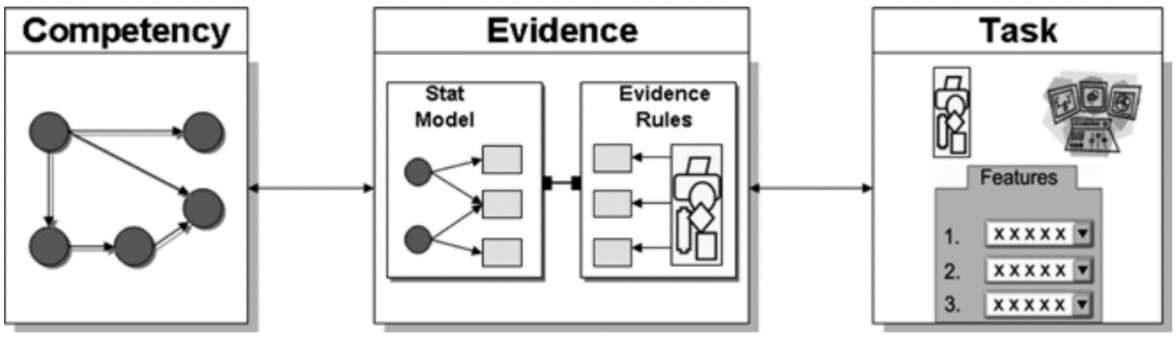


Figure 7: Main modules of an Evidence-Centred Design (Source: Shute et al., 2010, p. 139)

Competency Model: What collection of knowledge, skills, and other attributes should be assessed? Variables in the competency model (CM) are usually called "nodes" and describe the set of person variables on which inferences are based. The term "student model" is used to denote a student-instantiated version of the CM, like a profile or report card only at a more refined grain size. Values in the student model express the assessor's current belief about a student's level on each variable within the CM. For example, suppose the CM for a science class that valued the general competency of systems thinking contained a node for "Create a causal loop diagram." The value of that node - for a student who was really facile at understanding and drawing causal loop diagrams - may be "high" (if the competency levels were divided into low, medium, and high), based on evidence accumulated across multiple, relevant contexts.

Evidence Model: What behaviours or performances should reveal differential levels of the targeted competencies? An evidence model expresses how the student's interactions with, and responses to a given problem constitute evidence about competency model variables. Basically, an evidence model lays out the argument about why and how observations in a given task situation (i.e., student performance data) constitute evidence about CM variables. Using the same node as illustrated in the CM section above, the evidence model would clearly indicate the aspects of causal loop diagrams that must be present (or absent) to indicate varying degrees of understanding or mastery of that competency.

Task Model: What tasks should elicit those behaviours that comprise the evidence? A task model (TM) provides a framework for characterizing and constructing situations with which a student will interact to provide evidence about targeted aspects of knowledge or skill related to competencies. These situations are described in terms of: (a) the presentation format (e.g., directions, stimuli), (b) the specific work or response products (e.g., answers, work samples), and (c) other variables used to describe key features of tasks (e.g., difficulty level). Thus, task specifications establish what the student will be asked to do, what kinds of responses are permitted, what types of formats are available, and other considerations, such as whether the student will be timed, allowed to use tools (e.g., calculators, dictionaries), and so forth. Multiple task models can be employed in a given assessment. Tasks are the most obvious part of an assessment, and their main purpose is to elicit evidence (which is observable) about competencies (which are unobservable).

This methodology has been used in the pilot test to connect the skills and knowledge defined as part of skills requirements for the ESSA Continuous Casting Operator job profile and occupation with the learning objectives and learning outcomes that need to be made evident thru assessment. The following image shows a flow chart as an example for the definition of the "Competency Model". From a particular "Job Profile" Tasks are defined, in this case two different tasks. Each Task requires some Skills and those skills need some basic knowledge. We connect the knowledge with Learning Objectives which are the basis to define the Evidence Model. These Learning Objectives are used to connect the competences with training content offer. The following flow chart shows a codification of each Skill, Knowledge and Learning Object to be organized and connected into a DB.

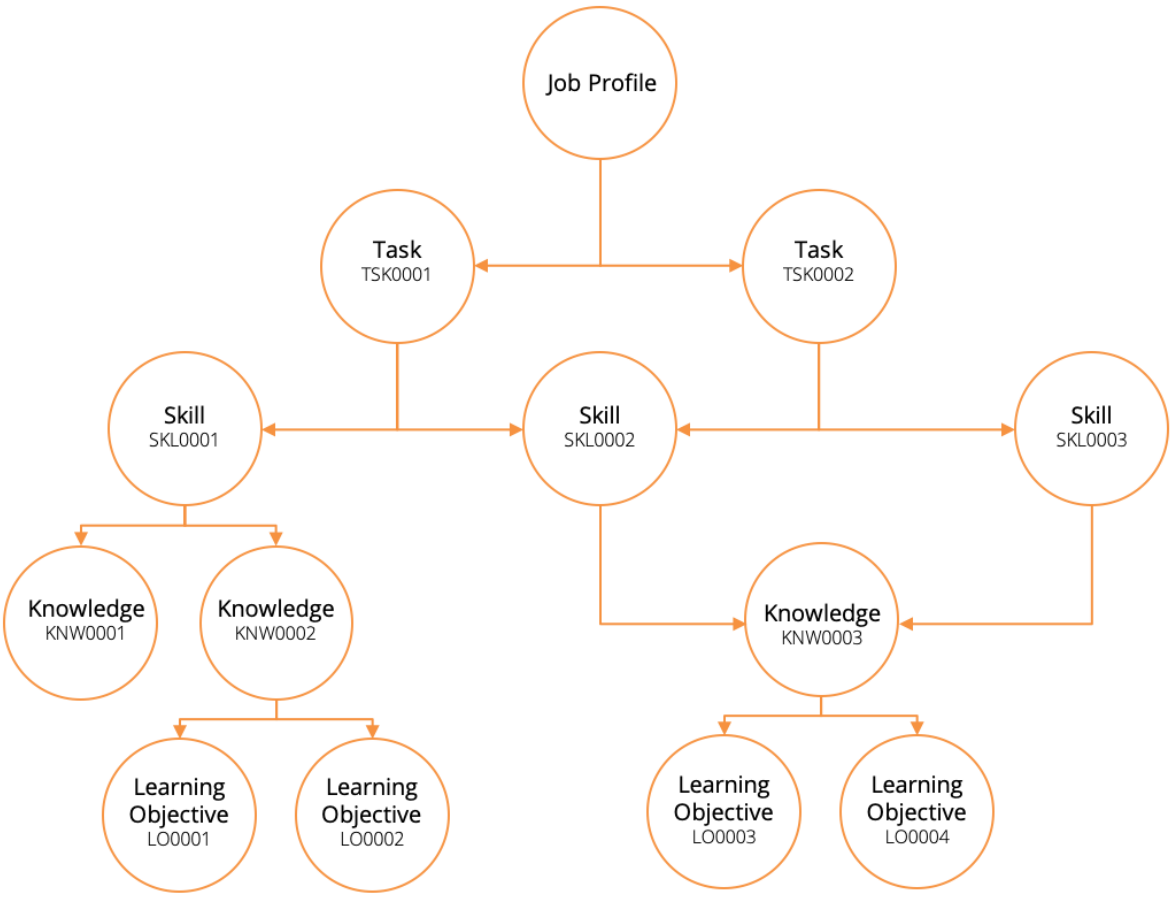


Figure 8: Flow chart for competency model.

3.2 Training Content

(New) training offers should reflect **(new) learning arrangements**. Digital transformation is not only focusing on re- and upskilling of the workers but also relevant for new learning and teaching arrangement. Digitalisation will also improve and increase new learning possibilities and arrangements (quantitatively and qualitatively): Training providers, companies, workers and apprentices have to improve their digital skills for both **learning and operating** at the workplace. Not only the Covid-19 pandemic but also the speed of (technological and continuous) changes show the importance of more and new (digital) online learning and training possibilities. Digitalisation of learning modules, improved digital skills, flexible and agile trainers and learners are relevant elements of new digital learning strategies and alliances. New formats are needed articulating new developments in time comprising different possibilities such:

- Online training and simulation
- On the job training
- Integration of general or specific modules in company training schemes
- Reverse mentorship as a two-way process between older and younger employees (as suggested by the Steel Sector Careers Blueprint SSC)
- Webinars
- Individual and specific groups training paths (incompany, across companies, individuals, ...)
- Self-learning modules and models (with real time feedback for iterative corrections)

- Experiential learning (e.g. production process assessment concerning energy efficiency)
- Blended learning, combining classroom and workplace, linking VET schools and workplace, improved coordination of knowledge acquisition and practical learning)
- Project-based, challenge-based and integrative learning, game-based learning
- Social and collaborative learning
- New forms of assessment and validation: ePortfolios, learning challenges, feedback to learners, new links between assessors and learners
- Virtual Reality environments
- and others.

Hundreds of digital education tools have been created with the purpose of giving autonomy to the learner, improving the administration of training processes, encouraging collaboration, and facilitating communication between teachers/trainers and learners. The following image summarizes the digital resources and interaction that can be part of a training program at the level of the online and regional ecosystem.

Figure 9: The learning ecosystem (adapted from Gipple (n.d.))

Against this backdrop, the focus of the ESSA pilot test is around traditional, asynchronous and synchronous training as well as in web delivery. Social learning is very important but it was not included in this first phase of the project. Additionally, the ESSA Training Framework is paying special attention to a Train the Trainer program.

3.3 Train the Trainer Program

Cedefop's skills forecast states teaching professionals as one of the most in demand future occupations up to 2030 (Cedefop, n.d.). Because no education and training system is better than its teachers and trainers, ESSA recognises this by train the trainer programmes and offers it as part of the steelHub of the Online Training Eco-System and also of the Regional Training Eco-System approach. Developing train the trainer programmes as off-the-shelf solutions based on the demand-side (what training

needs arise out of the use of new technologies) and supply-side analysis (what are companies/ providers offering) we are looking to provide an overview of methodologies of trainer developments and specific training courses for trainers (e.g. on new training methodologies and technologies): (1) improving digital skills for trainers, (2) content around new technologies for training courses, (3) enabling non-trainers (peers, leaders) to train. We will elaborate requirements, strategies, guidelines for train the trainer programmes to train trainers and middle managers, workers delivering skills training to steelworkers in relation to the gaps missing in VET delivery and/or within firms or more widely, including guidelines for delivering the strategy or programmes.

The new digital tools implemented in the pilot test generate a large amount of data about the experience and results obtained by the learners. The data processing requires that trainer be more prepared in this field. Learn2Analyze[32] (L2A) is an Academia-Industry Knowledge Alliance for enhancing Online Training Professionals' (Instructional Designers and e-Trainers) Competences in Educational Data Analytics, co-funded by the European Commission through the Erasmus+ Program of the European Union (Cooperation for innovation and the exchange of good practices). This alliance developed a MOOC to learn to Analyse Educational Data and Improve Blended and Online Teaching.[33]

On the other hand, the ESSA training program will be developed around digital tools, which are in charge to generate the data of the learner. Therefore, the design of the tools needs to have user friendly visual interface with guidelines and help embedded to make easier the implementation. In line with this goal, two modules around the Continuous Casting Simulation need to be developed as shown in the following figure.

Figure 10: Completing modules for Continuous Casting Simulation

The first module is used to define and setup the parameters that define the case study that need to be solved by the student and a second module that analyse the results obtained by all the students participating into the exercise. The second module, which is name "Audit Tool", have been developed as part of the Pilot Test and described in the Pilot Test Section. This online tool has a user-friendly interface that simplifies the access of a teacher/trainer to the results obtained by the trainees.

