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

Training Framework (steelHub)

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

Deliverable D5.1

(Final Version)

(Status: 30th of June 2023)

Project acronym:	ESSA
Project title:	Blueprint “New Skills Agenda Steel”: Industry-driven sustainable European Steel Skills Agenda and Strategy
Project number:	2018-3059 - 600886-EPP-1-2018-1-DE-EPPKA2-SSA-B
Coordinator:	TU Dortmund University (TUDO)
Funding Scheme:	Erasmus+
Due date of deliverable:	June 2023
Actual submission date:	June 2023
Project duration:	01.01.2019 – 30.06.2023 (54 months)
Work package:	WP 5 – European Blueprint
Work package leader:	TU Dortmund University
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Dissemination level:	Public

Co-funded by the Erasmus+ Programme of the European Union

Content

1 Executive Summary

To enable the Green and Digital transformation for the steel sector, ESSA developed a strategic Blueprint to facilitate communication, coordination, and collaboration between all the stakeholders of the training and development ecosystem to consolidate an Alliance to guarantee a **current and future *workforce highly qualified, specialized, and multi-skilled for the industry***. Against this backdrop, the ESSA developed the European level the **Online Training Ecosystem steelHub** and on the level of steel regions specific **National-Regional Skills and Training Ecosystems** (national-regional networking). Both systems are complementary and could be combined by adding specific advantages to each other (such as combining online and on-site training modules that could be integrated in a broader training program of the companies and VET providers and schools).

As a central element of the strategic Blueprint, ESSA developed the steelHub. Based on a business model steelHub is a centralized digital platform that facilitates communication, collaboration, and coordination. steelHub sets the infrastructure for a worldwide exchange of training content, integrating offers of and to be used by all the relevant stakeholder groups from industry, VET systems, training providers, public authorities, research and education, associations, and equipment and service providers. Central elements of the steelHub are the Learning Solution Directory, Skill Directory, Capability Assessor, and the Integration in different learning paths. The Learning Solution Directory is a collection of learning solutions delivered by Publishers into the framework of a marketplace business model. Another important component of the steelHub is the Skill Directory, which represents the current and future training needs of the steel sector. This Directory is used to curate the learning solutions. A Capability Assessor is using a variety of methods to evaluate an individual's capabilities, including self-assessment, interviews, tests, and job simulations. The flexible integration of this platform offers organizations the ability to easily connect and integrate learning solutions with their own systems.

steelHub have been successfully integrated in 28 industries, 8 associations, 2 equipment providers, 1 Education and training provider and 10 R&D institutes and Universities. A total of 13,406 activate learners used learning solutions available in steelHub. Besides, steelHub offer an additional distribution channel for stakeholders of the training ecosystem that develop and deliver learning solutions (Publishers). There are 7 Industries, 5 Associations and Social Partners, 1 Equipment Provider, 3 Education and Training Providers, 5 R&D institutions and Universities, 6 Service Providers and 4 Subject Matter Experts contributing to a directory of 1,896 solutions.

To test the flexibility of the infrastructure and develop an innovative training experience not only the feedback of the companies was integrated. ESSA took also 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. Participants from VET system and Industry followed a training path that 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.

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 courses).

2 Introduction

This deliverable summarises the Training Framework development based on the results of and for the European Steel Skills Alliance and Agenda (ESSA) and its testing and implementation. It comprises the background and framework (chapter 3 and 4) and describes the methodology, implementation and results of 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, ESCO, etc.). Main elements of the Blueprint for this integration are (a) the *Online Training Eco-system steelHub* and (b) the rollout to the *National-Regional Training Eco-systems (ESSA RTS)* in dedicated steel regions. As the ESSA RTS is described in detail in Deliverable D6.2 Implementing and Testing the Blueprint, this report focuses on the steelHub.

The Training Framework as a central Blueprint task includes 4 main pillars, which are described in its functions in the chapters 5 to 8, illustrated by a concrete example in chapter 9:

1. **Learning Solution Directory,** which is a collection of learning solutions for up- and re-skilling current and future workforce.
    a. Identify and analyse learning solutions available.
    b. Develop and implement learning solutions.
    c. Identify and implement new training method using possibilities of digital learning and support (social media, moodle, virtual labs, online learning, among others).
    d. Identify and implement new training method to improve engagement of workers (e.g. workplace innovation, but also by using digital tools like tablets, augmented reality glasses, virtual reality, among other).
    e. Innovative learning solutions for Train the trainer.
    f. New Leadership and Work 4.0.
    g. Develop a Quality Assurance System to collect feedback from learners.
    h. Collect information and data for monitoring and reporting.
    i. Translation of learning solutions mainly for lower skills levels solutions.
2. **Skill Directory**, a centralize repository of skills and knowledge that represent the current and future training need of the steel sector.
    a. Develop a flexible IT infrastructure to upload, update and distribute skill Data Base.
    b. Curate Learning Solution Directory with skills and knowledge.
    c. Collect information and data for monitoring and reporting.
3. **Capability Assessor**, solutions to deliver capability assessments to organizations and individuals for Self-Directed Learning, to support individuals take primary responsibility for planning, organizing, and executing their own learning process.
    d. Develop and implement **Self-assessment** tool based on Skill Directory and Learning Solution Directory.

e. Develop and implement technology-based assessment using **Evidence-Centered-Design (ECD)** methodology based on Skill and Learning Solution Directory.
f. Collect information and data for monitoring and reporting.

4. **Integration,** which a flexible IT infrastructure that assure several integration options to meet the unique needs of organizations of different sizes and types as well as individuals. This includes the development of integration solutions for the following cases.
    g. Small and medium enterprises.
    h. Universities and Schools.
    i. Regional and national associations.
    j. Large organization.
    k. Individuals.

    Developing a Dashboard with the data collected from the interaction of the learners with learning solution curated with skill directory, which will support the Expert Panel in the identification of emerging skills and training needs.

3 Training and Development Ecosystem

To enable the Green and Digital twin transformation for the steel sector, ESSA developed a strategic Blueprint to facilitate communication, coordination, and collaboration between all the stakeholders of the Training and Development Ecosystem to consolidate an Alliance guaranteeing a **current and future *workforce highly qualified*, *specialized*, *and multi-skilled for the industry***.

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 (steelHub and National-Regional Learning Arrangements) as the **supply side** (see highlighted part of Figure 1. 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 demand has 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 the core Online Training System and as the support tool for Regional Training Eco-systems will serve new ways to incorporate new skills related to job profiles within company training provision in more immediate ways to meet pressing needs.

However, this was also 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 (see Deliverable D4.5 summarising the VET system related impact (Antonazzo et al., 2023)).

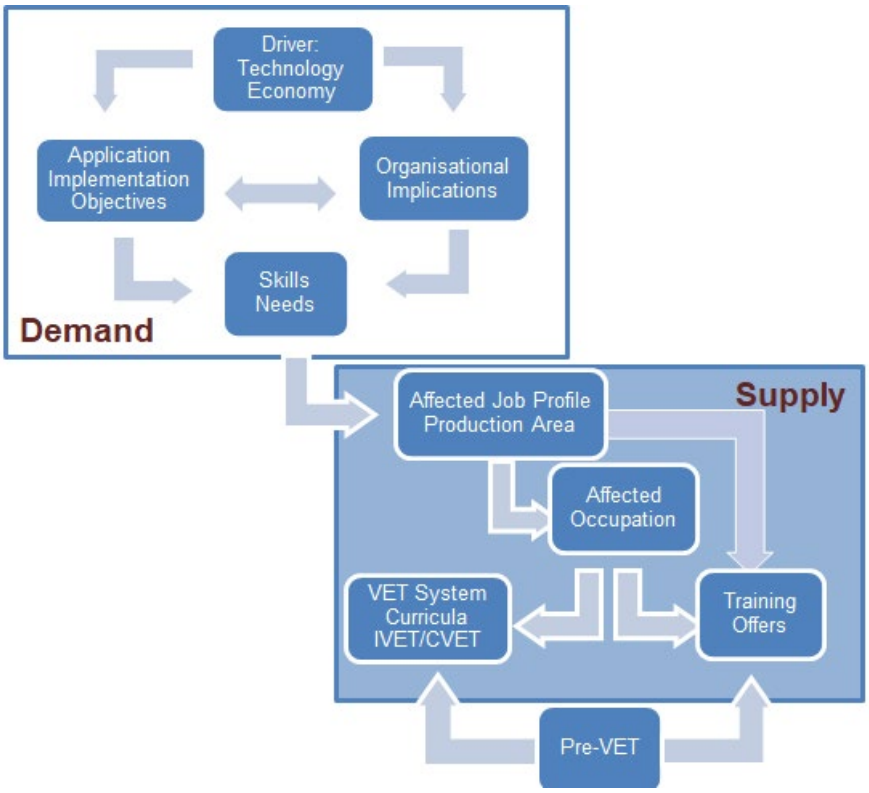


Figure 1: Vocational Education and Training as an answer to skills demands - the supply side

ESSA stresses both virtual and on-the-job learning, which are in a best way combined with each other. Therefore, the European perspective of ESSA intends to focus on the European level by the **Online Training Eco-system steelHub** (digital platform) and on the level of steel regions by specific **National-Regional Training Eco-Systems**. 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 provides 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 addresses 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.

The online eco-system **steelHub** 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 relevant 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.

Identify the key stakeholders for executing different aspects of the strategic blueprint requires clearly definition of their roles, responsibilities, and areas of ownership. These stakeholders collaborate to ensure the effective design, delivery, and management of training and development initiatives inside and outside of the industry. The table below describes 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
Training providers	Given the improvements in delivery methods, online learning environments provide a greater degree of flexibility than traditional classroom settings (Douglas Business School, 2017; Giesbers et al., 2014). Online platforms can also offer more diverse representations of student populations as learners prepare for working in the twenty-first century (Stewart et al., 2011). 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., 2011). 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.

[1] https://degreed.com/
[2] https://www.coursera.org/
[3] https://www.linkedin.com/

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 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 rating capability for each content, the evaluation of the students can be centralised in order to identify best practice and trends from pedagogic perspective.
Government, 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]

[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/
[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

	– 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 it 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 intelligence[16] and Europass[17].
Steel Associations	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 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

[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
[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

	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. Most 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. 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

Against this background and to develop a highly qualified, specialised and multi-skilled workforce the steelHub and the National-regional Training Ecosystems (ESSA RTS) were composed as platforms to facilitate coordination, communication and collaborative partnership between all the relevant stakeholder groups of the ecosystem: research centres, associations and social partners, equipment and service providers, companies, training providers, and public authorities to be interlocked (see Figure 2).

[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

Figure 2: Training and Development Ecosystem (steelHub and ESSA RTS)

By integrating publishers and organizations into steelHub, which is a marketplace of learning solutions, the platform can offer a comprehensive collection of educational resources to organization while providing publishers with increased visibility, collaboration opportunities, and access to a broader customer base. The following video explains the value proposition provided by steelHub
https://cdn.hub.steeluniversity.org/assets/videos/play.html?id=MRK0010
To become part of the platform, register at https://hub.steeluniversity.org/.

As a central element of the strategic Blueprint and being an ecosystem as well, ESSA developed the steelHub, a centralized digital platform to facilitate communication, collaboration, and coordination. steelHub sets the infrastructure for a worldwide exchange of content to create a Learning Solution Directory for the steel sector. This directory is a collection of learning solutions delivered by Publishers into the framework of a marketplace business model.

One important component of this platform is the Skill Directory, which represents the current and future training needs of the steel sector. This Directory is used to curate the learning solutions. Using a standard terminology and big data infrastructure, steelHub is able to identify skill gaps and the most demanded skills for the steel sector to guide the training solutions development as well as analyze trends that can support governments to define new regulation and funding tools to support the transformation of the steel sector.

The integrated design of the platform offered by steelHub enable the possibility to develop new and innovative solutions into the context of Capability Assessor using a variety of methods to evaluate an individual's capabilities, including self-assessment, interviews, tests, and job simulations. The goal of the assessment is to determine whether an individual has the necessary skills and experience to perform effectively in each role, task or skill needed and design a custom development plan for each organization or individuum.

The flexible integration of this platform offers organizations the ability to easily connect and integrate learning solutions with their own training systems, which can improve productivity, reduce costs, and enhance overall efficiency. Besides, regional industrial and professional association are able to integrate these solutions to provide learning solutions to their members.

Figure 3: Modules of Digital Platform – steelHub

The industries are rethinking their approach to human capital and talent management (for more, see Madgavkar et al., 2022) and moving beyond degrees and job titles to focus more on the skills a job requires and that a candidate possesses, and they're doing so in greater numbers, based on McKinsey research conducted in partnership with the Rework America Alliance (Rework America Alliance, 2021). Therefore, *skills-based development program methodology*, which is a structured initiative designed to enhance and develop specific skills and competencies among individuals, was selected to design the infrastructure of the steelHub.

There are several frameworks and models to implement skills-based development methodology. The main purpose is to breakdown the process into actionable steps. This systematic process, ensures to follow key steps for successful development, provides a guide for managing the training project, and helps to support communication about the scheme with internal and external stakeholders in the company. Every organization use a specific framework or model that fits to their specific training needs. The solutions of steelHub can be integrated at different stages of the particular framework that companies use. To have a common ground to identify key steps to improve communication and integration of steelHub solutions, ESSA selected and implemented *ADDIE Model* (elmlearning, n. d.; van Vulpen, n. d.) adapted to skills-based development program. The ADDIE model is a widely used instructional design framework that provides a systematic approach to developing effective training programs.

In the following sections, more in detail description for each module of steelHub and the ADDIE model are provided.

4 Skills-based development program Framework (ADDIE model)

ADDIE model describes a flexible, systematic process to develop training programs for adult learners. The cyclical model has five stages: Analyze, Design, Develop, Implement, and Evaluate. Each stage has a deliverable that feeds into the next stage and includes opportunities to gather feedback that informs training development. The following diagram shows how the different modules of steelHub are integrated in this Framework, to ensure that training is well-planned, aligned with objectives, and continuously improved based on feedback and evaluation.

Figure 4: ADDIE Model adapted to skill-based development programs

Starting with the analysis of skills gaps and related objectives and training needs, designing and developing, implementation and evaluation of the trainings are subsequent phases.

Analysis

The Analysis phase involves conducting a thorough needs assessment to identify the training needs and performance gaps within the organization or a specific department. It includes gathering information about the target audience, their existing knowledge and skills, and the desired learning outcomes. The analysis phase helps establish clear objectives for the training program and informs subsequent design decisions.

01 **Identify Skill Gaps:** Assessing the current skills of your employee, team or organization and compare them to the desired skill set needed to achieve your goals.

02 **Set Objectives:** Select what skills need to be acquired or improved from the skill gap identified and establish measurable targets to track progress. Make sure the objectives are aligned with the overall strategic goals of the organization and define priorities based on them.

03 **Training Needs Analysis:** Perform a comprehensive analysis to determine the specific training and development needs required to bridge the skill gaps. This

analysis may involve surveys, interviews, performance evaluations, and benchmarking against industry standards.

Design

In the Design phase, the focus is on creating the blueprint for the training program. Based on the objectives identified in the analysis phase, instructional strategies, content, and activities are determined. The design phase includes developing the overall structure and sequencing of the training, defining learning objectives, selecting appropriate instructional methods, and designing assessments or evaluation methods. This stage ensures that the training program aligns with the identified needs and desired outcomes.

04 **Design Training Program:** Based on the identified skill gaps and training needs: Design a training program that addresses those gaps. Determine the appropriate training methods such as workshops, online courses, coaching, mentoring, or on-the-job training.

Development

The Development phase involves creating the actual training materials and resources based on the design. This may include developing instructional materials, such as presentations, handouts, e-learning modules, or interactive exercises. Content is organized and presented in a format that supports effective learning and engagement. The development phase also includes reviewing and refining the training materials to ensure accuracy and relevance.

05 **Select and Develop Learning Solutions:** Select the appropriate learning solutions that align with the training program. This can include internal solutions such as subject matter experts, existing training materials, or external resources such as third-party training providers, online courses, or books.

Implementation

In the Implementation phase, the training program is delivered to the participants. Trainers or facilitators conduct the training sessions using the developed materials and instructional methods. They create a supportive learning environment, provide clear instructions, engage participants in learning activities, and address any questions or concerns. This stage involves effective communication and delivery of the training content to maximize learning outcomes.

06 **Deliver Training Program:** Execute the training program by scheduling, delivering and monitoring the learning solutions. Use evaluation methods such as quizzes, tests, assignments, and practical assessments to measure knowledge and skill improvement.

07 **Transfer Learning:** To assure transfer learning, offer ongoing support and resources to the participants even after the formal training program ends. Encourage continuous learning through mentoring, coaching, access to learning materials, and creating a supportive work environment.