3.4 Assessment

In Self-Directed Learning it is very important to measure the level of the learning outcomes in order to help the learner to identify learning gaps. In this sense, the assessment is a key element in the Adult Learning. Besides, it is important to mention that Self-Directed Learning is normally done during non-formal or informal learning. More European countries are emphasising the importance of making visible and valuing learning that takes place outside formal education and training institutions, for example at work, in leisure time activities and at home (European guidelines for validating non-for-

[32] https://learn2analyse.eu/proj/about/
[33] A YouTube video is presenting this course briefly.
https://www.youtube.com/watch?v=hWm533GpMKg&feature=youtu.be

mal and informal learning assessment, see Cedefop, 2015). The validation of non-formal and informal learning is increasingly seen as a way of improving lifelong and lifewide learning. Therefore, the following section will make a short description of the main findings of the European Guidelines that were used to design our technology-based pilot test.

Digitalisation presents opportunities in areas such as non-formal learning and eLearning, and digital technologies are already used for skills obtained through nonformal and informal learning: As indicated in the European guidelines for validating non-formal and informal learning, the 'use of (online) self-assessment tools is widespread (and increasing) in Europe' (Cedefop, 2015, p. 42) Numerous initiatives and projects develop digital instruments in which the main focus is on the identification and documentation of competences but might also include assessment and in some cases be used for certification purposes.

The ESSA Training Framework focuses on digital forms of assessment or digital assessment tools, which are understood as a form or instrument for obtaining and presenting evidence for the assessment of learning outcomes managed using computer technology. The assessment is based on the data collection of the centralised repository. The digital self-assessment tools can, for example, be used as part of guidance or coaching offers, e.g. enabling individuals to take a first step towards validation. Such tools can be more or less standardised, include different forms of assessment (self-assessment or external assessment) and might be combined with face-to-face guidance sessions. These digital assessment tools can, for example, be used for supporting decisions related to the choice of further education programmes or career changes. The tools can refer to

- key competences, such as foreign language skills for which often self-assessment tools are provided based on the Common European Framework of Reference for Languages (Council of Europe, 2001, p. 6) or Digital Competences Framework for Citizen[34]
- competences related to a specific occupational field or
- they can be considered as comprehensive skills audits covering various forms of competences and contexts in which they have been acquired.

In the Final Synthesis report of the European inventory on validation of non-formal and informal learning (Cedefop, 2018) several countries in Europe have been studied to understand the different tools used for assessment. In 2018, most of the countries with validation arrangements in at least one of the education and training subsectors used a wide range of tools for obtaining evidence on knowledge, skills and competences. As the following Figure shows, 'tests and examinations' were identified as the single most frequently used method. This was reported to be in use in 28 countries, followed by 'portfolios' (27 countries) and 'interviews, debates and dialogues' (26 countries). 'Third party reports' appear to be least commonly used, reported by nine countries. It is, however, expected that, in line with the upskilling pathways recommendation, the use of documentation (reports or skills profile i.e. in the form Europass) will gain further attention in the future.

[34] https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework

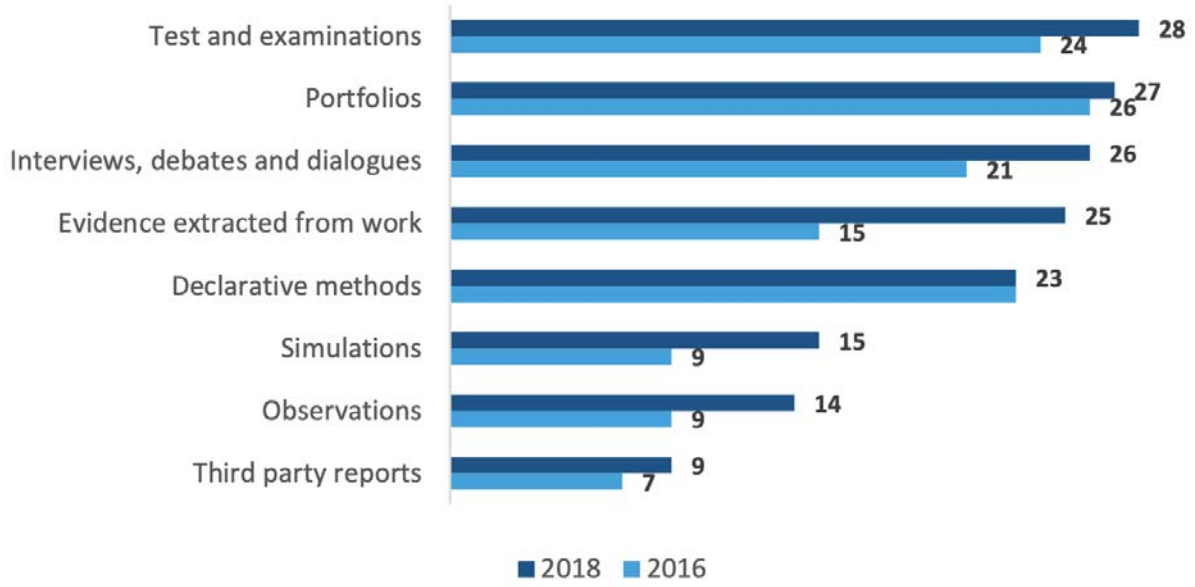


Figure 11: Tools used for validation of non-formal and informal learning (Cedefop, 2018, p. 39).

Whilst the overall picture emerging from the 2018 Inventory data is largely comparable to the situation in 2016, it also suggests certain developments in this area. In general, more countries make use of the different validation methods compared to the previous inventory. In 2016, "portfolios" were most prevalent but in 2018 they have been surpassed by "tests and examinations". As for the latter, these appear to be typically organised by education providers and, to a lesser extent, by other stakeholders. "Evidence extracted from work" and "simulations" and use of "observations" gained considerable popularity in 2018 compared to 2016.

Following this trend, a technology-based assessment on "simulation" and "test and examination" have been developed in the ESSA Training Framework for some of the competences included into the Job Profile of Continuous Casting Operator in order to show the integration of the skills and knowledge defined for this position, the development of the learning outcomes and finally the definition of the assessment. The results are described in the following pilot test sections.

4 Pilot Measures and Tests

The objective of the pilot measures and tests described in this section is to make a first integration of the relevant ESSA results so far to obtain digital training and evaluation tools. In addition, these tools need be integrated within and available to the industry and VET System through the steelHub to test the centralised repository infrastructure.

Relevant ESSA results for the pilot measures and tests are:

- incremental upskilling of existing job profiles → continuous casting operator as one of the central job occupations in the steel industry,
- training framework infrastructure to integrate external training offers and to allow retrieval of training measures by external organisations, first exchange connections between the different parts/players of the ecosystem (first priorities: industry requirements and individual learners), creation and test of nodes, …
- combining professional technical skills with transversal skills

- improve the usage of online training courses and measures: not only due to the increased relevance caused by the Covid-19 pandemic but because of its increasing importance for short-term skill adjustments
- enhance the ESSA Blueprint so far with additional components: translating skills demands into learning outcomes, evaluating (individually) learning outcomes/results, new learning arrangements like competition with other learners (globally, company internal, comparing with other companies), ...
- integration of new features in customisable and individualizable training paths and modules
- test interactive features, e.g. interactive simulation of central production parts: entering different parameter values and get a direct feedback of impact on the production.

The Job Profile of "Continuous Casting Operator" has been selected to perform this pilot test, because of its central relevance for steelmaking as part of the formal occupation of the "**Metal Processing Plant Operator"** comprising skills to monitor, operate, adjust and maintain single-function process machinery and equipment to process and convert mineral ores and refine, harden, roll and extrude metals.

The Pilot Test comprised the following training measures (identified in the topics above and described in detail below):

- Learning arrangement into an online worldwide competition, which include a complete blended Training Path with 3D models, videos, webinars, competition, analytic and user-friendly audit tool.
- Technology Based Assessment, which implement the ECD to connect competences with two type of assessment, "Test and Examination" and "Simulation".
- Integration of the learning arrangement into VET System and Industry

4.1 Training Path (Metal Processing / Continuous Casting Operator)

4.1.1 Introduction

To test the Continuous Casting Operator training program ESSA will take advantage of the learning competition program "steelChallenge" of worldsteel already in place to implement a blended learning experience which include learners from the VET System and Industry as well as faculty members from the academy, research and industry for coaching and mentoring the participants. While the steelChallenge is focusing explicitly at the steel industry there are also other broader competition programs, e.g. the World Skills Competition https://worldskills.org/ which is focusing on occupations that might also be steel related but not defined singularly for the steel industry under a more general approach, e.g. engineering skills.

Each year since 2005 worldsteel has hosted the "steelChallenge". It is a competition challenging students and employees in the steel industry to learn about steel manufacturing and test their skills using sophisticated online manufacturing simulators delivered by steeluniversity. The students are training during three months to accomplish the task of producing a specified grade of steel at the lowest cost within a period of 24 hours.

steelChallenge has grown in popularity with 18,000 participants registered for the competition since inception, typically achieving 2,000 registrations in recent years. Use of the steeluniversity manufacturing simulators has surpassed 3 million attempts. For introducing young people to the steel industry

and learning about making steel, steelChallenge is a worldwide leader. However, not only young students but also steel workers are integrated in these challenges.

Due to the target of integrating the competition in VET Systems and Industry, the setup of the steelChallenge-15 was the perfect choice to test the integration in the ESSA steelHub and the reception of the learning arrangement proposed. During the steelChallenge-15 competition, **633** participants of the industry and **608** students registered and practiced during September, October and November of 2020 to compete on November 25th 2020. The following infographic summarises the results and participation in detail, showing the big success of this kind of tool. At the end of the competition a survey has been conducted to evaluate the level of satisfaction of the students related to this learning arrangement. The results of analytics and evaluation are listed in the next chapters below.

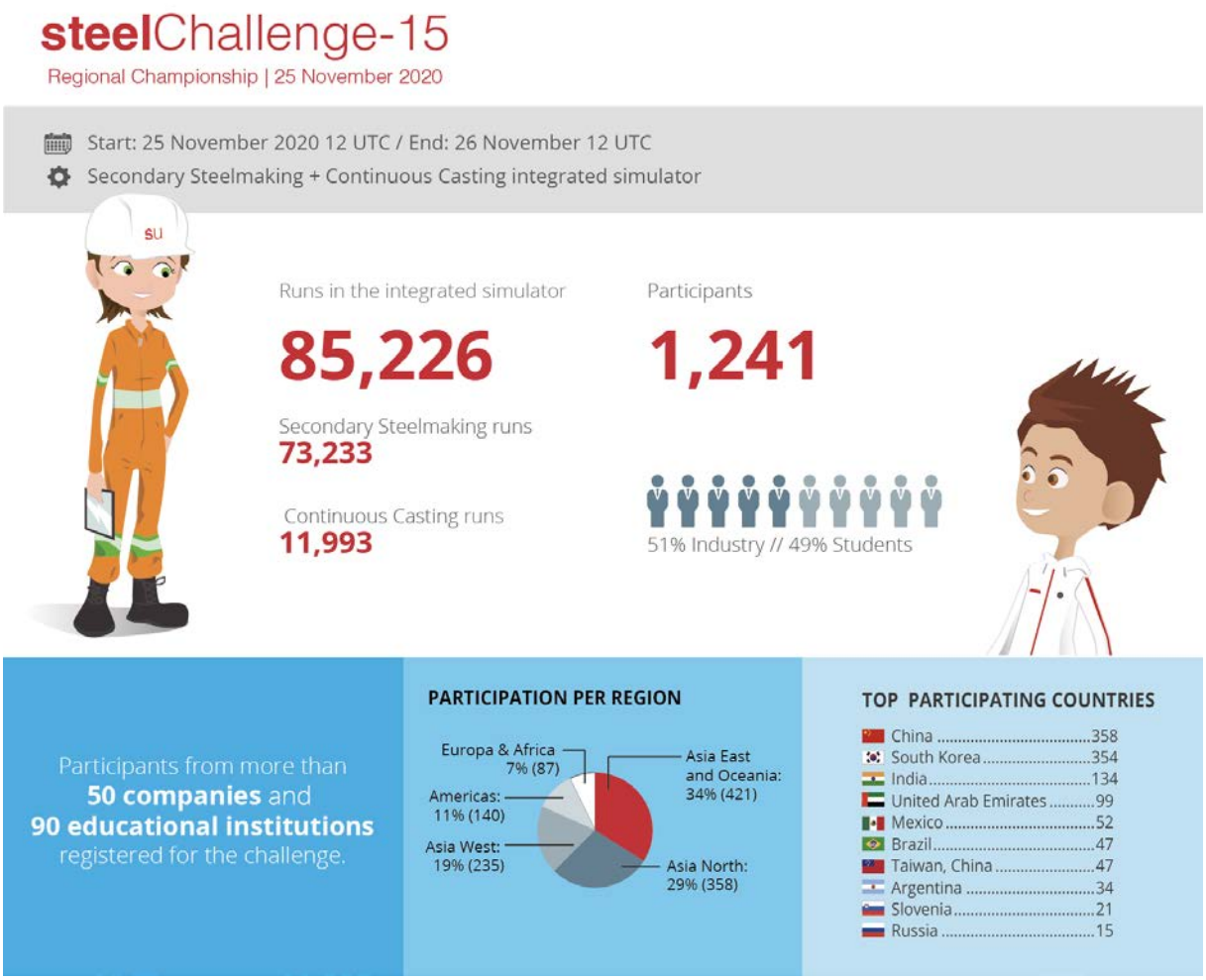


Figure 12: Infographic with the results of steelChallenge-15

4.1.2 Blended Learning Arrangement

The (online) training path of the steelChallenge is a blended training process that includes e-learning modules, online session (webinars), 3D models, interactive HTML5 exercise, practice simulation and a worldwide competition between peers. When the learner is registered in the steelChallenge at steeluniversity.org, the training path will be available MyAccount. The following figure shows a screenshot of MyAccount page at steeluniversity.org. The left column contains filters of the learning

resources by type. steelChallenge tag filters all the steps related with this blended experience. As can be seen in the Figure below, the training path has six steps:

1. Interactive 3D Model of Ladle Arc Furnace
2. Interactive 3D Model of the Recirculated Degasser
3. Interactive 3D Model of the Vacuum Degassing.
4. Secondary Steelmaking e-learning
5. Continuous Casting e-learning
6. steelChallenge-15, a worldwide competition between peers using simulations

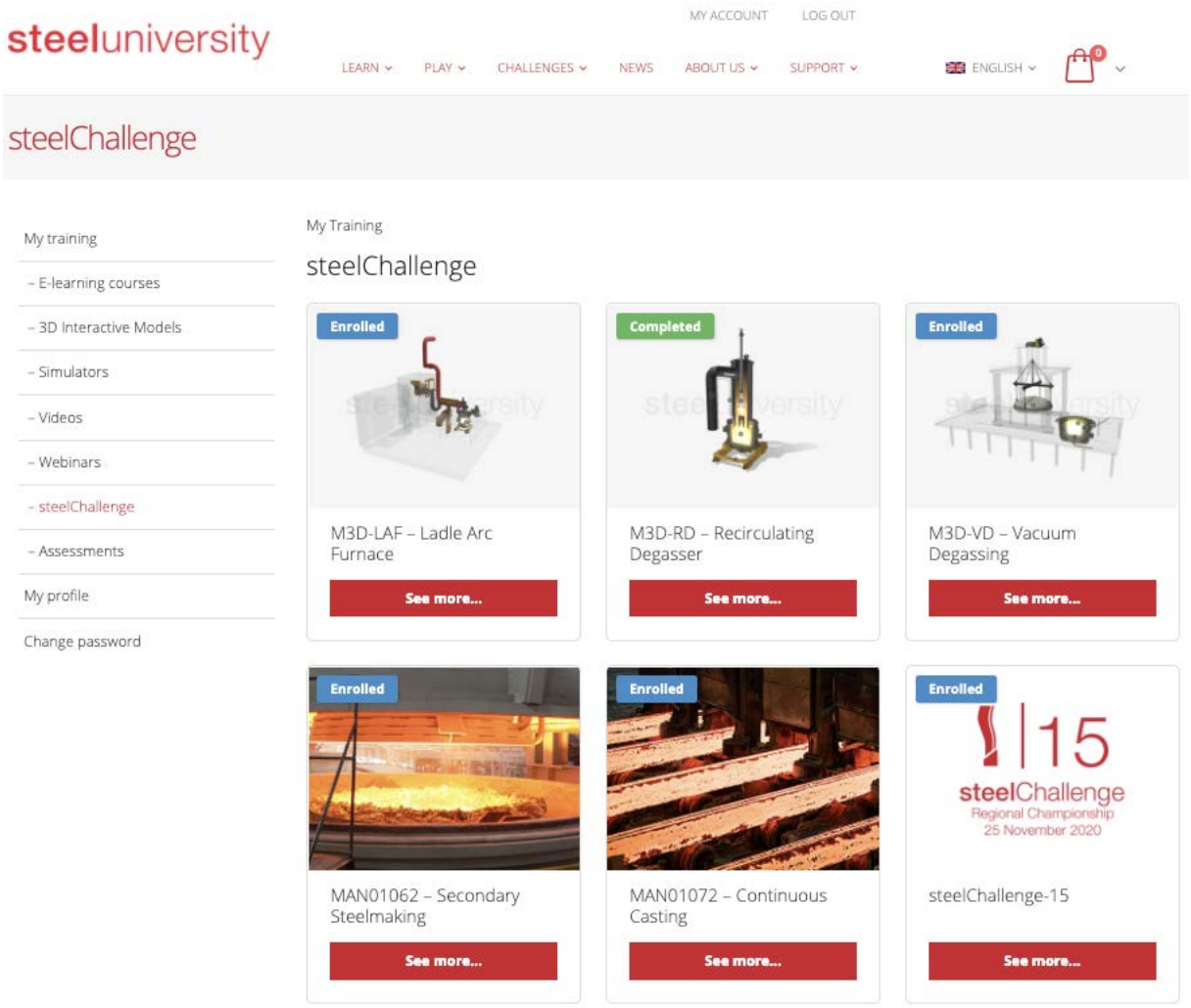


Figure 13: Screenshot of MyAccount in steeluniversity.org website

1st to 3rd Step: Introduction and Context

The main objective of the steps 1 to 3 is giving the learner an introduction to the equipment used in the steelmaking process, to understand the magnitude and complexity of those, identify the main components and their functions in the steel making process. The introduction is given by 3D Interactive models, which use exploration and interactivity as a main driver to motivate the learner. Making zoom-in, zoom-out and rotation of the 3D model, the learner is able to explore Ladle Arc Furnace, Recirculated Degasser and a Vacuum Degassing, which are the three main environments of the secondary steelmaking process.

The following Figure shows an example of one of the 3D Interactive models used, a simple ladle degassing unit with provisions for alloying additions. Here, vacuum is created through a vacuum pumping system. Pressure as low as 0.5 mm Hg is created in order to homogenisation of liquid steel bath with regard to both temperature and composition, fine adjustment of chemistry, and improved deoxidation and reduction in H_2, N_2, and O_2 contents. In the 3D model, the learner clicks on the black bubbles, the camera is adjusted and a description of the component is pop-up, like the one shown in the Figure below.

Figure 14: 3D interactive model of a vacuum degassing[35]

4th Step: Secondary Steelmaking Process

The next step in the Training Path is the Secondary Steelmaking e-learning course. The primary steelmaking furnaces, such as Basic Oxygen Steelmaking and Electric Arc Furnace are not capable of meeting high quality demands of some steel grade leading to the growth of what is known as Secondary Steelmaking. This process is in charge of further refining of liquid steel after it is tapped into the ladle from the primary steelmaking furnace.

As important part of the training path, this course introduces the learner to the critical step of refining the chemistry of the steel in order to impart the desired properties required for the grade of steel being produced. During the course, the main functions are described as well as the importance into the whole steelmaking process. Besides, the learners will be able to understand the operation and control variables and understand the process of Deoxidation and Decarburisation and Desulphurisation. The course includes exercises for self-assessment of the learner to identify gaps and close the gap with feedback. The course is concluded with a simulation of the secondary steelmaking process in order to apply the knowledge.

[35] https://skfb.ly/6RpRv

In the simulation, the learner will take charge of a ladle of molten steel from the Basic Oxygen Furnace (BOF), and attempt to deliver it to the appropriate caster at the **specified time** and at the correct **composition** and **temperature**. The **cost** also needs to be **minimized** for the whole operation. A ladle of steel has to be processed though the virtual secondary steel shop which houses a ladle furnace, tank degasser, CaS-OB and recirculating degasser. Cranes and ladle cars have to be manipulated to transport the ladle around the shop. Each of the four grades (and a self-selected grade) requires a different solution and process route. One requires decarburisation, another desulphurisation and various alloy and micro-alloy additions are required. The amounts of the additions, their timing and order have to be decided and the ladle has to be delivered to the appropriate caster at the requested time and temperature.

5th Step: Continuous Casting Process

Once the chemical composition of the steel is achieved during the secondary steelmaking process, the next process is the Continuous Casting. During this process, molten metal is solidified into "semi-finished" products, like billet[36], bloom[37], or slab[38] for subsequent rolling in the finishing mills. The Continuous Casting course introduces the learner to this critical process, where the learner will understand the main control parameters of Ladle, Tundish and oscillating mold, like Temperature, speed, oscillation frequency and heat flux.

This course has embedded Interactive HTML5 exercises (see Figure below). The learner can play around with different variables to understand the impact into the quality and stability of the process. The following figure shows an example of this kind of exercise. In this case, the learner can change the temperatures of any of the three ladles arriving to the Continuous Casting Station from Secondary Steelmaking Process using the spinners in the left side. The red line represents the temperature of the steel into the ladle, which is losing heat at a constant rate defining in the dropdown menu, which is an indication of how well maintained the refractories are. The blue line is the temperature calculated at the Tundish. Finally, the dot red line is the approximately liquidus temperature below which the liquid steel is solidified. After completing the exercise, the learners will be able to understand the impact of not properly maintain the refractories of the ladle and Tundish as well as the importance to have a stable temperature profile in order to improve quality and cost of the process.