Evaluation

The Evaluation phase focuses on assessing the effectiveness and impact of the training program. Evaluation can occur at multiple levels, including the reaction of participants, their learning outcomes, changes in behavior or performance, and the overall impact on organizational goals. Evaluation methods may include participant feedback surveys,

assessments, observations, or interviews. The feedback and data collected are analyzed to identify strengths and areas for improvement in the training program. The evaluation results inform future iterations or modifications to enhance the training's effectiveness.

08 **Evaluate Impact:** Evaluate the overall effectiveness of the development plan by measuring the impact on closing the skill gaps. Use quantitative and qualitative measures to gauge success. Identify areas for improvement and refine the development plan for future iterations. Continuously adapt the plan to changing skill requirements and emerging needs.

Against this backdrop the four central elements of the steelHub (as already outlined in Figure 3 and chapter 2)

1. Learning solution directory
2. Skill Directory
3. Capability Assessor
4. Integration

will be described in detail in the related following chapters.

5 Learning Solution Directory

The steelHub and its infrastructure is composed to support the **Online and National-Regional Training Eco-Systems**: 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. steelChallenge, see chapter 9.1), job contents and opportunities in the sector could be spread to candidates of varied disciplines (included 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)).

5.1 Publishers

steelHub can be defined as a marketplace of learning solutions, therefore, a publisher is any member of the ecosystem, like university, expert, industry, equipment and service providers, among other that creates, develops, and distributes educational content, materials, or resources for learners. They play a crucial role in the ecosystem by producing and curating educational content for various subjects, disciplines, and target audiences, which is the source to **design and implement training program**.

The following figures show a list of the current publishers and those that are in the process to be integrated in the steelHub, differentiated by the stakeholder groups of the ecosystem.

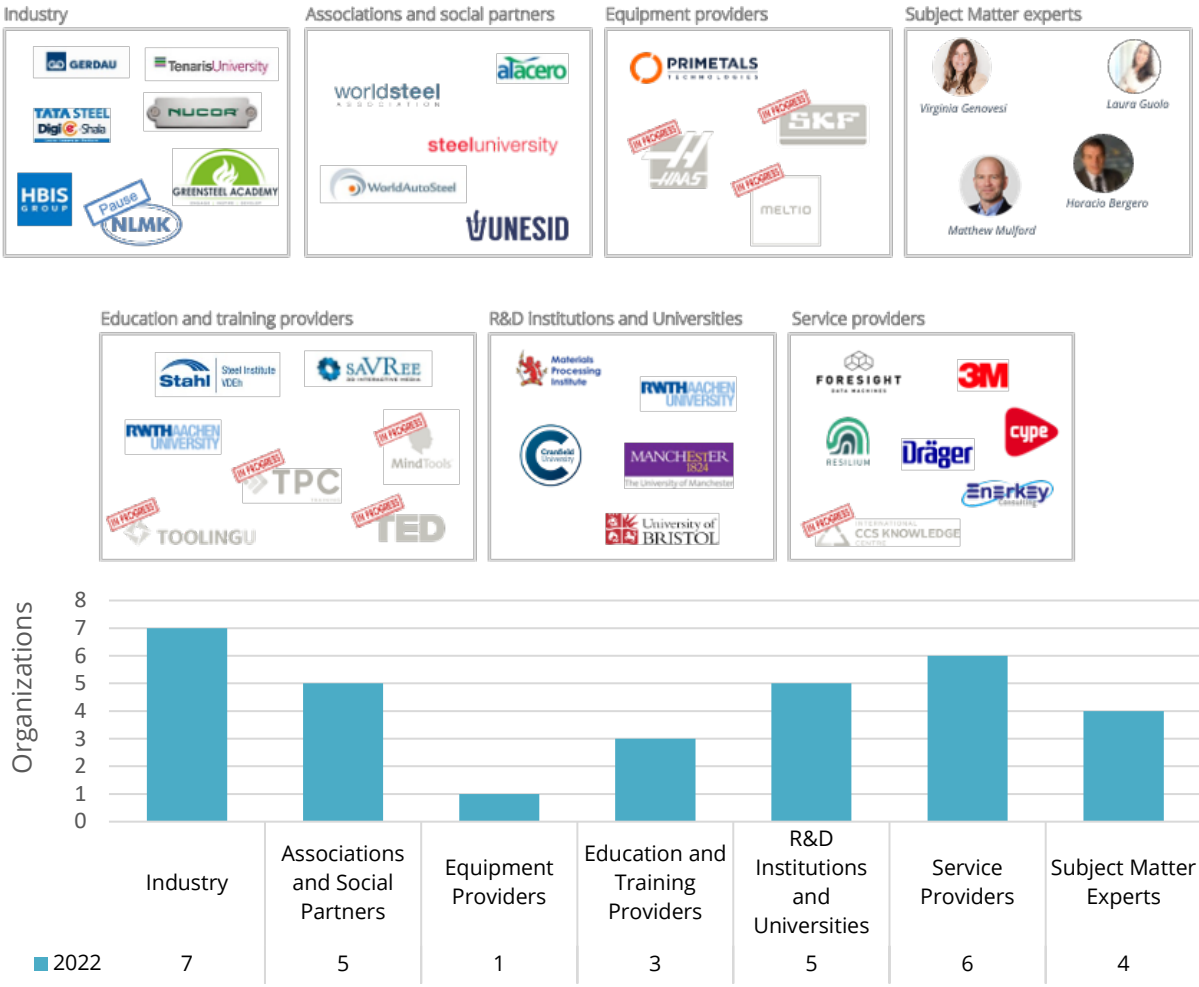


Figure 5: Publishers integrated and in progress

5.2 Learning Solutions

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)
- Webinars
- Individual and specific groups training paths (in-company, across companies, individual)

- 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.

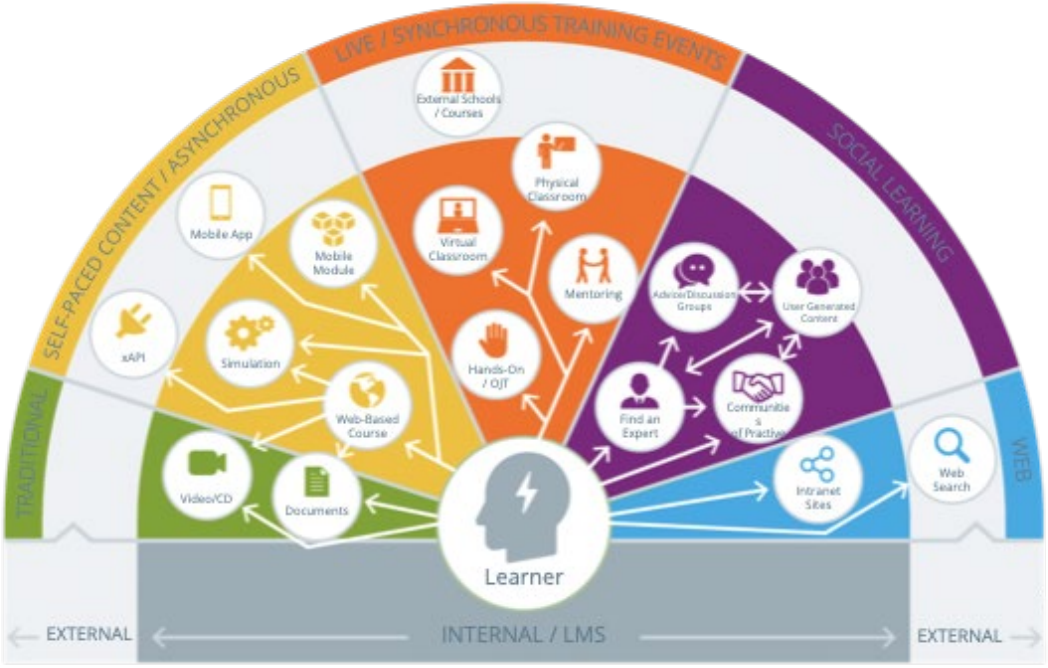


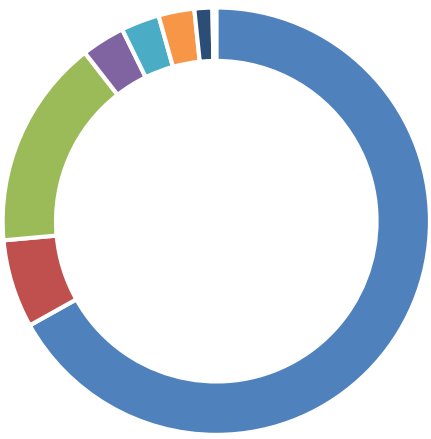
Figure 6: The learning ecosystem (adapted from Gipple (n. d.))

To organize the Learning Solutions provided by Publishers in steelHub, ESSA defined a categorization of the solution as follow:

- **E-Learning**: educational content and training through digital platforms and technologies. It involves the use of the internet, computers, and various digital learning modules (3D Models, Videos, Interactive HTML5 exercise, among others) to facilitate and enhance the learning process.
- **Webinar**: web-based seminar or presentation conducted over the internet. It is a live, interactive online event that allows participants to join remotely and engage in real-time learning and discussion. Webinars could be recorded and delivered asynchronous over a digital platform.

- **Certification**: It is a formal document that serves as evidence or proof of accomplishment, completion, or achievement in a specific area of study or training, for example, after completion of an Exam, Simulation or Games.
- **Cognitive Assessment or Exam**: It is a standardized evaluation that assesses an individual's cognitive abilities and mental functioning. It measures various aspects of cognitive processes, including attention, memory, language, problem-solving, reasoning, and perception.
- **Videos:** They offers several benefits, including visual engagement, increased retention, accessibility, and the ability to cater to different learning styles. There are several formats, like i) Educational Tutorials, ii) Animated Educational Videos, iii) Virtual Lab Demonstrations, iv) Subject Explainers, v) Science Experiments and Demonstrations, among others.
- **3D Interactive Models:** These models provide a highly engaging and immersive learning experience that enables learners to visualize and interact with complex concepts and objects.
- **Simulations:** They are a powerful educational tool that involves creating realistic, interactive environments or scenarios to replicate real-life experiences and situations. It allows learners to actively engage, experiment, and apply knowledge and skills in a safe and controlled setting.
- **Game:** the use of games for education offers a unique and effective approach to engage learners, promote active learning, develop skills, and bridge the gap between theory and practice. By making learning enjoyable and meaningful, games have the potential to transform the educational experience and improve learning outcomes.

The community of publisher collaborate in the steelHub to create a Learning Solution Directory of up to now 1,896 innovative digital learning modules in different languages. The following table represent the distribution of those learning solutions.



Type	Quantity
E-Learning	691
Webinar	69
Certification	164
Exam	34
Video	30
3D Model	28
Simulation	14
Game	3

In the process, steelHub includes several innovative learning tools, like i) 3D interactive models, ii) Simulations and iii) Multiplayer games. These tools showed an effective and engaging experience for the learners. Therefore, the following section describes more in detail these solutions for the steelHub.

5.2.1 3D interactive models

Interactive 3D models are increasingly being used as a powerful tool to deliver training across various industries and educational settings. These models provide a highly engaging and immersive learning experience that enables learners to visualize and interact with complex concepts and objects. 3D models allow learners to visualize objects, processes, large and complex machine and environments in a three-dimensional space. This enables a more comprehensive understanding of the subject matter compared to traditional two-dimensional images, pictures or diagrams. Learner can rotate, zoom in, and examine the model from different angles, providing a deeper insight into the subject.

Besides, this interactive 3D models incorporate multimedia elements such as audio, animations, and annotations to provide a multisensory learning experience. This engages multiple senses and helps reinforce learning by associating visual, auditory, and tactile information. For example, the model includes labels that describe more in detail each component, like is shown in the following figure, which is a 3D model of the Blast Furnace. This 3D models have been included in e-learning courses and wrapped in SCORM 2004 4th edition and SCORM1.2 edition to be embedded into Learning Management System of companies.

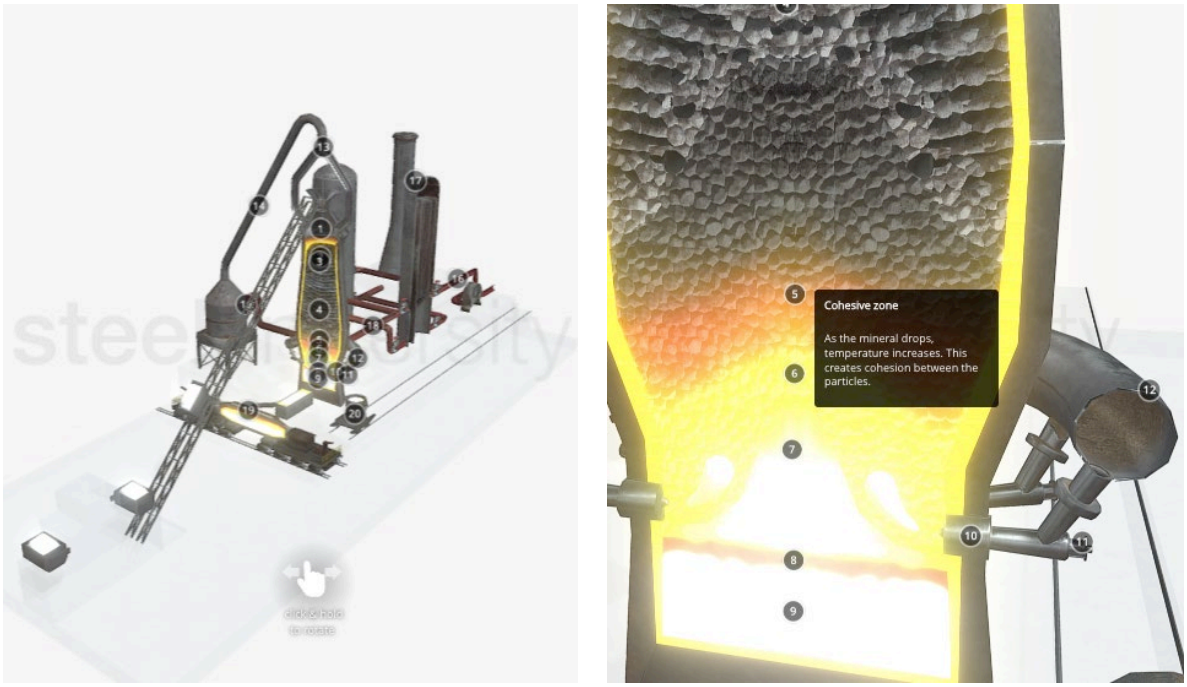


Figure 7: 3D interactive model of a Blast Furnace (38,600 views) https://skfb.ly/DVTJ

Interactive 3D models can simulate real-world scenarios, enabling trainees to practice skills and decision-making in a safe and controlled environment. For example, in risk identification in working at high temperature activities inside of a steel plan, the 3D models replicate the scenario of two workers changing a cooling panel inside of an Electric Arc Furnace.