[36] https://en.wikipedia.org/wiki/Billet_(semi-finished_product)
[37] https://en.wikipedia.org/wiki/Bloom_(casting)#Bloom
[38] https://en.wikipedia.org/wiki/Slab_(casting)#Slab

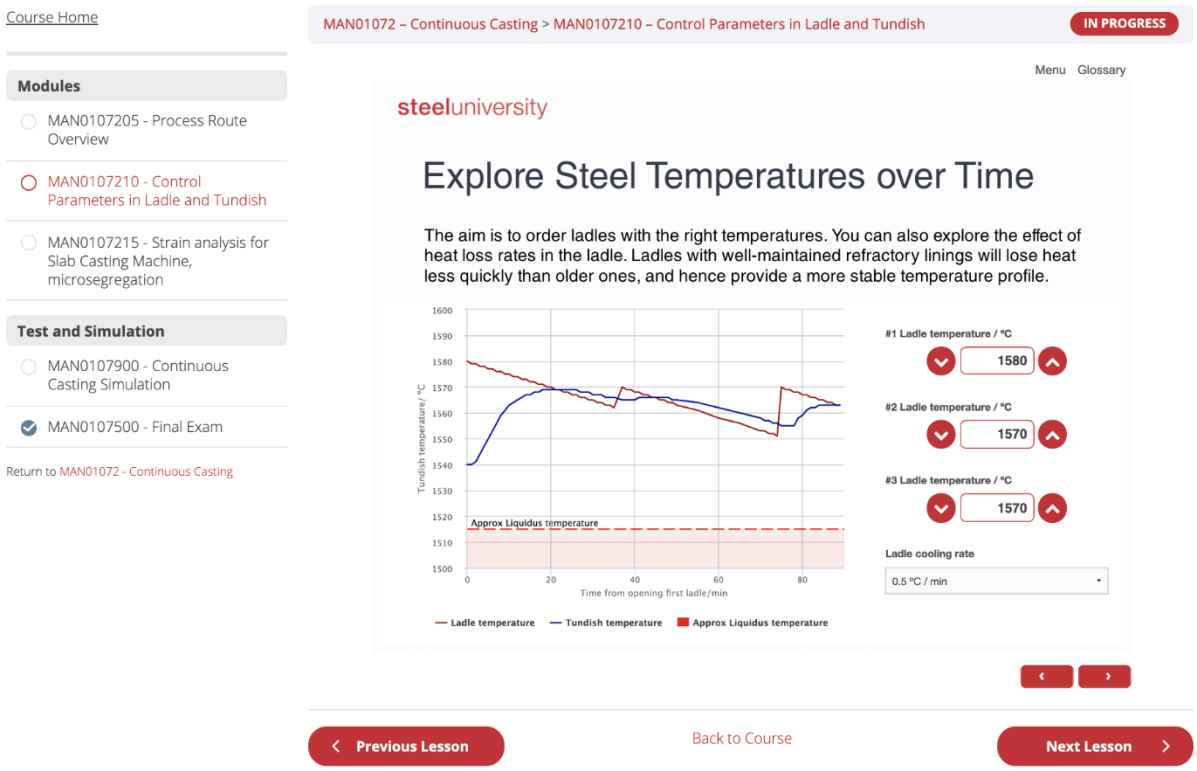


Figure 15: Interactive HTML5 exercise to understand temperature profile in ladle-tundish in Continuous Casting Process

The knowledge developed during the course is applied into the Simulation where the student has to successfully sequence cast three ladles meeting the specified criteria of the surface quality, internal quality and inclusion content. Besides, the cost of the operation needs to be minimized. In order to access the Final Exam, the learner needs to perform a good run of the simulation that meet all the requirements. The result of the run is saved into the LMS[39].

Finally, to validate the knowledge transfer, a multiple-choice exam has been developed and implemented at the end of the course. The exam has conventional multiple-choice questions as well as questions that need to be answered using HTML5 interactive tools described in the course. The following Figure shows an example of a question which learners need to answer according results given by the HTML5 exercise tool. Therefore, we are not only testing the knowledge (technical skills) but also the use of digital tools to take decisions (**transversal or soft skills**).

[39] https://en.wikipedia.org/wiki/Learning_management_system

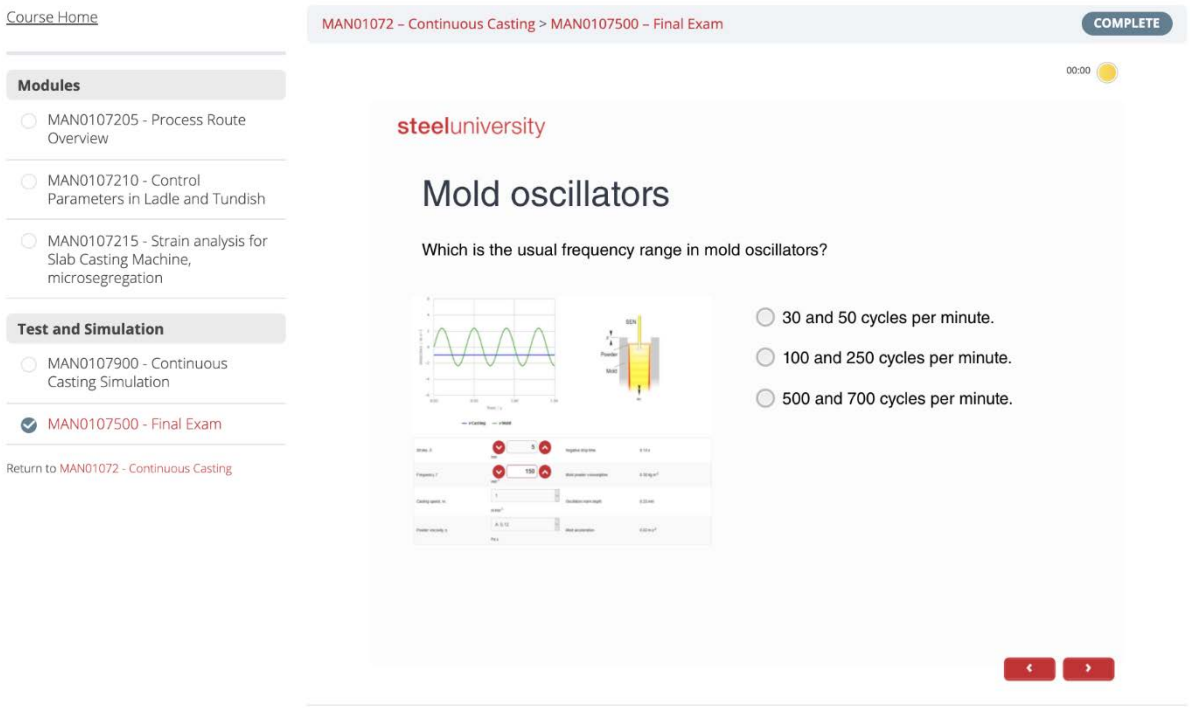


Figure 16: Example of a multiple choice using the HTML5 interactive tool

The modules are developed with a commercial tool, Articulate Storyline 360[40]. A bank of questions was developed and it is arranged randomly each time the student enters the Test. Besides, this tool allows to package the content in several formats (SCORM, Tin Can xAPI, LTI, HTML, etc) that allow a smooth integration in the ESSA steelHub with the main learning management tool available nowadays.

6th Step: steelChallenge-15

At the end of the previous steps, the learners develop the general and specific knowledge of the Secondary Steelmaking process and Continuous Casting. In this step, the learners need to apply the knowledge to solve a case study using two simulations, Secondary Steelmaking and Continuous Casting Simulation, and compare the results between peers. The best solution to the case study is the winner of the competition. The following figure shows the Learner Interphase into MyAccount at steeluniversity.org.

[40] https://articulate.com/360/storyline

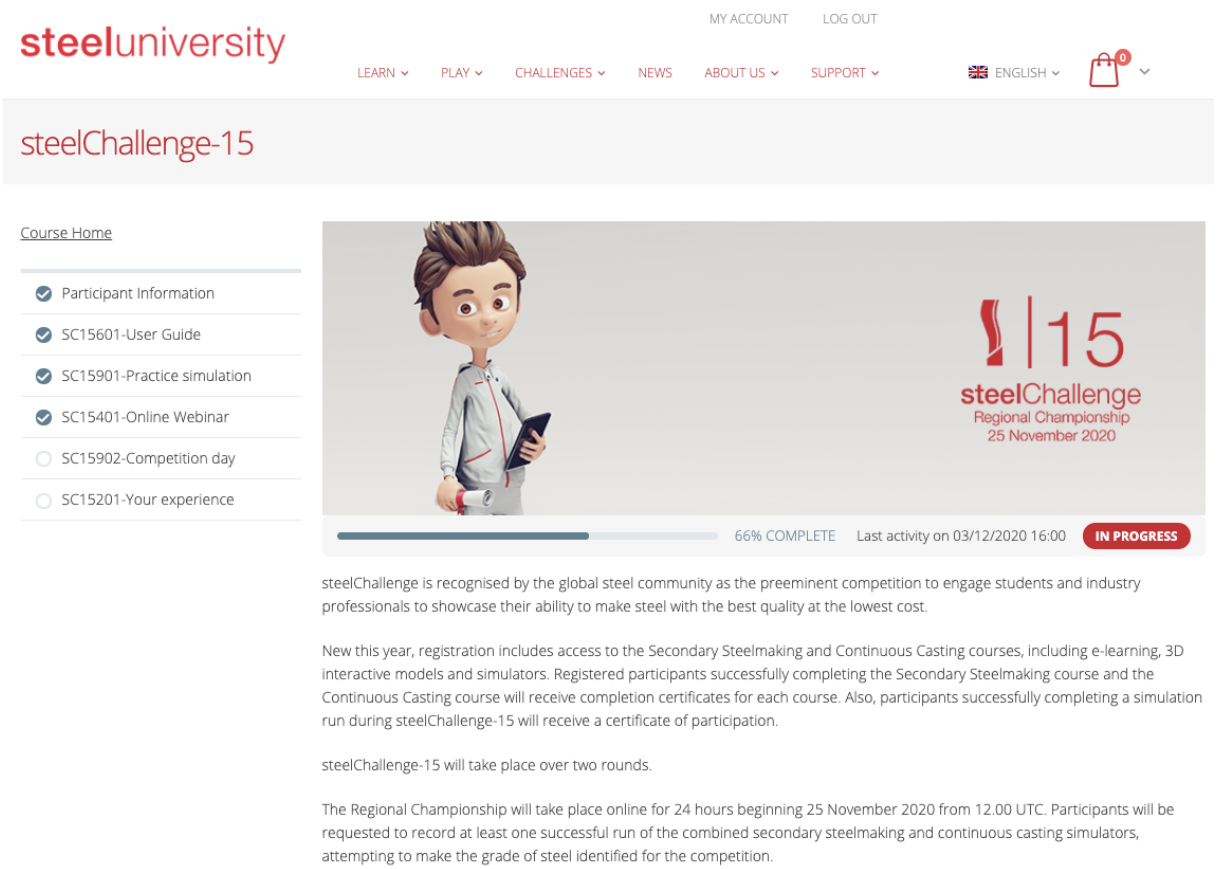


Figure 17: Learner interphase of 6th Step "steelChallenge"

In a first activity, the learners have to fill in the relevant information of their profile, like First Name, Last Name and University/Company name, etc. Besides, they need to choose the name and contact information of the Faculty Advisor. The advisor is in charge of coaching and mentoring of the learner during three months of practice with the simulations and he/her will be awarded as well if the learner wins the competition. The Faculty Advisor need to be part of a School, University or Company/Industry.

In the second component, the learner accesses the Secondary Steelmaking Simulation User Guide[41] and Continuous Casting Simulation User Guide[42] in pdf format. These guides describe the user interface of the simulation, relevant equations to use the simulation and a general explanation of the hypothesis used in the mathematical models.

Then, the learners start using the practice simulation in order to solve the following problem.

> *Case Study*
>
> *We received an order to produce railroad tracks for an important company in the sector. The grade of steel to be produced must meet mixed traffic specifications that include high-speed trains, for which steel grade R260Cr or 1.0911 is required.*

[41] https://content.steeluniversity.org/simulators/sc15/practice/ss/help/SSM_User_Guide_EN_v02.pdf
[42] https://content.steeluniversity.org/simulators/sc15/practice/cc/help/SIM-CC-UG-ContinuosCastingSimulation-EN_v03.pdf

You are the technical manager of the Secondary Metallurgy and Continuous Casting processes. For both processes, you must comply with the chemical composition and inclusions content specified by the client. In addition, you must control the production parameters, such as temperature and production time, in order to reduce production cost and improve profitability of our company.

You must consider that the temperature and cost of the three ladles going into Continuous Casting process will be the same obtained in the Secondary Metallurgy process.

The following Figure shows the interphase of the integrated simulation. The learner clicks on the Secondary Steelmaking Simulation and a pop-up window is open to start using the simulation. Once the learner archives a result that accomplish all the required parameters of the case study, the system automatically recognizes the run as successful and it will be available in the Table "Available batches" to be used in the Continuous Casting Simulation. Next, learners open the Continuous Casting Simulation and use this successful run. If a good run in this simulation is achieved, the final result is included into the "Results" table. During the practice session, an email communication channel with the developer team is open to answer questions of the learns.

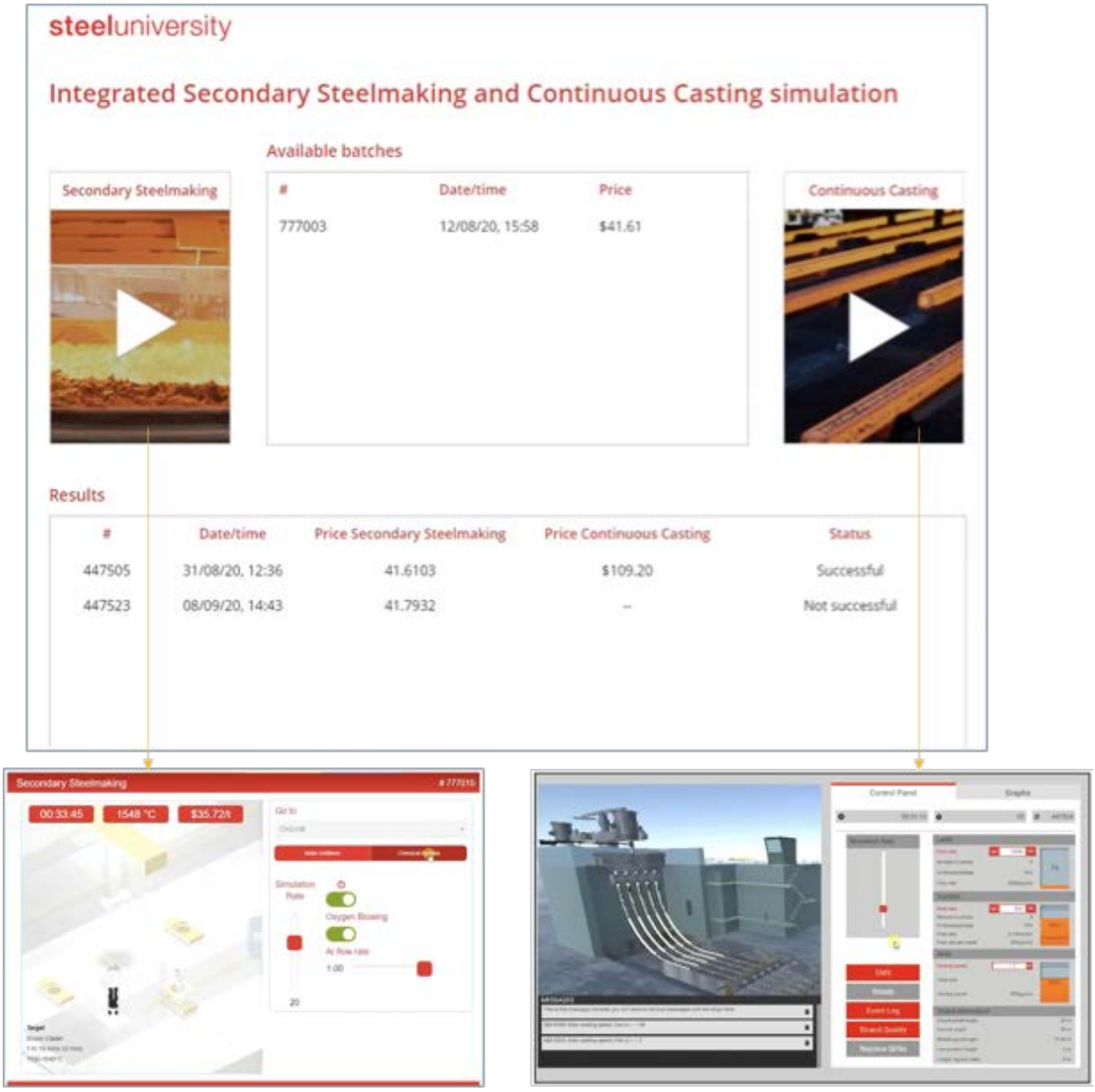


Figure 18: Secondary steelmaking and Continuous Casting Integrated Simulation

After the practice session with the simulation, a series of webinars have been conducted in order to train students and teachers/trainers, who coach students/learners, for the competition. During webinars, experts explain the main variables of the simulation and answer questions. The following Figure shows the expert explaining the Continuous Casting Simulation online.

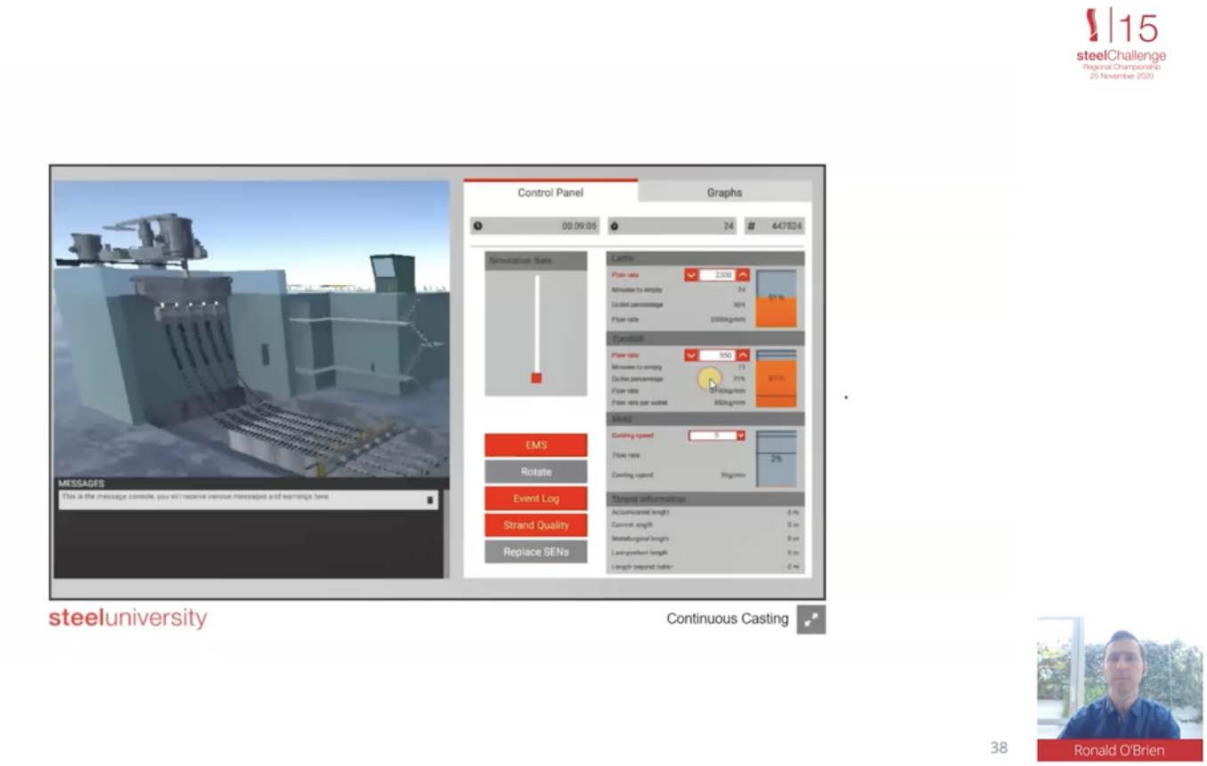


Figure 19: Expert Support for Continuous Casting Simulation

Finally, the day of the competition, the Regional Championship took place online for 24 hours on 25 November 2020. This year's steelChallenge attracted over 1200 participants representing more than 50 companies and about 90 academic institutions from 27 countries. New this year, all participants successfully completing a simulation run received a competition certificate that prove the participation and the accomplished of the results.

4.1.3 Transversal Skills

Although the specific technical and professional skills development seem to be in the forehand, it already appears through the description of the training path ahead that also the transversal skills (e.g. work autonomously, critical thinking and decision making, data input and processing, complex information processing and interpretation, green skills, process analysis, complex problem solving, entrepreneurship) are relevant and trained (and assessed in the end of the course). Therefore, we are not only training and testing the knowledge (technical skills) but also the use of digital tools to improve transversal skills (digital, green, methodological, individual/personal skills). The remaining social skills are more of importance in the (on-site) Regional Training Systems to be developed.

4.1.4 Audit Tool for Simulation

In interrelation to the other topics and as an important element of ESSA the integration and iterative improvement of learning outcomes of the learners are audited (also in the sense of improving the individual responsibility for learning).

In order to provide a transparent process of selection of the best run and to define the winners during an audit, the work to be performed by experts to review more than 85,000 runs are simplified in a

developed audit tool for the simulations. The data available in the tool allows the audit team to re-construct the simulation. This can be used for teachers/trainers or instructor using simulation to create also their own competition to be used for motivation of the learners. It is important to mention that this tool don't include data from the training process, like test score, completion of the e-Learning or time spend. These data are already stored and analysed in the Learning Management Systems.

The access to the Audit tool is password protected and needed to be assigned by a master administrator. Once the audit team login, a list of online competition is listed. From this list the number of participants can be reviewed, some general setup of the competition and access to the audit tool be defined.