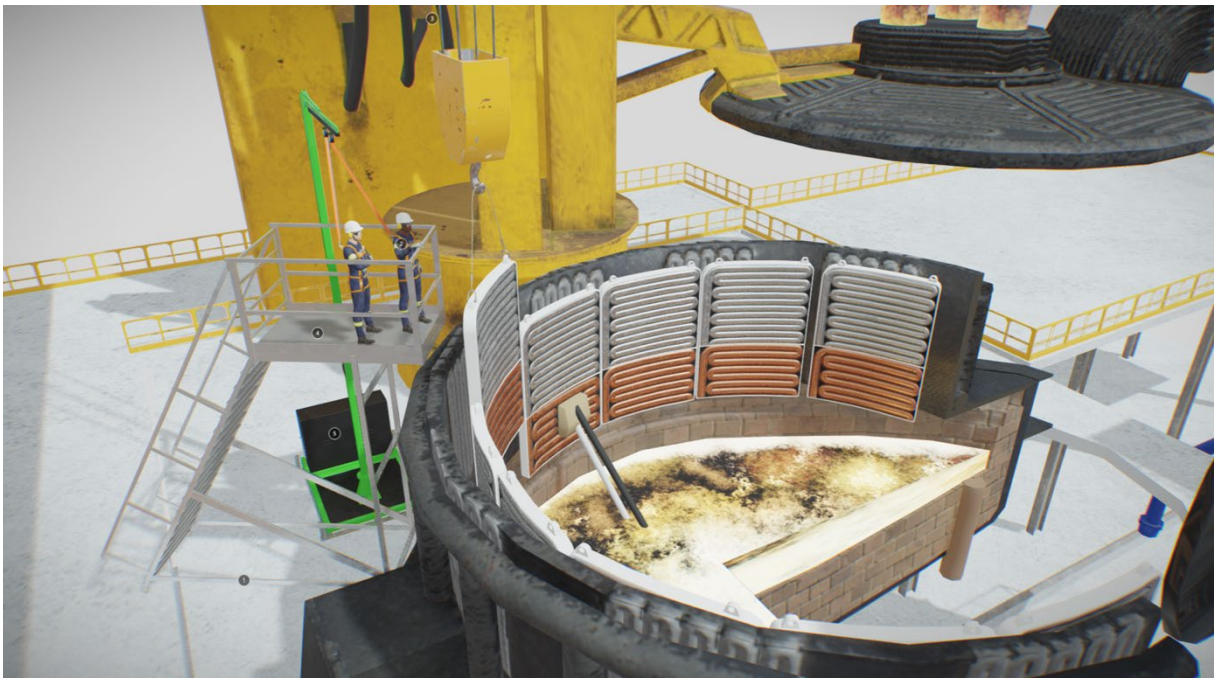
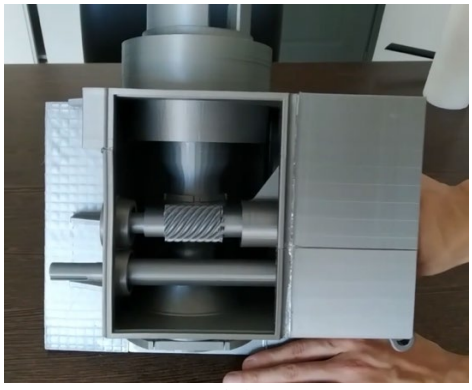


Figure 8: 3D interactive model of Maintenance scenario in an Electric Arc Furnace

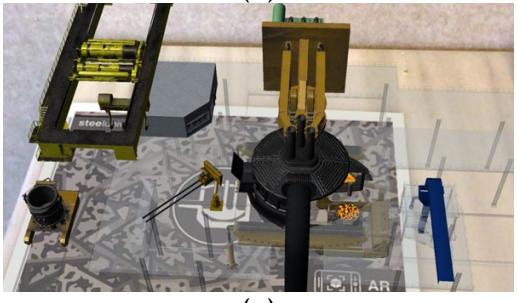
https://sketchfab.com/3d-models/sc0033-plan-equipment-f8839299047f45e6a7d5bd4397074d54

Finally, 3D model accepts the use of hands-on interactivity. Learners can actively interact with the 3D models, manipulating objects, disassembling and reassembling parts, and performing virtual experiments using Virtual Reality or printing the model in plastic. This hands-on experience fosters better comprehension, retention, and application of knowledge. The following figures are showing the example of a threading machine for steel pipes used in Oil and Gas Industry, in order to show the different components of the shredder and to train risk identification.



(a)

(b)



(c)

(d)

Figure 9: Threading Machine Model: (a) and (b) 3D printing plastic model, (c) AR of Electric Arc Furnace and (d) VR environment for risk identification

5.2.2 Simulations

Simulations offer several advantages for the learning process, such as increased engagement, active participation, risk-free experimentation, and the ability to visualize and manipulate complex systems. They can be used in a wide range of educational settings, from classrooms to professional training programs, to enhance learning outcomes and bridge the gap between theory and practice.

steelHub include a library of simulations of the steel production process that includes elements from the entry of raw materials to the finished steel product. They allow to design, produce, test and use steel for specific applications considering time and costs.

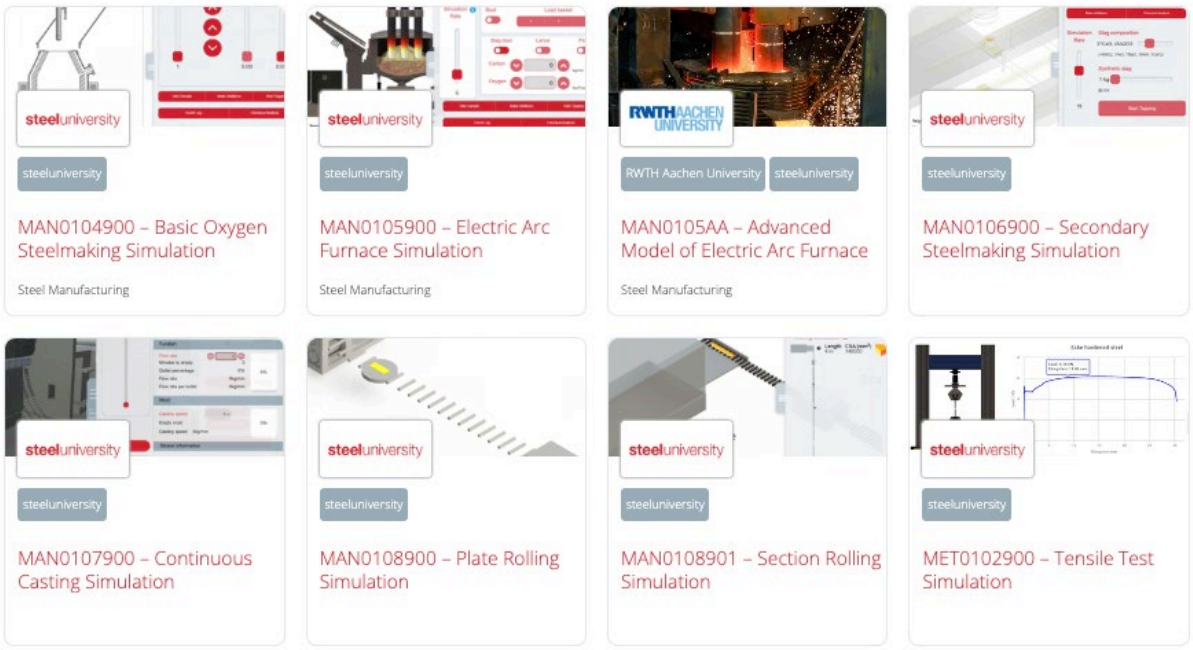


Figure 10: Process Simulations (Examples)

5.2.3 Multiplayer games

Game-based learning is an educational approach that incorporates the use of games to facilitate the learning process and achieve educational goals in a more exciting way. It leverages the engaging and interactive nature of games to enhance students' understanding, motivation, and retention of academic content and skills.

In game-based learning, educational concepts and objectives are integrated into the design and mechanics of the game. This means that students learn while actively participating in gameplay, rather than passively receiving information. The game serves as a context in which students can explore, experiment, solve problems, make decisions, and experience the consequences of their actions.

An example of Game-Based learning, steelHub include steelBusiness Game, which is a multiplayer game to teach strategy and financial management in the context of steel industry.

The game introduces financial concepts through competitive play. Players form teams and the teams compete to run a profitable steel plant in a virtual year. The **Learning Objectives** developed during the game are the following.

- Understand financial concepts used in running a steel company.
- How to manage financial indicators as they compete to win customer orders, paying attention to production capacity and market demand.
- How steel companies can be financially sustainable.
- How business decisions can impact the company's financial performance.

In the first half of the year, teams build their steel plant and set it up for operation. Along the way, financial concepts are introduced to the players.

Figure 11: Gamification: Run a profitable steel plant while learning financial concepts

In the second half of the year, teams compete to produce and sell steel in the marketplace. In this competitive environment, teams decide whether to expand capacity, add additional products, or take loans from the bank. Teams must monitor their financial situation to maintain a viable company as they try to maximise their profit without running out of cash. A session of steelBusiness typically takes 4-8 hours, including breaks.

The game has a facilitator Admin Panel, which allows administrators to control sessions of steelBusiness. The administrator can create new sessions, enable/disable sessions, restart and delete sessions. Certain game variables can be set for separate sessions, including access PINs, market size per month and product, minimum and maximum order size per month, and raw material price per month. This is done in the session setup panel.

The facilitator tool allows trained facilitators to control and monitor team sessions of steelBusiness. The facilitator can start sessions, manage the market timer, and force the market to execute.

The facilitator control panel also presents team information in graphical form. This allows the facilitator to track performance of the teams and keep them on-track. Besides, this information is used by facilitator to wrap-up the session.

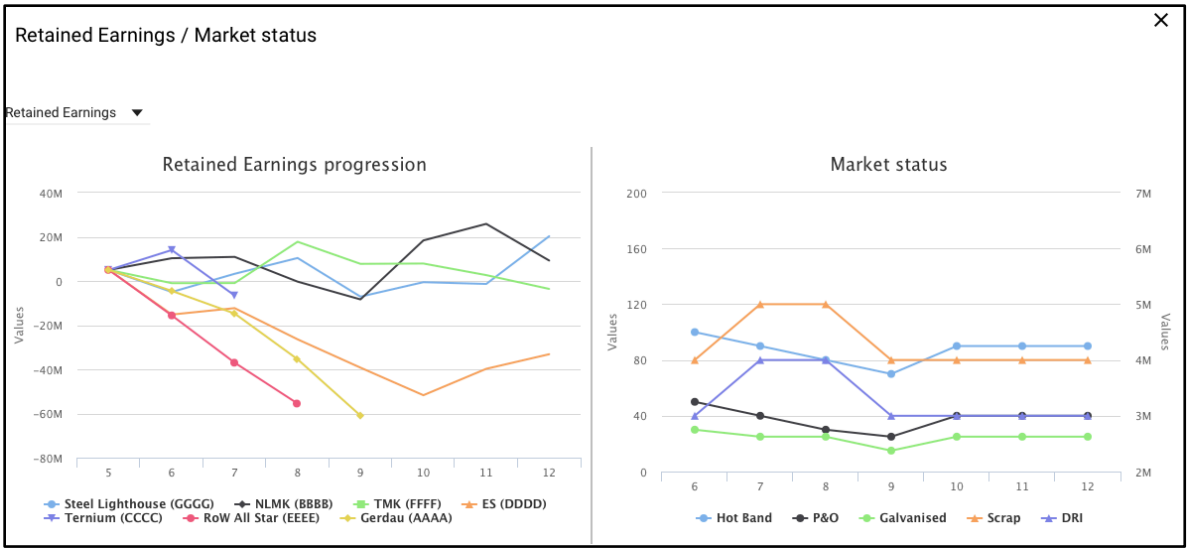


Figure 12: View of the facilitator control panel with example graphs.

The Business Game is supported by different guidance:

Facilitator Guide: The guide outlines how the game is delivered along with tips for the facilitator. The guide provides a summary of the key concepts taught in the game and serves as a valuable reference tool for the facilitator.

User Guide: The guide can be given to participants as a learning aid while they play the game or provided in advance of a session as pre-learning. The guide presents the financial concepts introduced in the game and offers guidance in understanding game play.

Avatar: steelBusiness includes an avatar who guides learners through the first half of the game as they set up their steel plant and introduced to the financial concepts related to running a steel company.

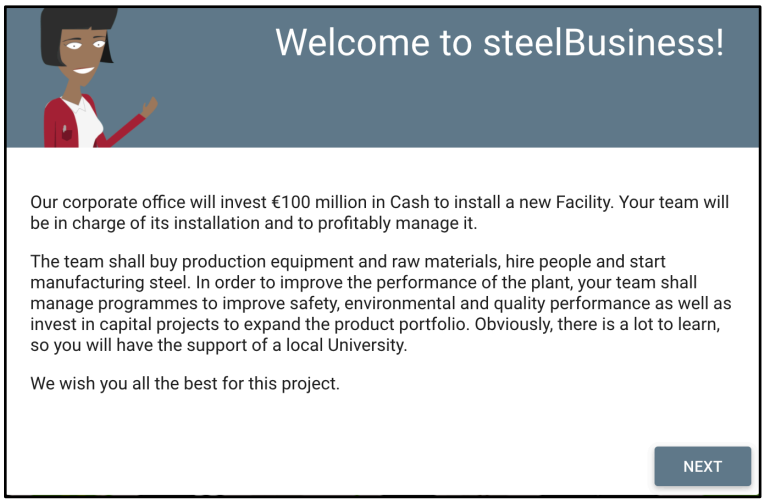


Figure 13. Avatar used in steelBusiness.

Facilitator Training: For those intending to run multiple sessions of steelBusiness, it is suggested to have a 'train-the-trainer' session whereby company people can be instructed in facilitating sessions of steelBusiness. The facilitator training can be done remotely or in person at a location convenient to the company.

The training includes a review of steelBusiness, working through the game and relating it to the facilitator guide. It would also cover how sessions can be managed, how the facilitator tool is used, and how steeluniversity support will be provided.

This is then followed by running a session of steelBusiness with the facilitators. This would provide a 'hands on' experience for the facilitators to see how people react to playing the game and learning about financial management. A debrief of the session would follow, with an exchange of ideas of how to best deliver the training throughout the company.

5.3 Organizations already using steelHub

On March 2020, ESSA started recording access of learners to steelHub. The tool was used by 13,406 learners until June 2023. The following graph shows the monthly evolution of active learners by month from January 2022 to June 2023.

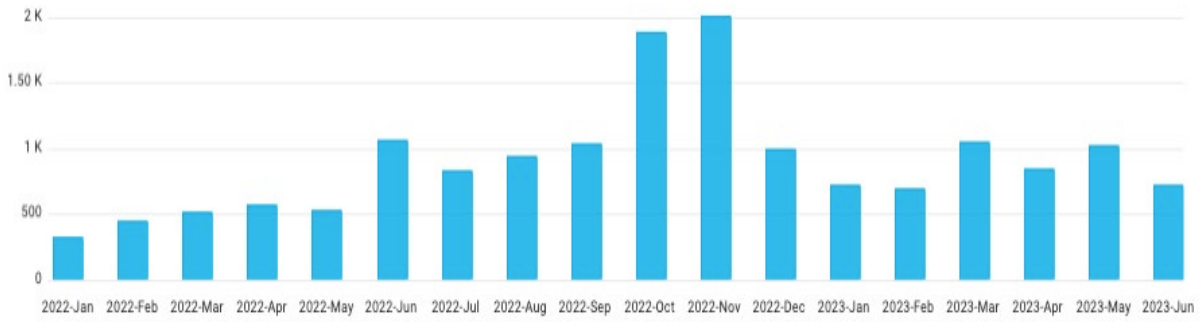


Figure 14: Active learners per month January 2022 to June 2023

The learning solutions are categorized in knowledge areas. In the period 01/2022 to 06/2023 the most demanded learning solutions were "Manufacturing", which includes learning solutions related to steel making process, like Electric Arc Furnace, Secondary Steelmaking, among others. Besides, the second category was "Occupational Safety and Health". The main learning solutions used in this segment are animated videos that replicate incidents in the steel industry that have the objective to generate awareness.

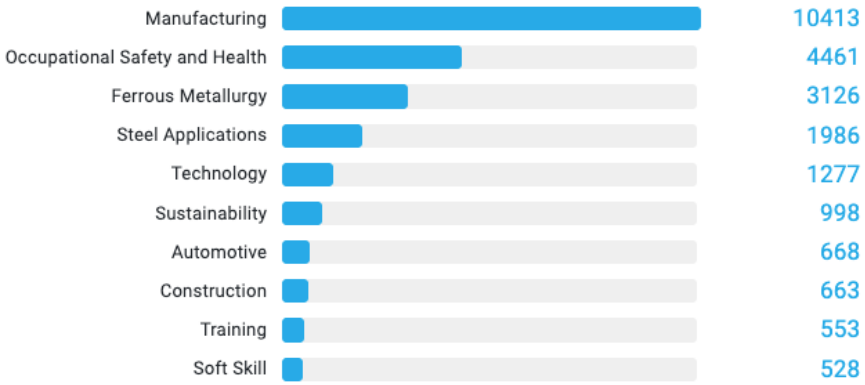


Figure 15: Active learners per knowledge area

The organisational background of the learners reflects the ecosystem of the steelHub: As most of them are employees of a company, also associations and social partners, research institutions and universities, equipment and training providers took part in training modules.

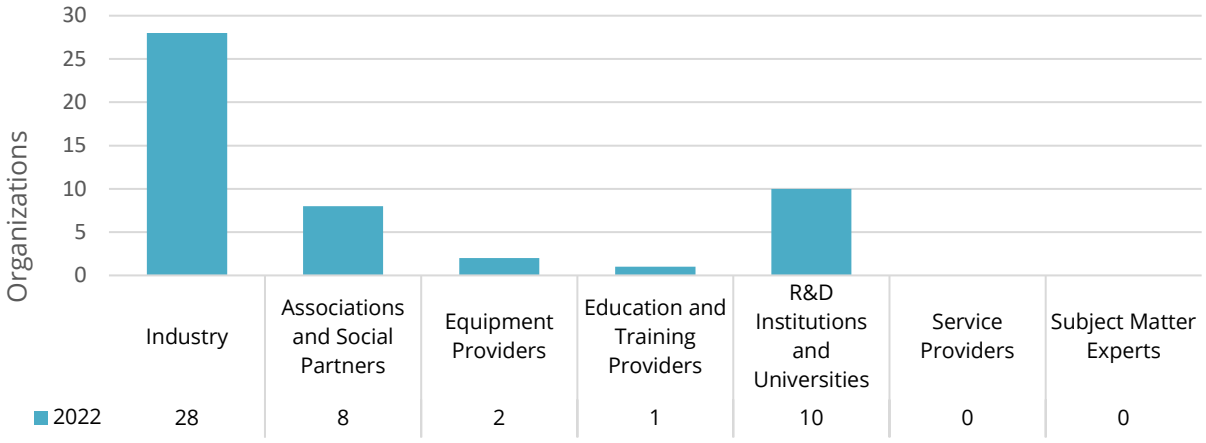


Figure 16: Organizations using steelHub

6 Skill Directory

The transition towards Industry 4.0 will require workers to develop a solid understanding of complex organisational and technological processes as well as interact with digital interfaces and analyse larger amounts of data in their day-to-day decisions (Kiss, 2017). There will be high demand for workers with finely tuned technological, social and emotional skills—skills that in cases, machines are a long way from mastering (Center for Digital Dannelse, n. d.). The mix of physical and manual skills required in occupations will change depending on the extent to which work activities can be automated. General equipment operation (skills used by manufacturing workers), inspecting and monitoring skills will decline faster than other physical and manual skills (Center for Digital Dannelse, n. d.).