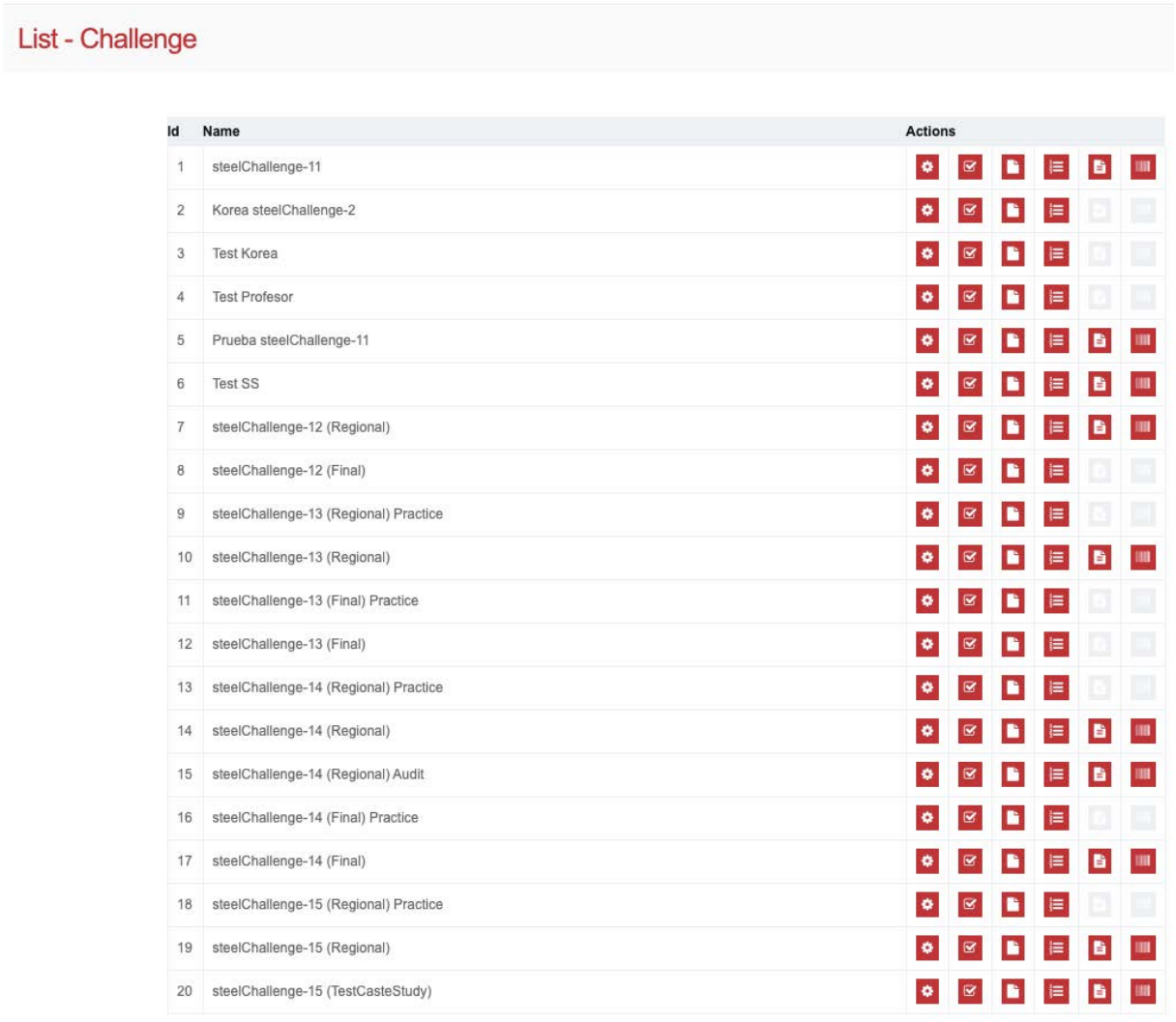


Figure 20: Dashboard of competitions

The Audit tool presents a list of the best run of each participant and can be filter by Category (Industry/Student), Region or Country. When a click has chosen the challenge selection in the list, a summary of the run is shown in the screen (see Figure below).

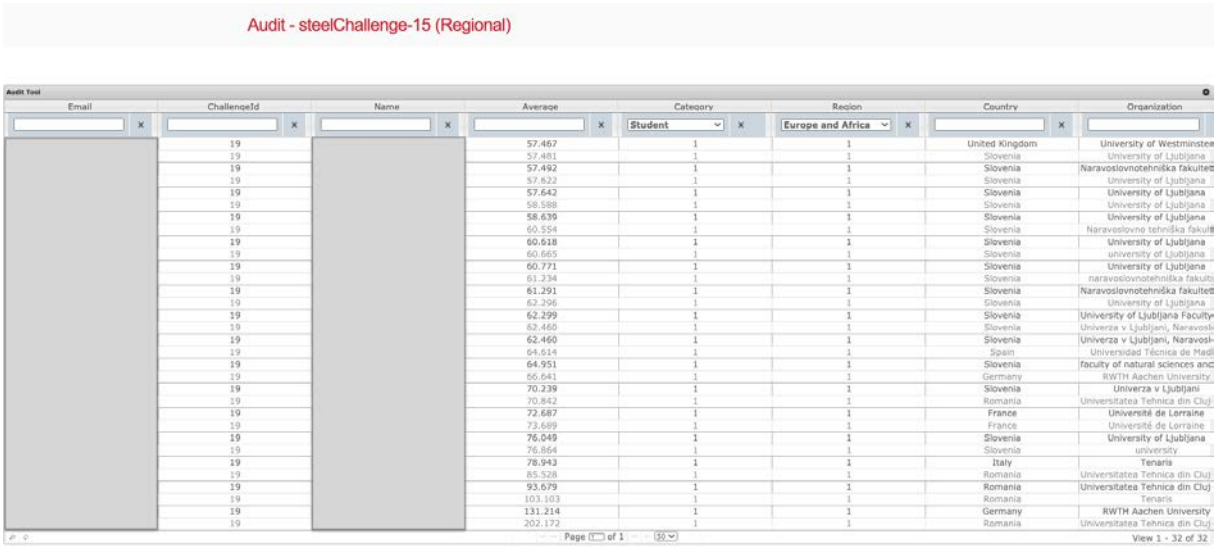
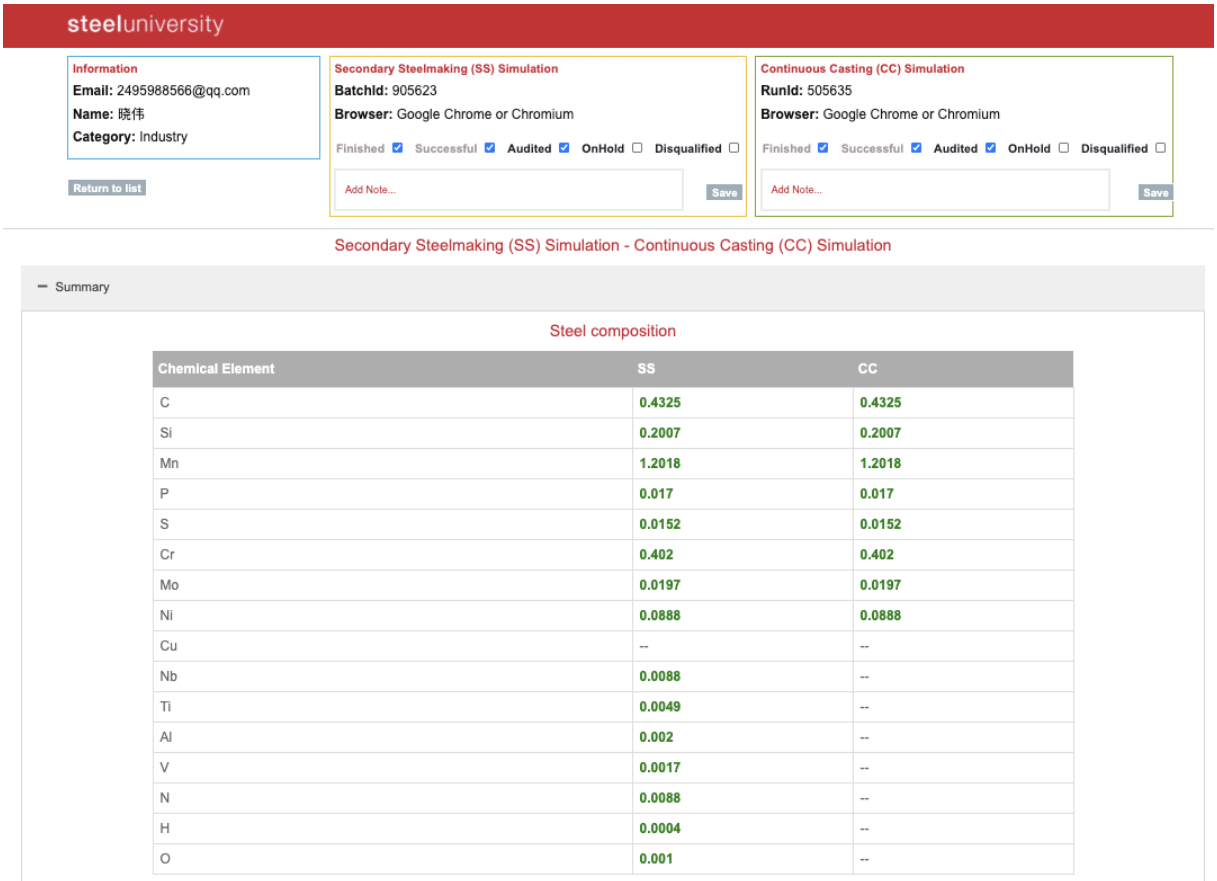


Figure 21: Participants overview for the audit

The interface of the results of a particular run in the Audit tool is shown in the following Figure. The green colours represent the parameters inside the limits proposed in the case study; in this case, the steel composition of the Secondary Steelmaking (SS) and Continuous Casting (CC) simulations are all inside the required limits.



Chemical Element	SS	CC
C	0.4325	0.4325
Si	0.2007	0.2007
Mn	1.2018	1.2018
P	0.017	0.017
S	0.0152	0.0152
Cr	0.402	0.402
Mo	0.0197	0.0197
Ni	0.0888	0.0888
Cu	--	--
Nb	0.0088	--
Ti	0.0049	--
Al	0.002	--
V	0.0017	--
N	0.0088	--
H	0.0004	--
O	0.001	--

Figure 22: Simulation audit tool

4.1.5 Analytics

In this section some of the results obtained are described a bit more. Due to the DataBase of competencies standards and its alignment to the evaluation process, it is possible to compare results aggregated in order to deliver analytics about the training eco-system, course and training path performance, individual user performance, etc.

The first graph shows the completion and participation rate. Each column represents a company, for example in the first company, we have 158 students registered. 64 didn't participate in the day of the competition, therefore, the participation rate was 60%. 94 participants took part in the competition but 22 of them (about one of four) did not successfully complete the task.

Figure 23: Company (AAA) related participation of learners/students

On the other hand, for those participants that had a good run of the training module, there are different levels of achievement. Again, each column represents the users of a particular company (AAA). Each point in each column represents the best run of the participant normalised with the best overall performance. Some preliminary conclusion can be extracted from this graph, like in some companies the dispersion of results achieved is bigger than in other, which can be associated with the level of preparation of the participants to compete.

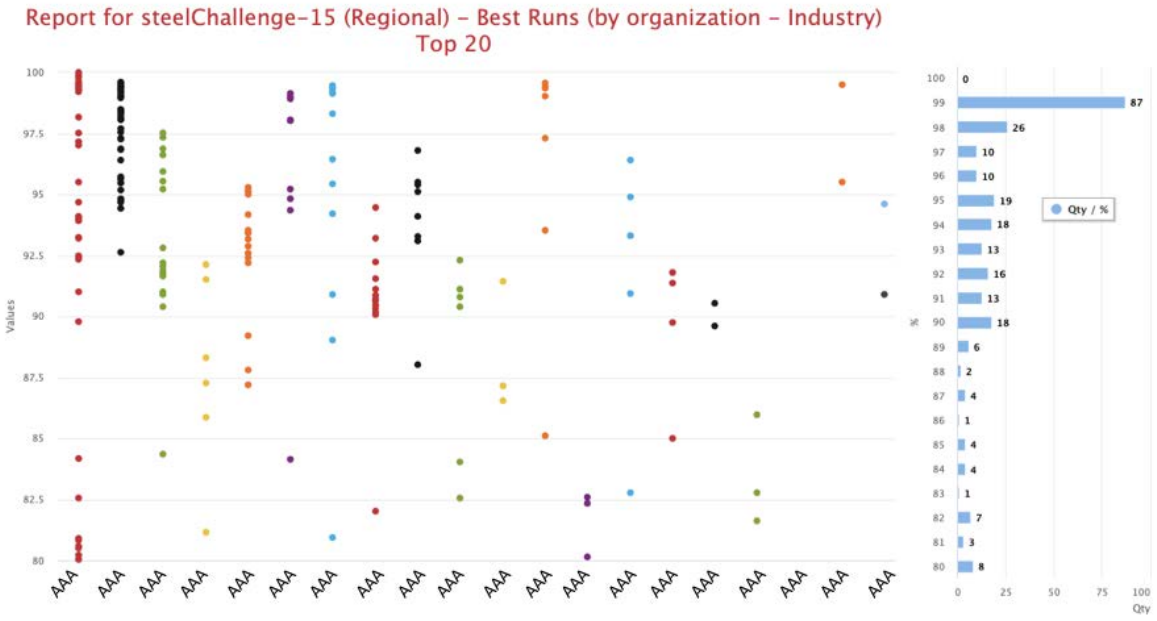


Figure 24: Level of achievement (in %) by the different participants of a company (AAA)

This kind of benchmarking is possible due to the standardisation of the competences, the standard methodology to prepare the assessment and a centralized DataBase to collect and aggregate the data.