Besides, the need for skills to adapt to new environmental and energy regulations arises from the growing recognition of the importance of sustainable development and the need to mitigate climate change. Governments, organizations, and societies around the world are increasingly implementing regulations and policies aimed at reducing environmental impact, conserving resources, and transitioning to cleaner and more sustainable energy sources. Adapting to new environmental and energy regulations requires individuals and businesses to possess specific skills and knowledge to navigate the changing landscape effectively.

To support this transition, ESSA proposed the design and implementation of a common Skill Directory i) to promote efficiency, collaboration, and inform decision-making in the labor market, ii) to help individuals make better career choices, iii) to support employers to find suitable talent, and iv) to maintain policymakers to develop effective strategies to address skill gaps and promote economic growth.

ESSA WP3 (Industrial Requirements & foresights) addresses the near future changes in the professional skills requirements of the steel industry facing Industry 4.0 and provides insights and hints from varied perspectives to deal with the current skills requirements and as well as the future skills requirements urging with digitalization. The methodology used by WP3 are described in Deliverable 3.2 (Company Skills Requirements and Foresight, Bayón et al., 2023).

The developed industry-based skills catalogue was integrated into the Skill Directory Module of steelHub. The Skill Directory Module is a centralized IT infrastructure to manage a skill database to offer the following benefits:

- **Data Consistency:** Storing all skill-related information in a single, unified database. This eliminates the possibility of duplicate or conflicting skill data and ensures that all users have access to the most up-to-date and accurate information.
- **Efficient Data Management:** Simplifies data management processes by providing a centralized repository for storing, organizing, and updating skill-related information, making it easier to maintain and manage the data. Centralized data management ensures that skill data is easily accessible, searchable, and shareable across members of the ecosystem.
- **Enhanced Data Integrity:** Implement robust data governance practices to ensure data integrity. This is done by established data quality standards, validation rules, and data maintenance processes to maintain the accuracy and consistency of skill data. Data validation and quality checks are performed at a centralized level, minimizing the risk of errors and inconsistencies.
- **Improved Collaboration and Communication:** A centralized IT infrastructure facilitates collaboration and communication within the members of the ecosystem. With a central skill database, different teams and stakeholders can access and contribute to the same pool of skill data. This promotes knowledge sharing, cross-functional collaboration, and effective workforce planning by enabling stakeholders to make informed decisions based on accurate and consistent skill information.
- **Streamlined Reporting and Analytics:** It allows streamlined reporting and analytics. It enables the generation of comprehensive reports and analytics on skill gaps, skill trends, training needs, and workforce capabilities. This centralized view enables data-driven decision-making, resource allocation, and strategic planning for talent development and acquisition.
- **Scalability and Flexibility:** Provides scalability and flexibility in managing the skill database. As the Steel Sectors skill demand grows or evolves, the centralized system can accommodate new skill data, additional users, and evolving skill taxonomies. It allows for easy integration with other systems and applications, enabling seamless data exchange and interoperability.
- **Data Security and Access Control:** Centralizing the skill database enhances data security and access control. steelHub implemented robust security measures, such as user authentication, data encryption, and role-based access control, to safeguard sensitive skill data. Centralized security measures reduce the risk of unauthorized access, data breaches, and data loss.
- **Cost Efficiency:** The centralizing IT infrastructure for skill data management leads to cost savings. It eliminates the need for multiple decentralized skill databases, reduces duplication of efforts, and streamlines data management processes. It also simplifies system maintenance and reduces the overall IT infrastructure complexity, resulting in cost efficiencies.

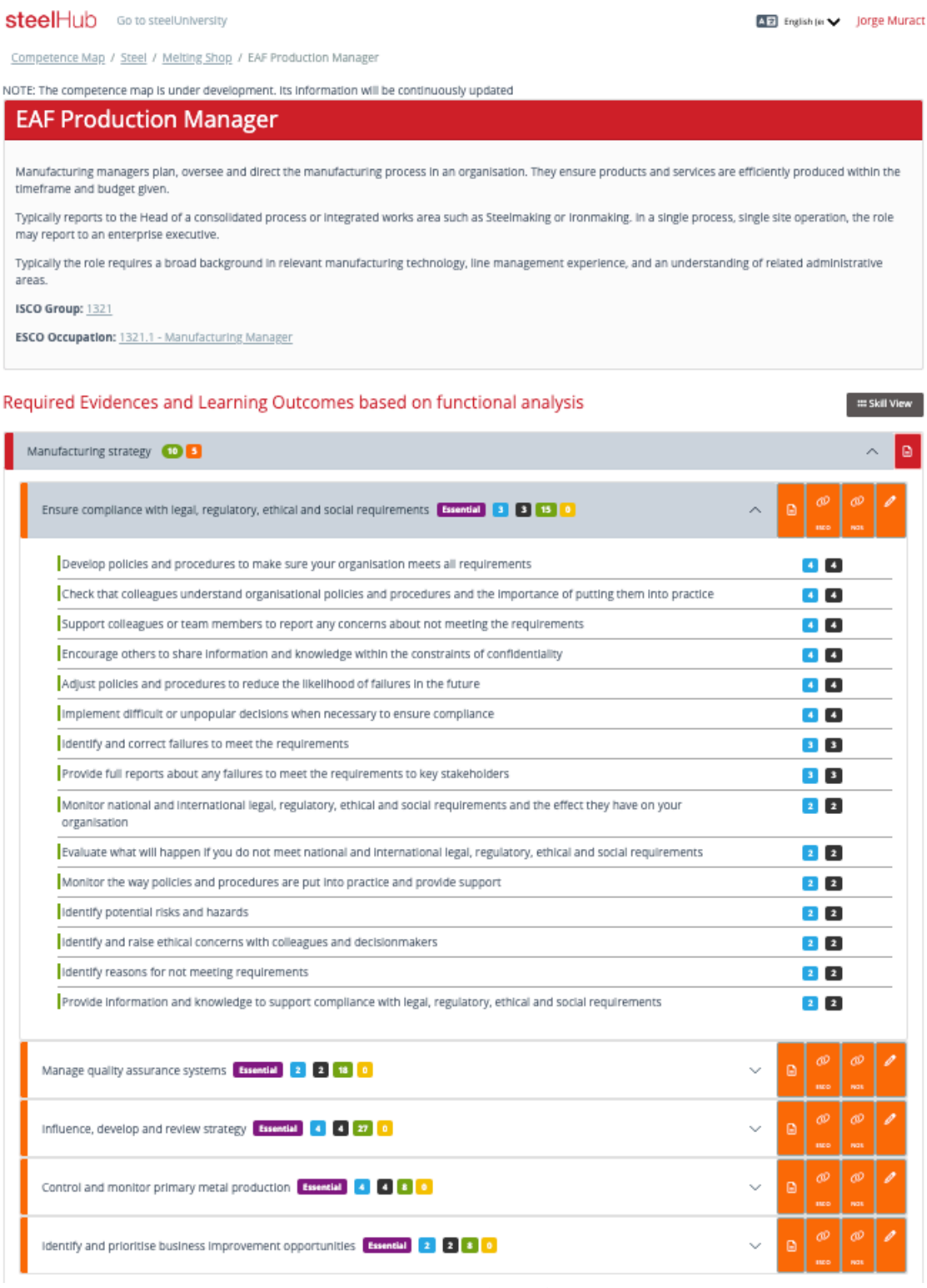
The Skill Directory has two main views:

- **Functional Analysis View:** Functional Analysis of the **occupation** following the methodology used in National Occupational Standards from UK (Carroll & Boutall, 2011). Functional analysis is the main tool the National Occupational Standard NOS UK uses to define the nature of an occupational sector and the functions performed within it. This is an essential process in defining occupational competence and in setting boundaries between different occupations. A detailed functional map allows to establish the unique contribution of each occupational area. In technical terms

this is referred to as “delimiting the occupational domain”. This is essential to ensure that all primary (main) and secondary (sub-) functions are identified

- **ESSA Skill Categories View:** After a detailed desk research and fruitful discussions among the skills development experts of ESSA, a set of **skills** across six broad categories were identified: physical and manual, methodological, social, individual and personal, green and digital skills under two main categories: technical and transversal skills. These skills are assessed by proficiency levels as described in the following chapter 6.1).

Both views (occupations and skills) are connected in the steelHub via “Learning Outcomes” and “Evidence”. The method to connect both views are described in Deliverable 3.2 (Bayón et al., 2023). The following figure show the example of EAF Production Manager.



(a) Functional Analysis View

(b) ESSA Standard Skill View

Figure 17: Skill Directory interphase for EAF Production Manager (a) Functional Analysis View and (b) ESSA Standard Skill View

The Skill Directory is comprising proficiency levels (used by the main steel companies) and the levels of the European Qualification Framework (EQF) to assess the recent status of the learner.

6.1 Proficiency level

The ESSA skills assessment is based on four proficiency levels, used by the main steel companies. A proficiency level refers to a measurement or assessment of an individual's competence or skill in a particular area of knowledge or performance. It represents the level of mastery or expertise that a person has achieved in a specific domain or skill set.

Proficiency levels serve as a useful tool for evaluating individuals' knowledge and skills, providing a standardized way to communicate their level of expertise. They help in setting learning goals, designing curriculum, assessing progress, and ensuring a common

understanding of competency across different contexts. Proficiency level frameworks also assist in identifying areas for improvement, tailoring instruction, and providing targeted support to help individuals advance to higher levels of proficiency.

In ESSA project have been defined four levels and each skill have been described in those levels. The following table is an example for the skill to “Manage Budget”.

Skill Definition		Definition of Proficiency Levels	Example of Manage Budget Skill
Manage Budget Gather information and prepare budgets for the organization to support short- and long-term business plans. Engage colleagues and stakeholders in the process. Submit them to decision-makers and agree final budgets to be implemented. Monitoring budgetary performance, taking corrective actions when required. Propose revisions and provide reports to decision-makers, including identifying potential fraud is necessary.	Level 1	Basic knowledge and ability and, with guidance, can apply the skill in common situations that present limited difficulties.	You have a general understanding of budgeting concepts and processes. You are able to create and manage simple budgets and can perform basic financial analysis..
	Level 2	Solid knowledge and ability and can apply the skill with minimal or no guidance in the full range of typical situations. Would require guidance to handle novel or more complex situations.	You have an in-depth understanding of budgeting processes and concepts. You are able to create and manage more complex budgets and perform financial analysis to identify trends and issues.
	Level 3	Advanced knowledge and ability, and can apply the skill in new or complex situations. Guides others.	You have a high level of expertise in budgeting processes and concepts. You are able to create and manage complex budgets, perform financial analysis to identify opportunities for cost savings and revenue growth, and provide strategic advice to senior management on financial matters.
	Level 4	Expert knowledge and ability, and can apply the skill in the most complex situations. Develops new approaches, methods or policies in the area. He/She is recognized as an expert, internally and/or externally. Leads the guidance of others.	You have a deep understanding of budgeting processes and concepts and are recognized as leaders in the field. You are able to develop and implement innovative budgeting strategies, identify and manage financial risks, and provide expert advice to senior management on financial matters.

Figure 18: Description of Proficiency Levels of the skill for “Manage Budget”

These definitions are part of the Self-Assessment tool to guide the learners to identify their recent proficiency level for a particular skill. The following figure is an example of this assessment.

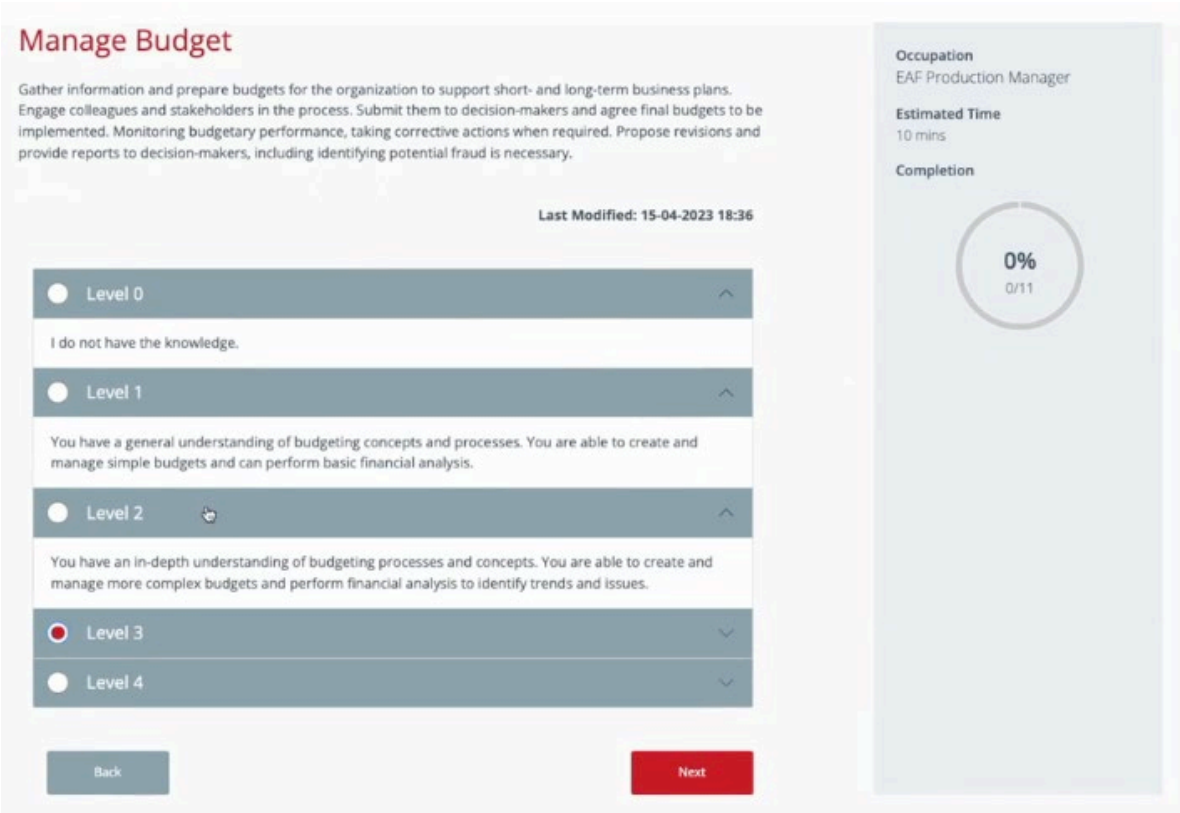


Figure 19: Proficiency levels as part of the self-assessment tool

6.2 European Qualification Framework (EQF)

Another important element to classify the level of skills is the interrelation of the steelHub to the European Qualification Framework (EQF) in order to make national qualifications easier to understand and more comparable. The EQF seeks to support cross-border mobility of learners and workers, promote lifelong learning and professional development across Europe.

The EQF is an **8-level**, learning outcomes-based framework for all types of qualifications that serves as a translation tool between different national qualifications frameworks. This framework helps to improve transparency, comparability and portability of people's qualifications and makes it possible to compare qualifications from different countries and institutions.

The EQF covers all types and all levels of qualifications and the use of learning outcomes makes it clear what a person knows, understands and is able to do. The level increases according to the level of proficiency, level 1 is the lowest and 8 the highest level. Most importantly the EQF is closely linked to **National Qualifications Frameworks**. This way it can provide a comprehensive map of all types and levels of qualifications in Europe, which are increasingly accessible through qualification databases.

The EQF was set up in 2008 and later **revised in 2017**. Its revision has kept the core objectives of creating transparency and mutual trust in the landscape of qualifications in Europe. Member States committed themselves to further develop the EQF and make it more effective in facilitating the understanding of national, international and **third-country qualifications** by employers, workers and learners.

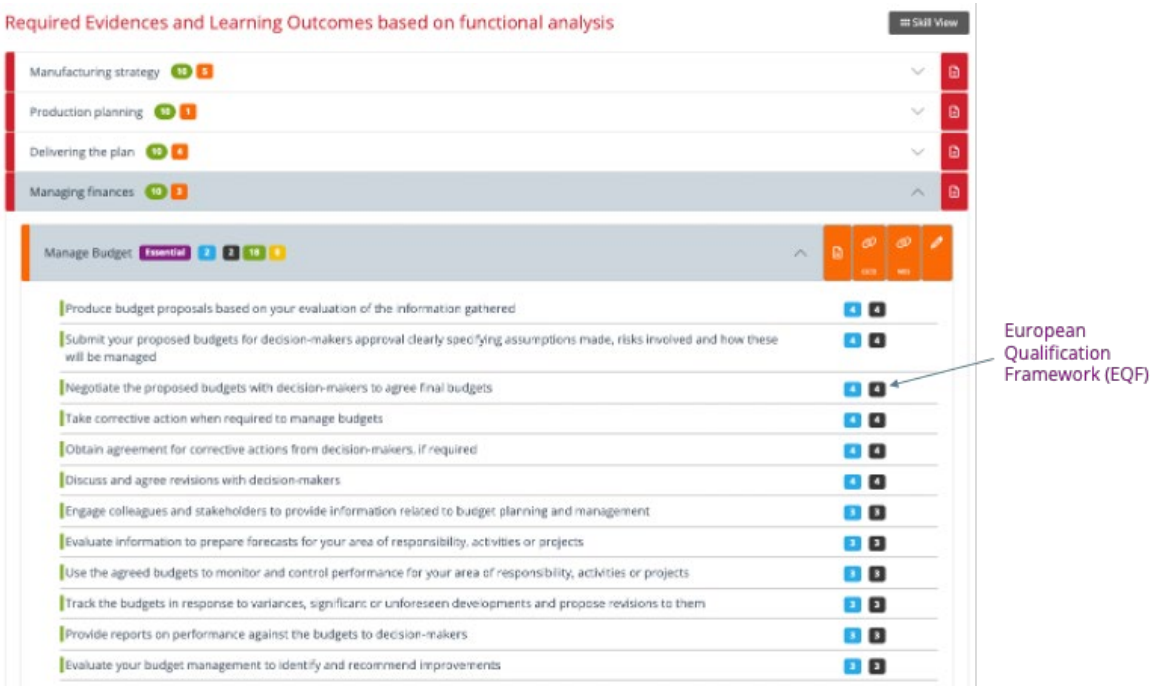


Figure 20: Competence Map View in steelHub (Proficiency and EQF Levels)

7 Capability Assessor

The ESSA Training Framework methodology is focusing very much on the upskilling and reskilling 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). 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. However, "voluntary" lifelong adult learning of workers has to be treated different than compulsory education.

Important element of the steelHub is the **connection of competences with learning content**. This is a main challenge for combining industry skills demands with occupational profiles and how industry demands fit with occupational profiles and thus IVET systems (this was and will be in the centre of the ESSA rollout to the member states and regional levels).

The design, development, and implementation of an adult learning or professional learning initiative is 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 (Gipple, n. d.). 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: self-directed 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 includes 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.

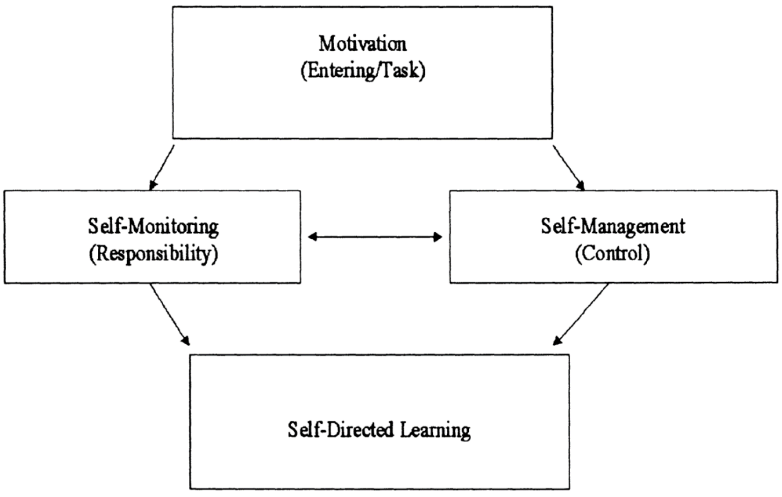


Figure 21: Dimensions of Self-Directed Learning (Garrison, 1997)

Against this backdrop, 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, which is offered by Skill Directory**.**
2. **Self-Assessment** of the Learning Outcomes to allow the learner to identify gaps, which is offered by **Capability Assessor** module.

3. Identify the relevant learning resources from the **Learning Solution Directory,** and implement a personalised training path. To help the learner, the content needs to be curated and associated with job profiles, content and assessment; in other words, the three pillars need to be integrated.
4. **Final Assessment** to assure the quality of learning outcomes obtained and recorded: The results must prove the achievement obtained thru an objective evaluation provided by **Capability Assessor** module.

These four points are integrated into the Ecosystem Learning Arrangement and digitally interconnected into an online platform to allow the massive access and self-management of the learning experience, based on subjective self-assessment and objective assessment of the online training system.

7.1 Self-Assessment (Subjective Assessment)

Self-Directed Learning, refers to a learning approach in which individuals take primary responsibility for planning, organizing, and executing their own learning process. In this context is very important to measure the level of the learning outcomes and evidence to help the learner to identify skill gaps and propose a customised training program to close this gap. In this sense, the assessment is a key element in the Adult Learning.

The capability assessor is a module of steelHub that assesses the capabilities or competencies of individuals or organizations. It evaluates the knowledge, skills, and abilities of the target audience and provides insights into their current capabilities and areas for improvement.

The capability assessor module is built upon a well-defined Skill Directory that outlines the specific skills and knowledge to perform a particular, job or task. Skills and knowledge are described in terms of evidence and Learning outcomes. The skills to be evaluated can be customized according to projects, team and company needs.

The module incorporates assessments that align with the Skill Directory. The assessments are designed to capture different dimensions of capabilities and provide a comprehensive evaluation. A *learner subjective evaluation* was implemented, which relies on subjective judgments, opinions, or interpretations of the learner. This assessment involves gathering qualitative data, perceptions, and subjective assessments to evaluate a person's skills and knowledge.

The module incorporates performance analytics and reporting capabilities. It generates detailed reports and insights on individual or organizational capabilities, highlighting strengths, weaknesses, and skill gaps. Performance analytics include visual representations, such as graphs or charts, to provide a clear overview of the assessment results. The report is shared with the manager to review skills gap and define a training program based on priorities of the company.

Besides, the module is integrated with Learning Solutions Directory in steelHub to create a seamless learning and development ecosystem. The assessment results support the automatic list of personalized learning pathways, recommend relevant learning resources or training programs, and track progress over time. Integration enables a targeted and tailored approach to capability development.

Finally, the module is designed to be accessible and user-friendly. It is compatible with different devices and accessible to individuals with diverse needs. User-friendly interfaces,

clear instructions, and intuitive navigation, which enhance the usability of the module and encourage engagement from the target audience.

Even though a subjective evaluation was implemented in this first instance, functional tests were carried out to tested objective evaluations in the infrastructure of steelHub. In this evaluation measurable and quantifiable criteria as learning outcomes in the Skill Directory are used. The aim is to provide a standardized assessment following an Evidence Centered Design Methodology (ECD) of some of the skills, for instance for the Continue Casting Operator using simulations and interactive tools.

Overall, a capability assessor module plays a crucial role in assessing and evaluating the capabilities of individuals or organizations. It provides valuable insights for personalized skill development, informs decision-making processes, and contributes to the overall effectiveness of learning and development initiatives.

7.2 Final Assessment (Objective Assessment)

To come to an objective valuation, it is relevant to connect the assessment with competences, skills and knowledge. After describing this approach an example for the digital online assessment is given.

7.2.1 Connecting Competences, Skills and Knowledge with Assessments

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. Behrens et al. (2012) addresses this problem with the implemented Evidence Centred Design (ECD) (Mislevy et al., 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 et al., 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 et al., 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 22 (adapted from Mislevy & Riconscente, 2006). The first layer is marshalling facts and theory about the domain. It is defined by the Industry Skills Requirements of ESSA, regularly updated by the ESSA Foresight 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, blueprints 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 process architecture for understanding assessment delivery.

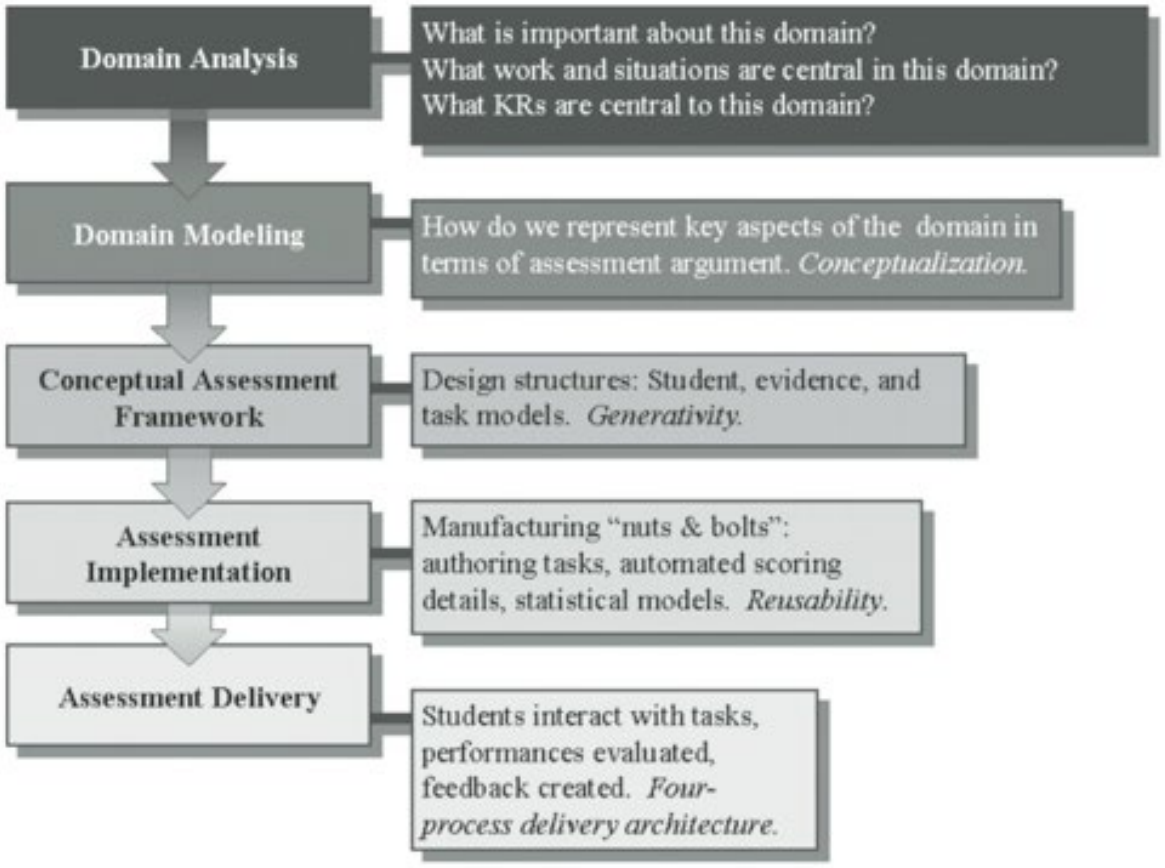


Figure 22: Layers in Evidence-Centered Design
KR = Knowledge Representations (adapted from Mislevy & Riconscente, 2006)

As an example, Shute et al. (2010) describe 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.

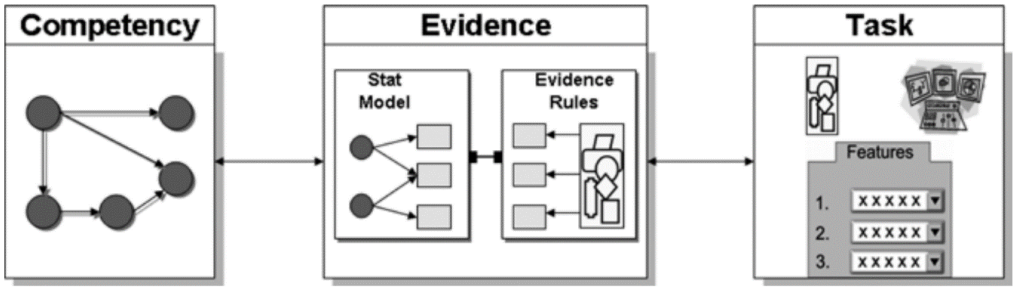


Figure 23: Main modules of an Evidence-Centred Design (Shute et al., 2010, p. 139)

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 steelHub pilot test to connect the skills and knowledge defined as part of skills requirements for the ESSA Continuous Casting Operator job profile and occupation, connecting 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 Database.

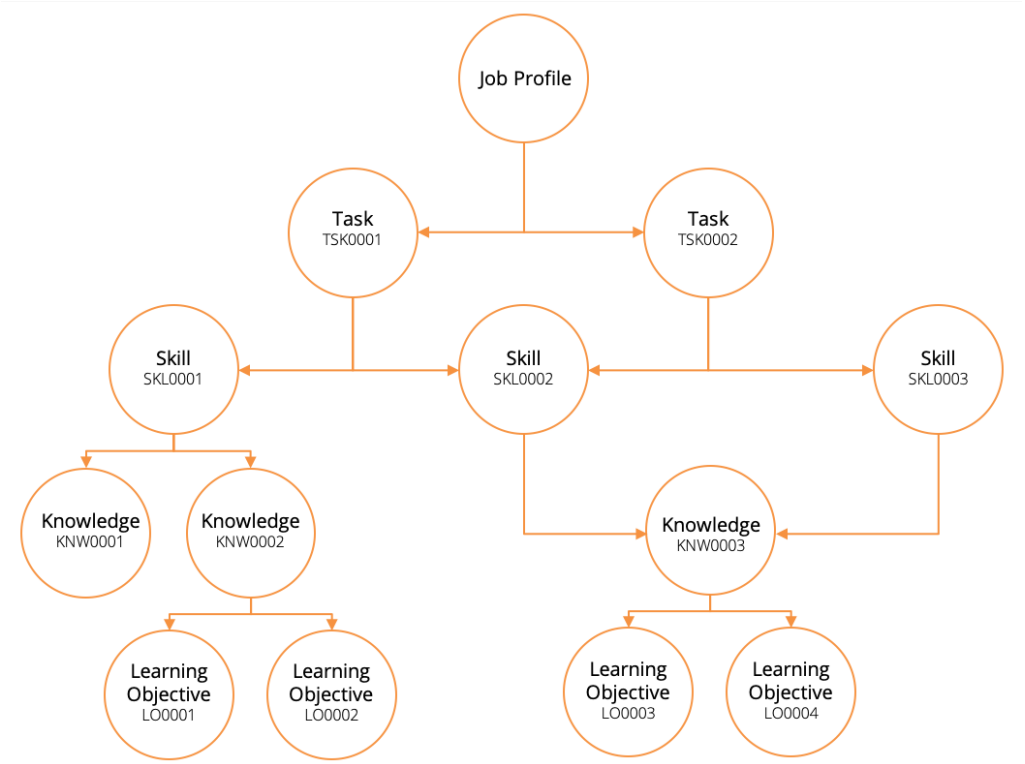


Figure 24: Flow chart for competency model

7.2.2 Example Digital Online Assessment (Technology-Based Assessment)

The training tools 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.

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 and use the link in the footnote for better reading) 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[27].

[27] https://filedn.com/lx5aRjQCjnjSpvs51MVE1CF/DrawIO/Continuous%20Casting%20Operator%20ver11.html

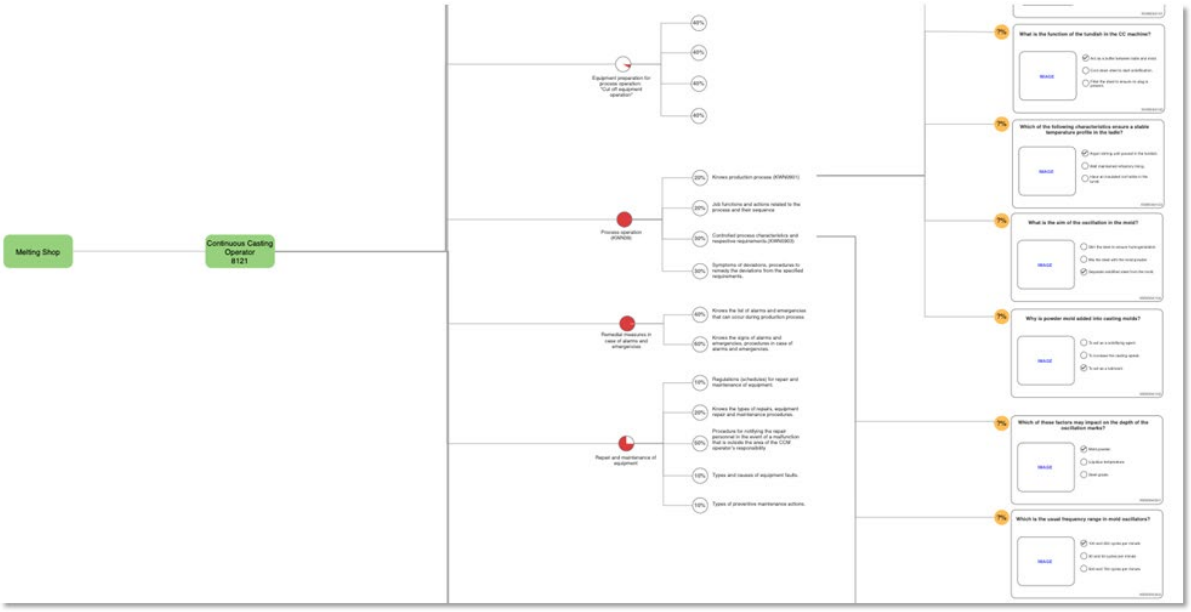


Figure 25: Learning outcome based competence map

The Continuous Casting Operator (8121) was selected for this pilot. The levels 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.