4.1.6 Evaluation of the Training Experience

At the end of the competition a survey has been run in order to evaluate the whole training experience. In this case the survey has been answered by 300 participants. While 99% of the participants will recommend this learning experience to others it is underlining that this kind of training is not only of growing importance but also have a high acceptance if they are used.

On the other hand, we have a particular interest to understand the reason for participating. 37% of the users participated because they have been looking for a learning opportunity and 33% because they see this competition as a way to boost their carrier.

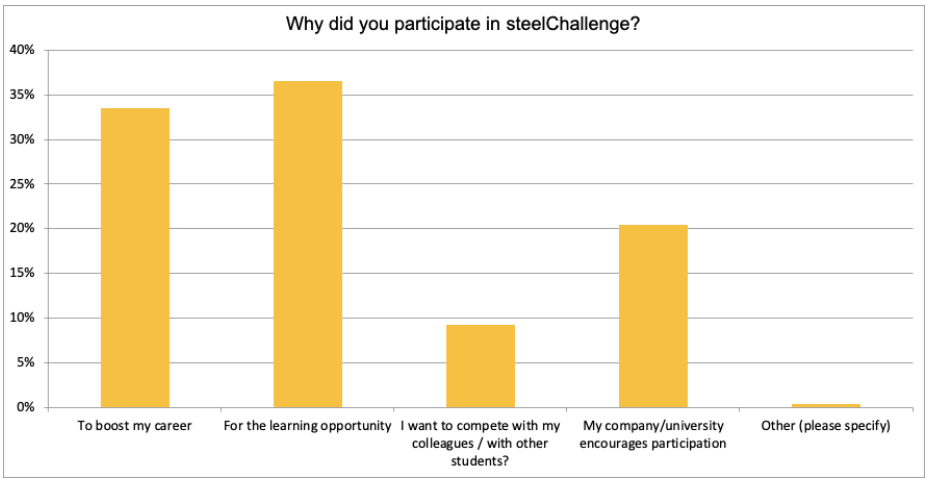


Figure 25: Results of the survey to the question "Why did you participate in steelChallenge?"

4.2 Digital Online Assessment (Technology Based Assessment)

The training tools (as described in the Training Path above) could be also used for a formal assessment of learning outcomes via a digital online assessment (also called Technology Based Assessment, as titled in the assessment overview of Mayrath et al. 2012). Therefore, a conceptual map was designed based on the ESSA frame, leading to test and examination and interactive simulation assessment tools.

4.2.1 Design of the Conceptual Map

The Job Profile of the **Metal Processing Plant Operators** (focusing on Continuous Casting) was further operationalised by learning outcomes (see figure below) for knowledge and skills assessments of the Continuous Casting Operator training. Using the ECD framework the tasks, which need to be performed by the Learner to get evidence of the Learning Outcome level into the "simulation" and in the "test and examination", have been designed. The following image shows an example of the Conceptual Map. To see the map more in detail and navigate it, click in the following link[43].

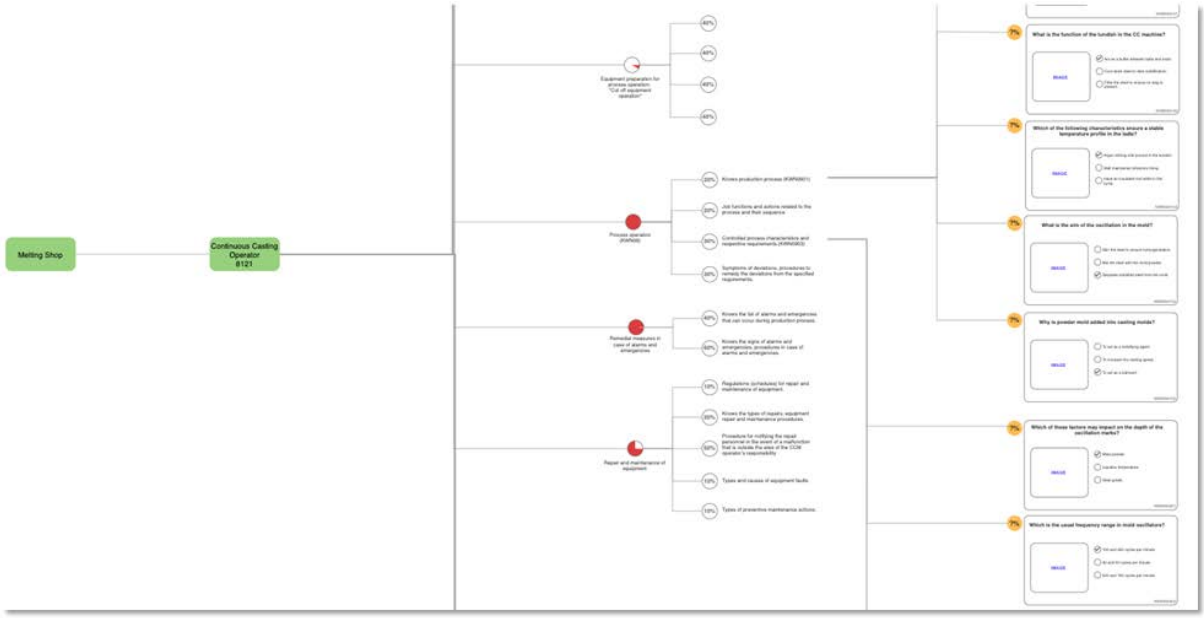


Figure 26: Learning outcome based competence map

The Continuous Casting Operator (8121) was selected for this pilot, the level of circle completed reflect the level of the skill (green) or knowledge (red). For each skill/knowledge a collection of Learning Outcomes is defined. For each Learning Outcome more than 2 options have been defined to evidence the level. The tasks have been implemented into the technology-based assessment tools described as follow.

4.2.2 Test and Examination

The test and examination implemented has the intention to validate **knowledge** about Continuous Casting process, which are **aligned with skills** defined in the **Metal Processing Plant Operators**. The

[43] https://filedn.com/lx5aRjQCjnjSpvs51MVE1CF/DrawIO/Continuous%20Casting%20Operator%20over11.html

Learning Outcomes defined in the conceptual map are the following (with an identification code for the DataBase, knowledge = KWN and skills = SKL):

1. Comprehend the fundamentals of continuous casting (KWN0101)
2. Be familiar with modelling techniques related to heat transfer and solidification (KWN0103)
3. Understand how the process water system works and identify its components (KWN0601)
4. Recognise system anomalies (KWN0603)
5. Know production process (KWN0901)
6. Controlled process characteristics and respective requirements (KWN0903)

The assessment was developed using Articulate Storyline 360[44] and integrated into the steelHub. The exam has conventional multiple-choice questions as well as questions that need to be answered using HTML5 interactive tools. The following Figure shows an example of a question.

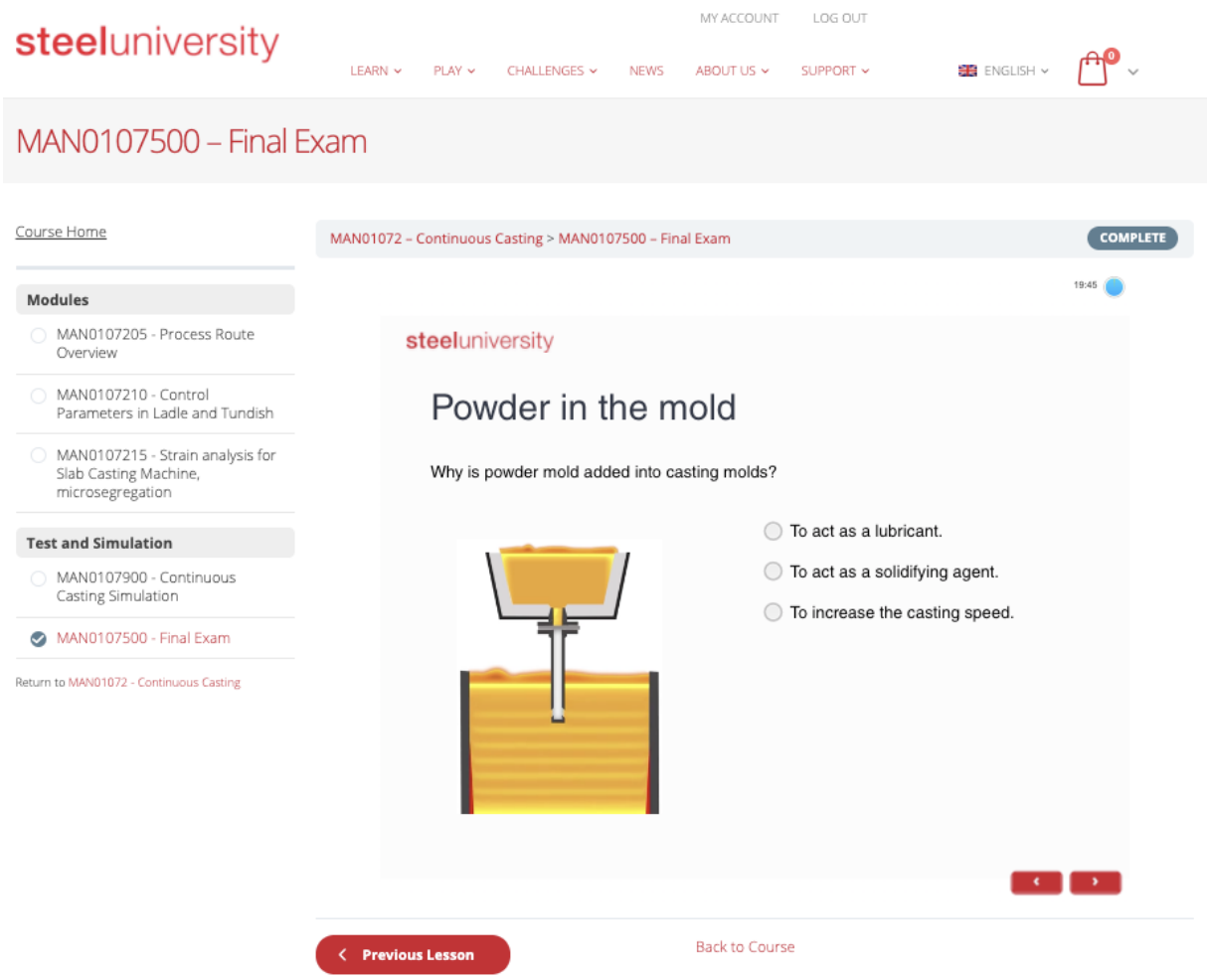


Figure 27: Example of a multiple-choice exercise

4.2.3 Interactive Simulation

The simulation targets steelmaking operators, university students and in-company engineers. The aim is to make a sequence of three casts of one of the same 4 grades of steel that can be made in other simulations, like EAF and Secondary Steelmaking Simulations. The virtual caster includes a two-

[44] https://articulate.com/360/storyline

strand slab, a four-strand bloom and a six-strand billet machines. The learner has to make several operational decisions including requesting the timing and temperature of the delivery of the ladles to the caster, the degree of soft reduction, the casting speed, cooling water flow rate, mold oscillation frequency and stroke and the mold powder. Once the ladle has arrived, the metal flow rate from the ladle to the tundish and then into the mold and the casting speed have to controlled very carefully in order to avoid internal and surface quality problems and break-outs. Misaligned rolls may occur and nozzles can be replaced as deemed necessary.