Test and Examination

The test and examination implemented has the intention to validate **knowledge** about Continuous Casting process, **aligned with skills** defined in the **Metal Processing Plant Operator** job profile. The 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[28] 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.

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

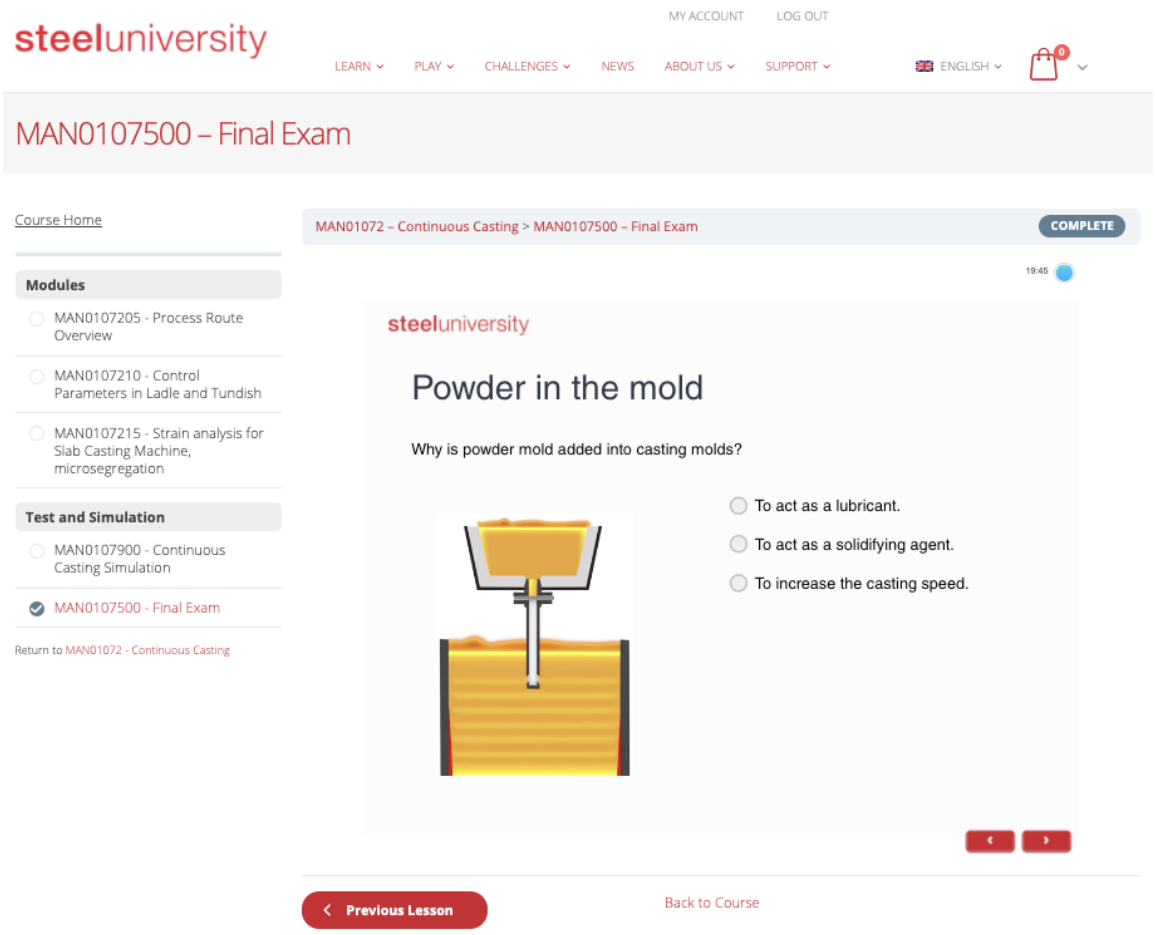


Figure 26: Example of a multiple-choice examination

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-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.

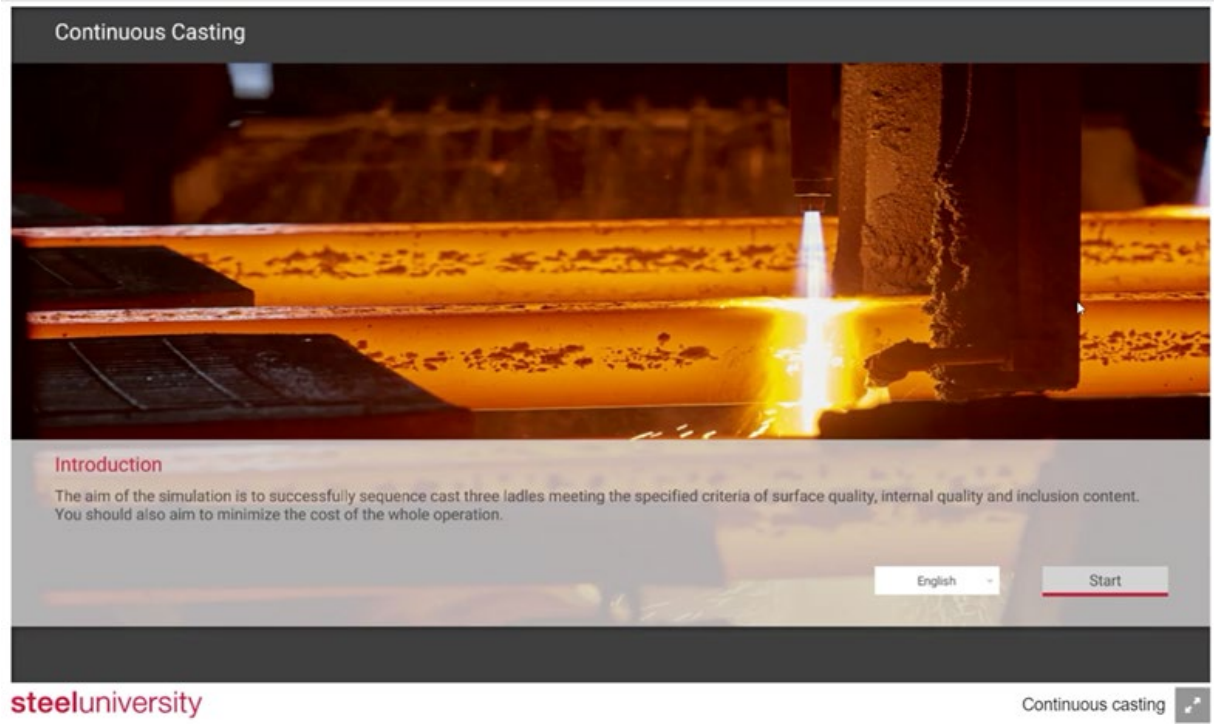


Figure 27: Continuous Casting Operation (pilot module)

The technology-based assessment using simulation is not just for assessment, but can be used also 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.

8 Integration in Learning Environments

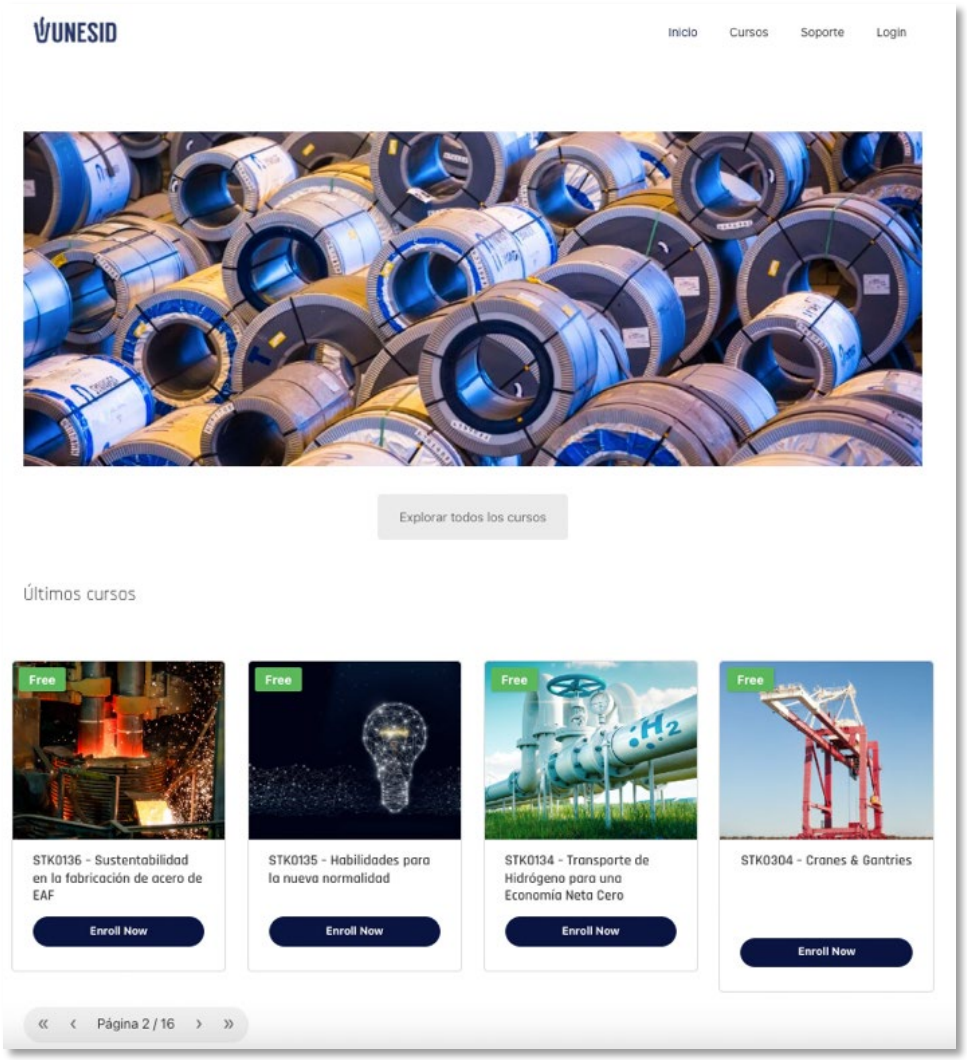
steelHub offers a flexible integration in learning environments to meet the unique needs of organizations of different size and type as well as individuals. The platform provides multiple channels to cover the different stakeholders needs. For individual and small groups of students, they can access to learning solutions in the steeluniversity website. On the other hand, for those companies, universities and schools without a Learning Management System (LMS), the learning solutions can be accessed from steelLMS, which is a custom platform with the branding, logos and colors of the organization. Finally, for those organizations with a Learning Management System, like Success Factor or Moodle, the content is embedded into their software suite thru the steelHub solution.

steeluniversity For Individual	steelLMS For Business	steelHub For Business
Online learning platform that offers a vast selection of Learning Solutions on a variety of subjects related to steel sector and related business, including technology, business, and personal development at affordable and accessible to individuals and small groups worldwide.	A white label learning management system (LMS) that allows small and medium organization to brand and customize a training platform with their own branding, logos, and colors. This means that the LMS appears to be a part of the organization's own software suite. Besides, the organization can get detailed tracking and reporting of employee progress.	The solutions are fully integrated into organization's own software suite (SuccessFactor, SumTotal, Moodle, among others). The content, format, and delivery of the training can be customized to meet the organization's unique requirements and assure a better fully integrated tracking and reporting of employee progress.

Table 2: Integration of Training Modules

Case Study – UNESID

As an example, the Spanish association UNESID used steelLMS to provide learning solutions to member companies at national level. This solution includes reporting tools to follow up the progress of learners and measure performance and effectiveness of the learning solutions. This solution provides also a good opportunity for Small and Medium Enterprises (SME) to up- and re-skilling their workforce. The platform is accessible with the link https://unesid.steeluniversity.org/. The following images are examples of the frontend and backend interphase.



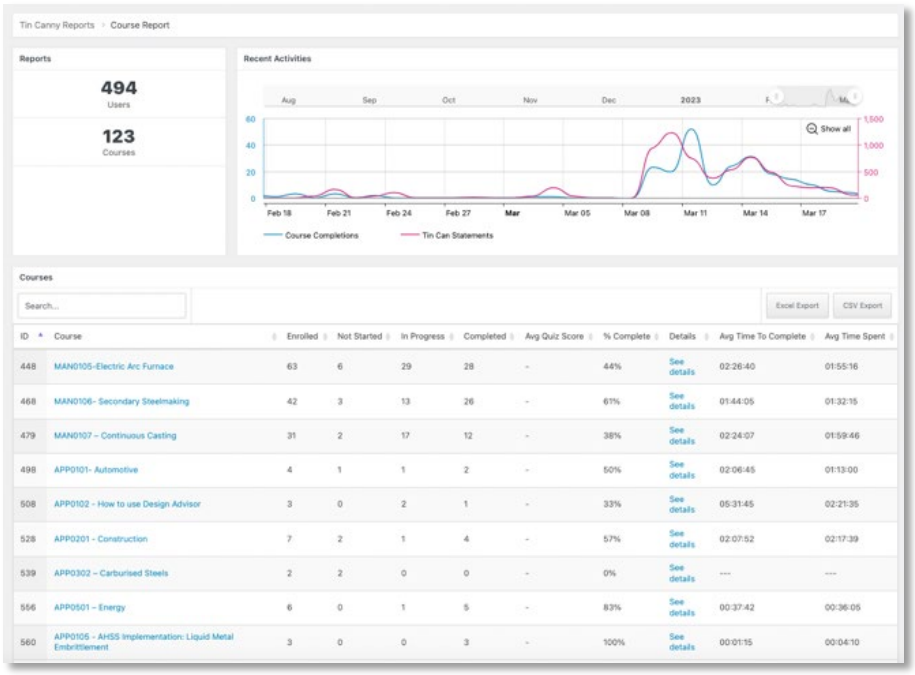


Figure 28: Integration of Training via steelLMS (Example UNESID)

9 Blended Training Path Example (Metal Processing / Continuous Casting Operator)

To better understand the steelHub an example of the implementation of steelHub, the game-based learning program "steelChallenge" of worldsteel will be outlined further. This learning program includes learners from the VET System and Industry as well as faculty members from the academy, research and industry for coaching and mentoring the participants.

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 learners are trained 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 outlining the blended learning arrangement, the focus on transversal skills, the audit tool for simulation, some analytics and the evaluation of the training experience.

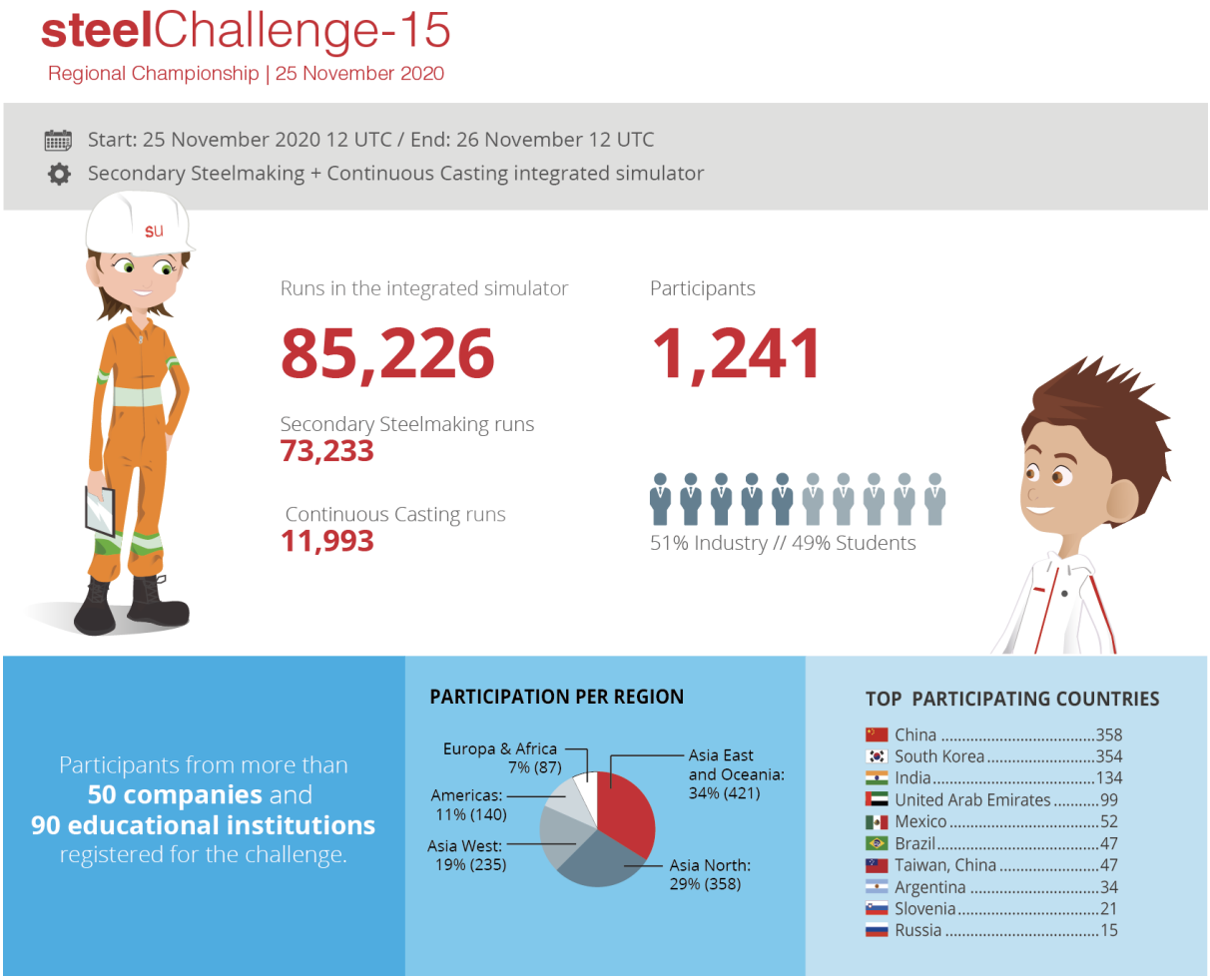


Figure 29: Infographic with the results of steelChallenge-15

9.1 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 by 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

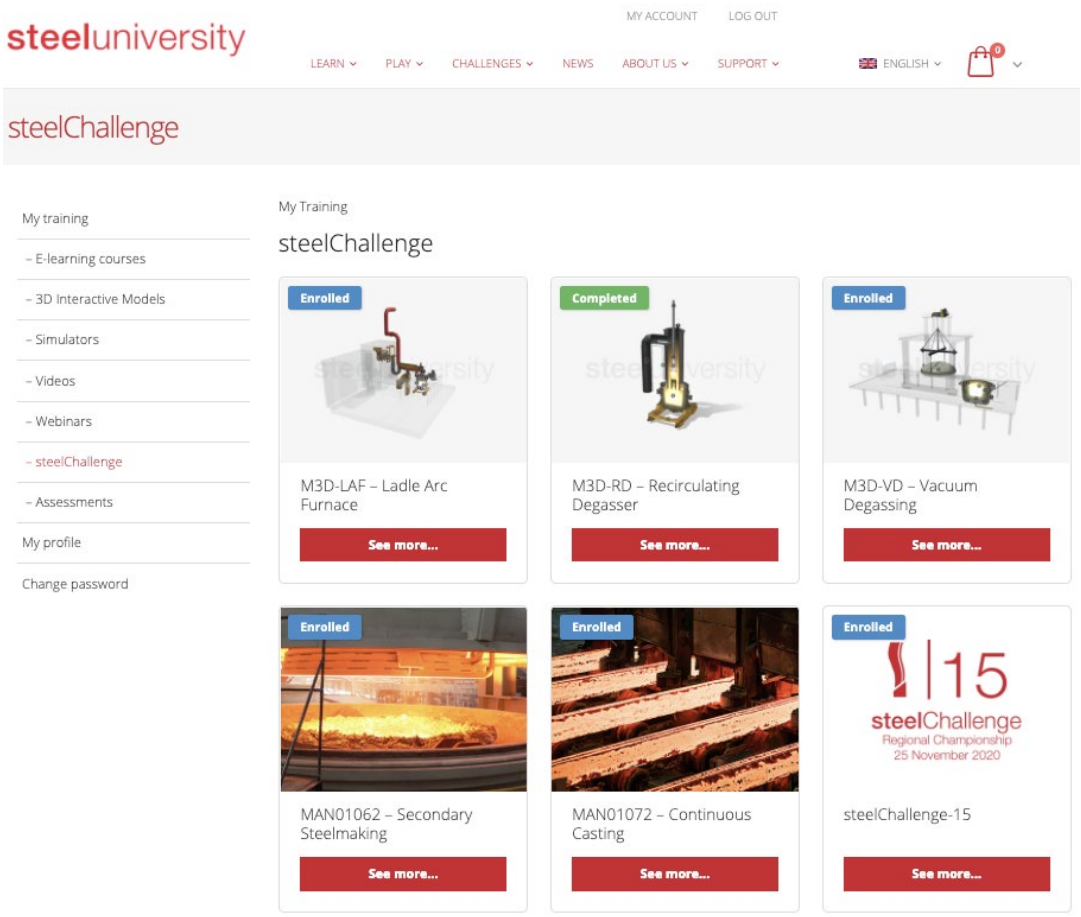


Figure 30: Screenshot of MyAccount of the steelChallenge (steeluniversity.org)

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 de-oxidation and reduction in H2, N2, and O2 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 31: 3D interactive model of a vacuum degassing[29]

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.

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

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

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[30], bloom[31], or slab[32] 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 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.

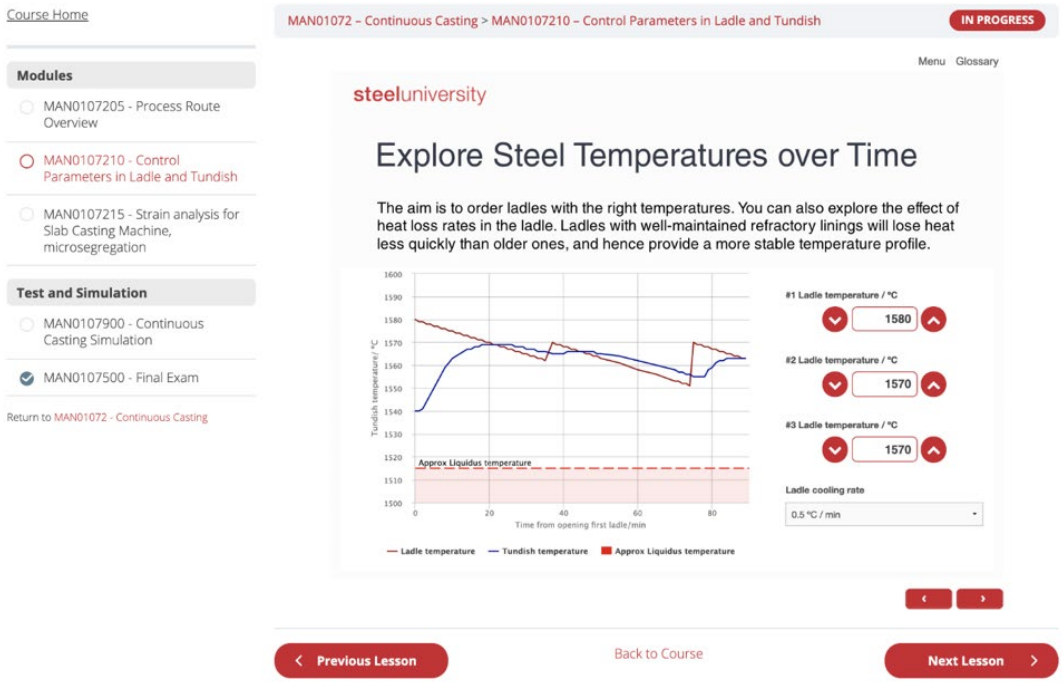


Figure 32: Interactive HTML5 exercise to understand temperature profile in ladle-tundish in Continuous Casting Process

[30] https://en.wikipedia.org/wiki/Billet_(semi-finished_product)
[31] https://en.wikipedia.org/wiki/Bloom_(casting)#Bloom
[32] https://en.wikipedia.org/wiki/Slab_(casting)#Slab

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[33].

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**).

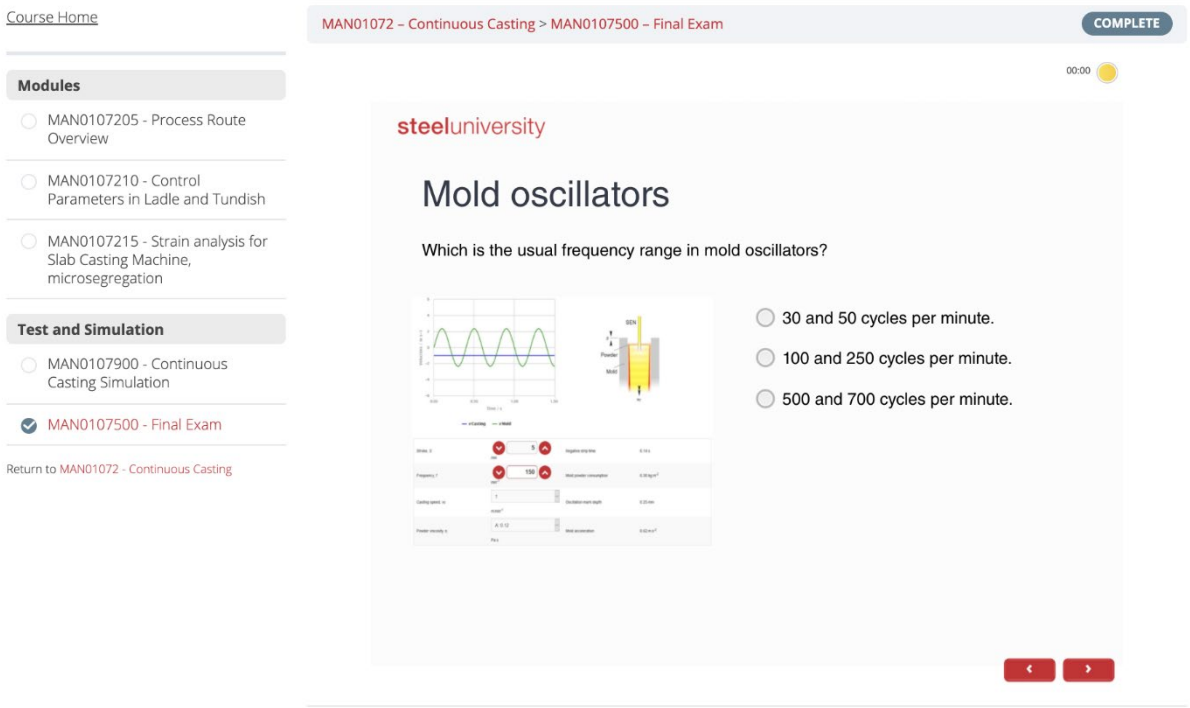


Figure 33: Example of a multiple choice using the HTML5 interactive tool

The modules are developed with a commercial tool, Articulate Storyline 360[34]. 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 tools 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

[33] https://en.wikipedia.org/wiki/Learning_management_system
[34] https://articulate.com/360/storyline

solution to the case study is the winner of the competition. The following figure shows the Learner Interphase into MyAccount at steeluniversity.org.

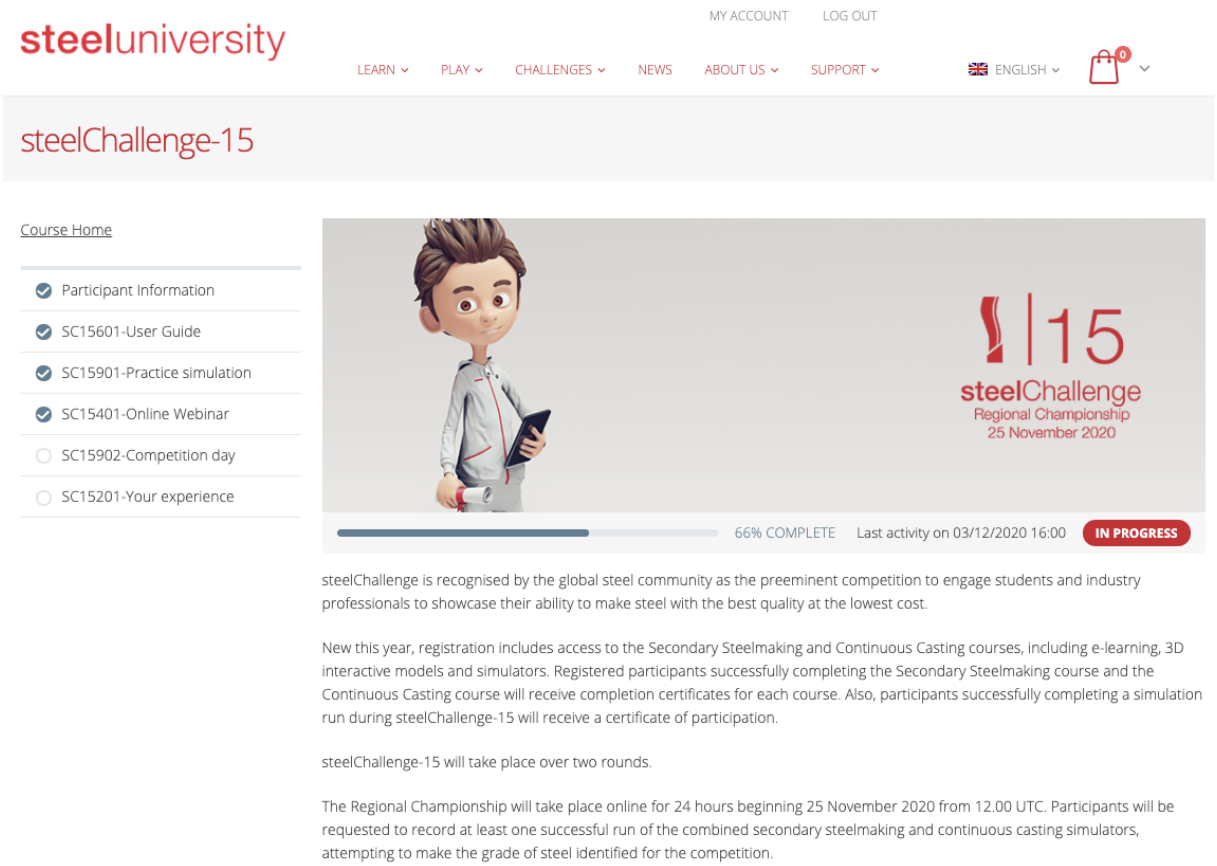


Figure 34: Learner interphase of 6th Step "steelChallenge"

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[35] and Continuous Casting Simulation User Guide[36] 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*

[35] https://content.steeluniversity.org/simulators/sc15/practice/ss/help/SSM_User_Guide_EN_v02.pdf

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

that include high-speed trains, for which steel grade R260Cr or 1.0911 is required.

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.