The user has to make many pre-selections before the casting process can start. Several parameters have to be adjusted beforehand in order to not only secure a continuous cast without breakouts but also to meet specific quality criteria. Close attention has been drawn to the formation of internal and surface cracks with a detailed description of the underlying modules. It is depicted that several deformation mechanisms contribute to an accumulation of strain in the solidifying strand shell. In case the accumulated strain exceeds a critical value, cracks will form, limiting the product quality.

Following the definition of learning outcomes in the conceptual map described before for the Continuous Casting Operator Job Profile, the process simulation of Continuous Casting is designed to evaluate the following Learning Outcomes:

1. Prepare equipment for process operation (SKL0201)
2. Start and stop the equipment, including an emergency (SKL0301)
3. Control the equipment operation based on instrumentation readings (SKL0302)
4. Adjust the operating conditions of the equipment (SKL0303)
5. Monitor the health and operability of equipment during the casting process (SKL0304)

The following link https://vimeo.com/404972052 is available for the video that shows a complete run of the simulation.

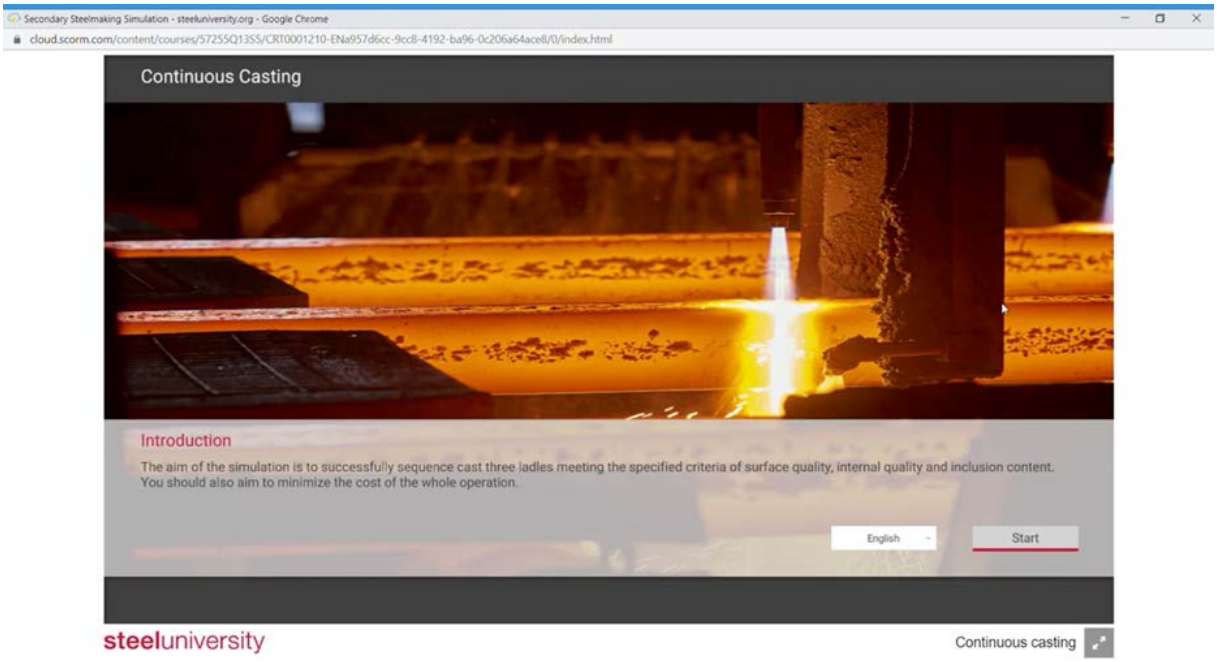


Figure 28: Continuous Casting Operation (pilot module)

The technology-based assessment using simulation is not just for assessment, but also can be used simultaneously as a learning tool. The add value of this dual tool is maximize efficiency and reduce the amount of "stop and test" for learners.

4.3 (Technical) Integration of the Learning Arrangement into VET System and Industry

The target audience for this Learning Arrangement are students of the VET System (IVET) and employees in the steel industry (CVET). In order to distribute this package of content and simulation, they have been uploaded into steelHub. Depending if the organization has a Learning Management System (LMS) or not, there are three options.

1. Access through LMS of the organisation, company
2. Access from online training providers, like steeluniversity.org.
3. Access with Single Sign-on[45] to steeluniversity.org.

Access through companies, institutions LMS

If the institution or company has a LMS compatible with some of the worldwide standards protocols (SCORM, TinCan, LTI, etc), the content can be connected with the platform through steelHub. This connection allows the user to access the training content from the platform of the institution (VET System, Industry, Association, etc). The content remains as storage in a centralised repository (steelHub) and in the institution system it is uploaded as a "Proxy File". From this the user has the credentials to access the content and the channel to register, for example number of access, time spend, score, etc. The main advantage of this configuration is that user interaction data is saved into the institution system and also in steelHub data structure, so the teachers/trainers or instructors can access to the user data within their systems.

During this pilot test, two companies connected the steelChallenge competition into their system. Both companies use SAP Success Factor[46], which is one of the most used LMS in the industry. 81 students from these companies have accessed the competition using the steelHub. The data have been stored in the steelHub infrastructure and integrated with data coming from other points of access.

Access from Online Training Providers

For an institution without a LMS installed, the users need to create an account in a training provider platform with a LMS installed, compatible with some of the worldwide standards protocols (SCORM, TinCan, LTI, etc). For example, if there is a University that want to access the training content available in steelHub and they do not have a LMS hosting the training content connecting, they need to access one of the training platforms, like Degreed[47] or steeluniversity.org, that already have an LMS as a service to access the content. The user accesses the content and the data of the user is storage into the platform of the LMS service provider as well as into steelHub.

[45] https://en.wikipedia.org/wiki/Single_sign-on
[46] https://www.sap.com/latinamerica/products/corporate-lms.html
[47] https://degreed.com/

Access with Single Sign-on to steeluniversity.org

There is a third access option that consists of user authentication through a cross-platform authentication protocol. In this case, the user does not need to have multiple accounts in different sites. These improve the user experience.

As part of the pilot test, this integration was done between the upskilling platform Degreed and steeluniversity.org. Unfortunately, the integration was not done on time for the steelChallenge-15 registration process, so there are no data available for this pilot. However, the integration has been tested and used in a private instance of Degreed for one of the steel companies' members of worldsteel. Courses and webinars generated every month are connected through this process.

5 Next Steps

The Training Framework so far is mainly based on the infrastructure of the Online Training Ecosystem and its steelHub conducted by worldsteel. It is an open infrastructure and a starting point to integrate training offers from company training institutions, training providers, associations and social partners (and others). The first tests of the steelHub infrastructure as a training exchange and development platform are very promising but there is still a lot of work to be done in the next implementation and transfer phase of ESSA.

The ESSA training offer will integrate training offers from companies, training institutions, associations and social partners. It will integrate also a series of new and (adjusted) existing steelUniversity webinars, that will be made usable on behind of the ESSA affordance in the steelHub.

The online and the regional training framework will be further developed complementarily. Parts of the Online Training System could be integrated in the Regional Training Eco-system, but while the European Online System is focusing on CVET and lifelong learning, the Regional Eco-system should be the link to the formal VET systems and their occupations and IVET. However, it has to be clearly noted that these are priorities and not excluding each other (IVET and CVET are parts of both Eco-systems). While ESSA is about steel training, but also about VET and skills for occupations that the steel sector employs and so reflects more widely also the VET system and steel related occupations in a more general way.

Another issue that has to be taken up more precisely is the focus on **transversal skills**. Within the first pilot module they are inherent present in the training module and in the evaluation, but we have to elaborate them in a more visual way. The recently started skills assessment survey of ESSA is focusing especially on an assessment of these transversal skills (digital, green, social, individual/personal, and methodological) current and in the future; results will give us relevant information how to implement this important part of the T-shape approach in the training development.

The further practical implementation of the Online training Ecosystem "steelHub" is related to:

1. Technological and economic challenges:
    - The more visible integration of transversal skills (this will be elaborated further and supported by the results from the skills survey of the nine pilot profiles)
    - Compliance of the infrastructure with GDPR regulation
    - Agreement to use aggregated data generated by users for data analytic processing

- Business model (including fees for usage of training modules and of the worldsteel infrastructure)
- Formal agreement and Copyright protection between administrative entity of the steelHub and content providers as well as users.

2. Content and target group related challenges:
    - Attraction and integration of elder and lower skilled workers/learners to such digital tools and how to do this
    - How to improve digital skills for online learning
    - How to attract trainers for such tools
    - How to integrate the modules in VET systems (e.g. as example for other industries than the steel sector)
    - How to integrate the online training measures in the companies and VET system structures, curricula, etc.

Annex

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Abbreviation	Meaning
AI	Artificial Intelligence
BOF / BF	Basic Oxygen Furnace - Blast Furnace
BTEC	Business and Technology Education Council
CEDEFOP	European Centre for the Development of Vocational Training
CFE-CGC	French Confederation of Management – General Confederation of Executives
CIELFFA	European Federation of the National Associations of Cold Rolled Narrow Steel Strip Producers and Companies
COCOP	Coordinating Optimisation of COmplex Industrial Processes
CSR	Corporate Social Responsibility
DB	Database
E.N.T.E.R.	European Network for the Transfer and Exploitation of EU Project Results
EAF	Electric Arc Furnace
ECVET	European Credit System for Vocational Education and Training
EFRE	European Regional Development Fund
EIT RawMaterials	European Institute of Innovation and Technology RawMaterials
eLLa4.0	excellent Leadership and Labour 4.0
EQAVET	European Quality Assurance in Vocational Education and Training
EQF	European Qualifications Framework
ESCO	European Skills, Competences, Qualifications and Occupations
ESF	European Social Fund
ESSA	European Steel Skills Agenda
ESSA ETF	European Steel Technology and Skills Foresight Observatory
ESSA OTS	Online Training Ecosystem
ESSA RTS	Regional Training Ecosystem
ESTEP	European Steel Technology Platform
EU	European Union
EUROFER	European Steel Association
H_2	Hydrogen
HR	Human Resources
HTSM	High Tech Systems & Materials
ICT	Information and communications technology
ILO	International Labour Organization

IMZ	Institute for Ferrous Metallurgy
IoS	Internet-of-Services
IoT	Internet-of-Things
ISCO	International Standard Classification of Occupations
IT	Information Technology
IVET	Initial Vocational Education and Training
KET	Key Enabling Technology
KPI	Key Performance Indicator
LMS	Learning Management System
LTI	Learning Tools Interoperability
NGO	Non-governmental organisation
NVQ	National Vocational Qualification
OPEX	Operational expenditures
PBL	Problem-based Learning
PjBL	Project-based Learning
pre-VET	pre Vocational Education and Training
R&D	Research & Development
RCS	Real Case Solving
RFCS	Research Fund for Coal and Steel (RFCS)
ROBOHARSH	Robotic workstation in harsh environmental conditions to improve safety in the steel industry
RTO	Research and Technology Organisations
SCORM	Sharable Content Object Reference Model
SME	Small and medium-sized enterprises
SPIRE	Sustainable Process Industry through Resource and Energy Efficiency
SSC	Steel Sector Careers
SSDCS	Sectoral Social Dialogue Committee on Steel
STEM	Science, technology, engineering, and mathematics
Tin Can API (xAPI)[48]	Experience API
TRL	Technology Readiness Level
VET	Vocational Education and Training

[48] https://en.wikipedia.org/wiki/Experience_API