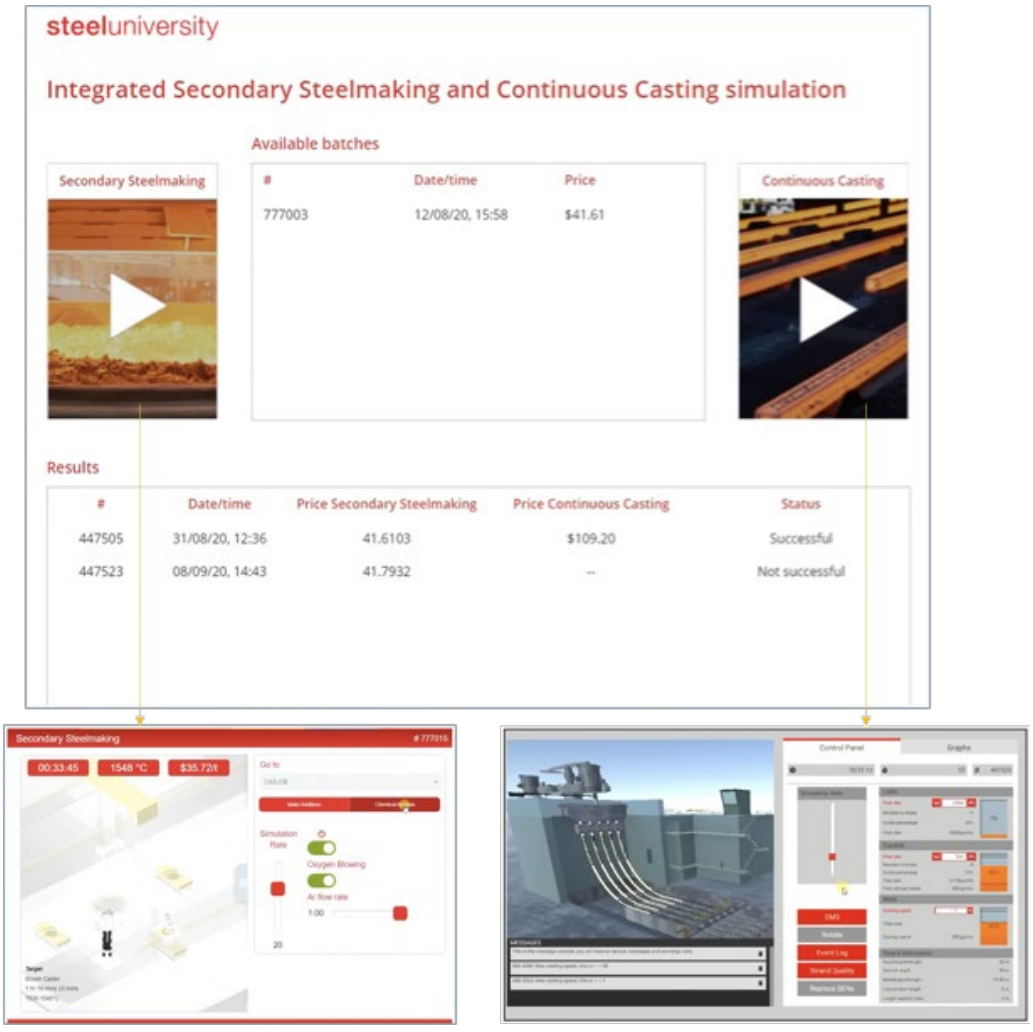


Figure 35: Secondary steelmaking and Continuous Casting Integrated Simulation

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.

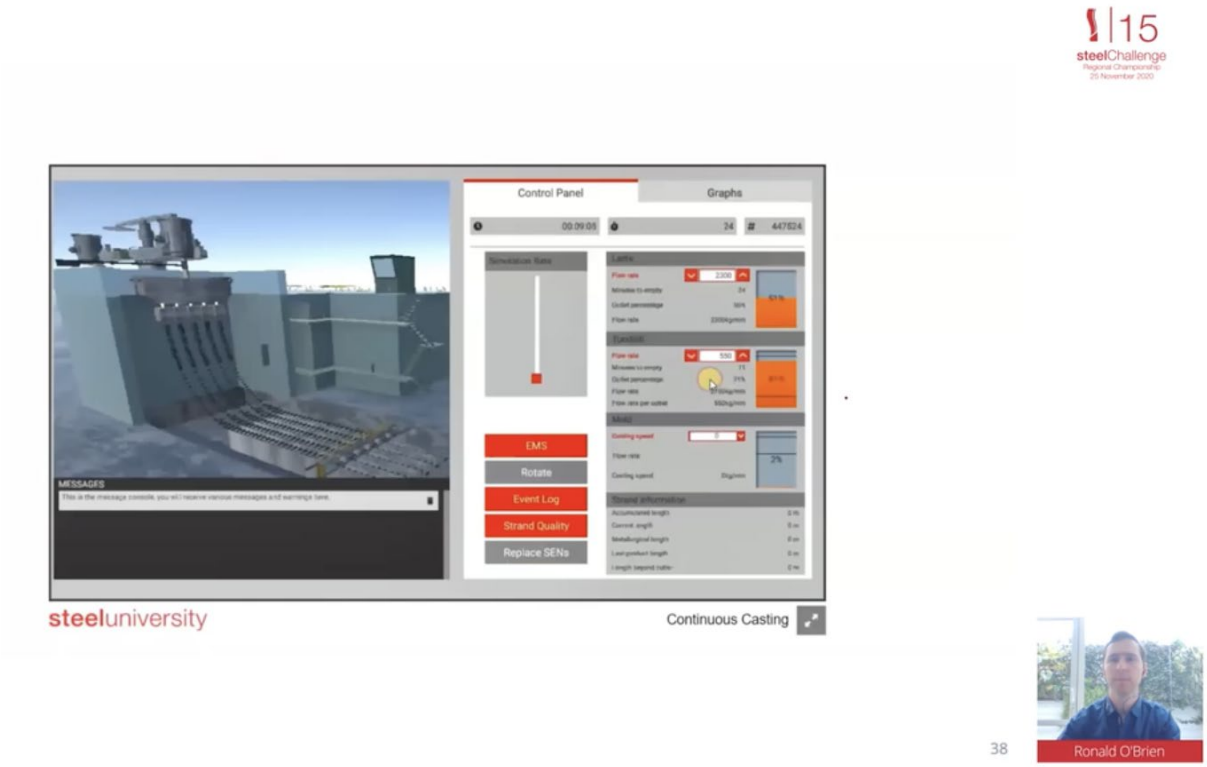


Figure 36: Expert Support for Continuous Casting Simulation

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.

9.2 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, and in line with the ESSA skills classification, 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.

9.3 Simulation Audit Tool

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 reconstruct the simulation. This can be used for teachers/trainers or instructors using simulation to create also their own competition to be used for motivation of the learners. It is important to mention that this tool does not 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 (see dashboard below).

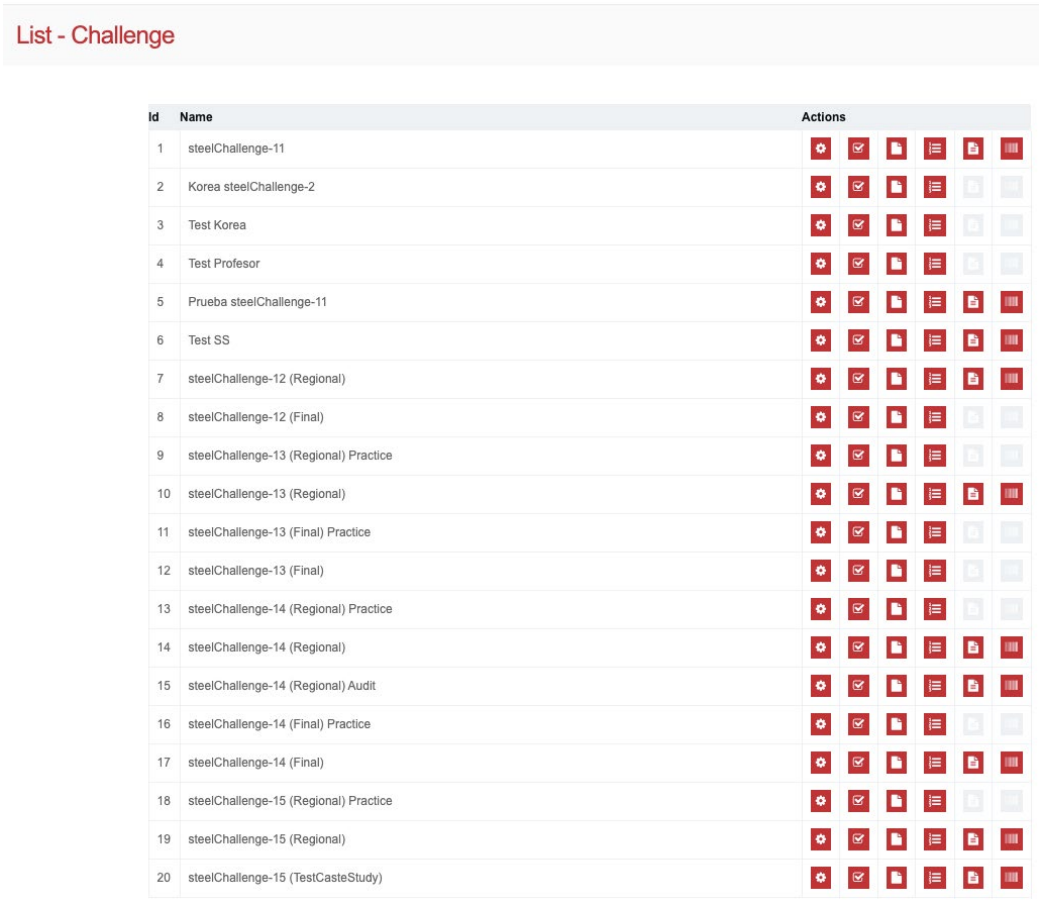
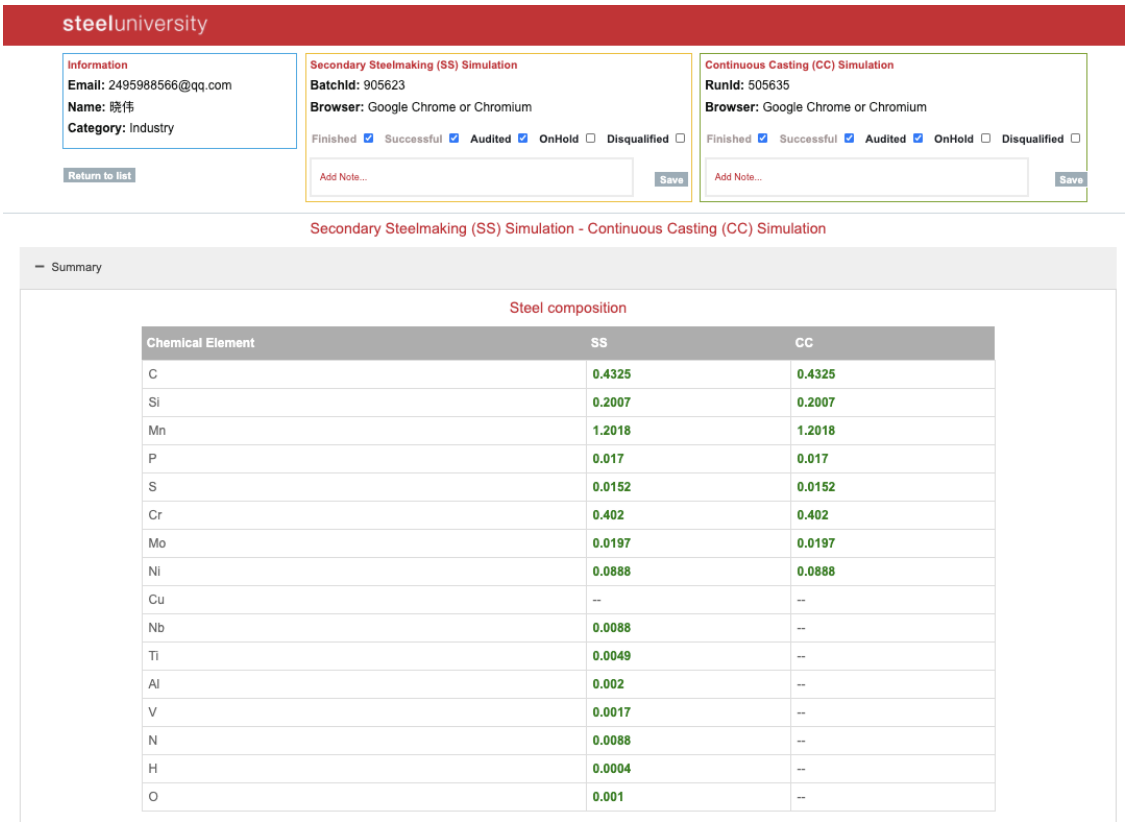


Figure 37: Dashboard of competitions

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.

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 and Continuous Casting 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 38: Simulation audit tool

9.4 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 39: 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.

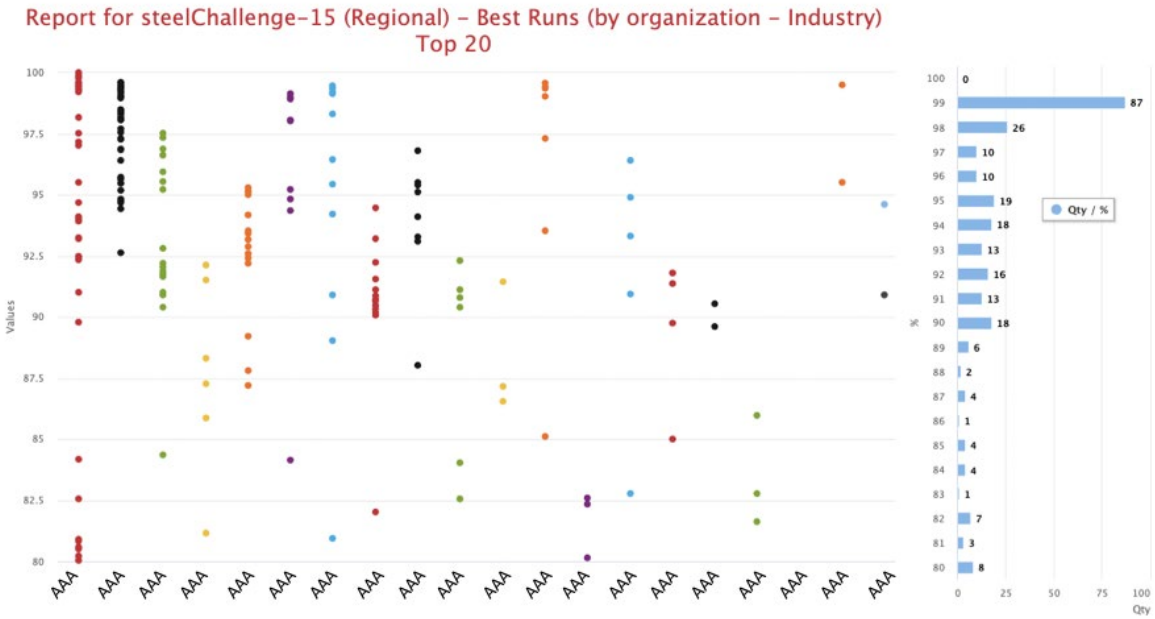


Figure 40: Level of achievement (in %) by the different participants of a company (AAA)

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.

9.5 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.

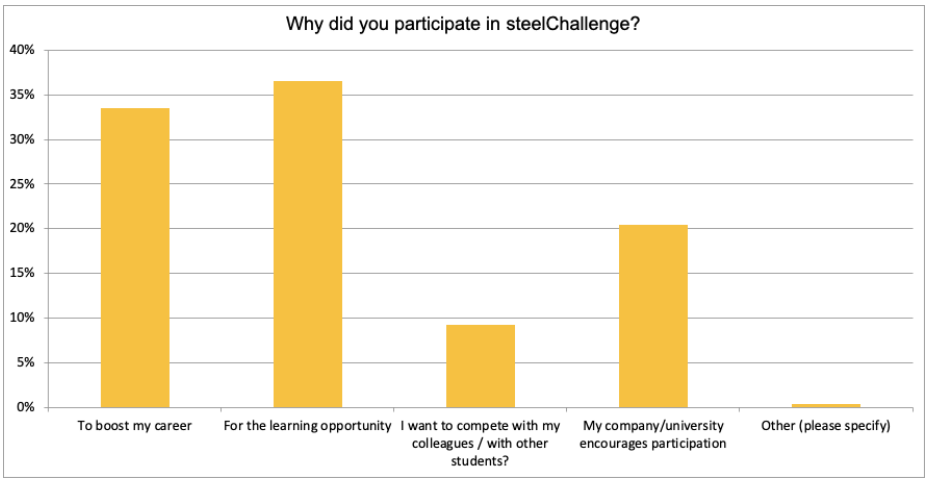


Figure 41: Results of the survey to the question "Why did you participate in steelChallenge?"

Annex

Figures

Tables

Abbreviations

Abbreviation	**Meaning**
ADDIE model	Analysis Design Development Implementation Evaluation model
CAF	Conceptual Assessment Framework
CaS-OB	Composition adjustment by Sealed argon bubbling – Oxygen Blowing
CM	Competency model
CVET	Continuing vocational education and training
EAF	Electric Arc Furnace
ECAR	Educause Center for Analysis and Research
ECD	Evidence Centered Design Methodology (
ECVET	European credit system for vocational education and training
EQAVET	European quality assurance in vocational education and training
EQF	European qualifications framework
ESCO	European skills, competences, qualifications and occupations
ESSA	European Steel Skills Agenda
H2	Molecular hydrogen gas
Hg	Mercury
HTML5	Hypertext Markup Language, fifth version
IVET	Initial vocational education and training
KWN	Knowledge
L&D	Learning and development
LMS	Learning Management System
LTI	Learning Tools Interoperability
MOOCs	Massive Open Online Courses
N2	Nitrogen
NOS	National Occupational Standards
O2	Oxygen
pre-VET	pre Vocational Education and Training
R&D	Research & Development
RTS	Regional Training Ecosystems
SCORM	Sharable Content Object Reference Model
SKL	Skill
SME	Small and medium-sized enterprises
VET	Vocational education and training
WP	Work package
xAPI	Experience application programming interface

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