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Report on the selection of skill simulators for the training of autistic individuals

Partrner: Learn Virtual Europe

Project 2023-1-HR01-KA220-VET-000157245

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Introduction

In this work package, our task is to explore simulation-based solutions that align well with the needs of individuals with autism and to examine the extent to which these solutions can be effectively integrated into school or specialized training environments.

In general, a good simulation is technologically reliable, accurate, and resilient to external disturbances. From a pedagogical perspective, it supports gradual and independent learning, provides feedback, and develops individual skills. Additionally, it can be easily integrated into educational settings and offers a cost-effective solution in the long term. All these aspects are further nuanced by the important findings presented by our project partners in the WP2 and WP3 work package reports.

The WP3 report especially emphasizes that autistic individuals do not form a homogeneous or generalizable group and questions the common assumption that STEM fields are the most natural career paths for them. Instead, it proposes a much more nuanced approach that considers individual strengths, interests, and possible co-occurring difficulties. It also highlights the fundamental importance of creating a personalized and inclusive environment. The report lists occupations that are well-supported by simulations and other assistive tools adapted to the needs of individuals with autism.

Building on the findings of WP2, we can say that by accepting the diversity of talents and interests of autistic individuals, we can move beyond narrow stereotypes and recognize the full spectrum of career options. This approach opens the way to more personalized and inclusive job roles where the work environment can be adapted to different strengths, preferences, and working styles.

Based on the above, this report proposes a two-stage training structure. This structure forms the backbone of the selection logic, which we supplement with other essential criteria.

The Role of Skill Simulators in Education

XR tools are increasingly widespread in vocational training, particularly in technical fields, where simulations improve the quality of training. Research is examining in which areas immersive methods are most useful, and what their benefits and limitations are. The prevalence of simulations is not uniform across manufacturing professions; they are more typical in areas such as shaping, forming, separating, joining, coating, and material property transformation.

Their introduction is typically decided by technical managers who prioritize economic benefits—productivity, energy efficiency, and quality. As a result, most simulators are used in areas such as assembly, machining, welding, disassembly, and liquid coating. There is also growing interest in fields such as woodworking, construction, forestry, and logistics, where the main goals are reducing health risks, optimizing material use, and improving training efficiency.

A good simulation tool in vocational education is not only a technological innovation but also an effective learning support tool—and must meet multiple criteria simultaneously. Below is a summary of what generally characterizes a good simulation in vocational training:

- A good simulation is **technologically reliable**, accurate, and stable in operation. The motion tracking system must provide accurate data—whether ultrasonic, magnetic, or optical. It should not be disturbed by external environmental factors (e.g., light, metal objects), and it should not require frequent recalibration or maintenance.
- It is essential that the simulation is **pedagogically well-structured**. It should not only provide a visually impressive experience but also include a learning structure that gradually develops students' skills. This includes a learning path, feedback system, and the ability to filter out incorrect movements. The goal is for the learner to acquire accurate, efficient motor coordination—even in the absence of a constantly present instructor.
- A truly useful simulation also supports **independent learning** and does not require the teacher's constant presence. This reduces staffing requirements and makes training more cost-effective in the long term. The simulation should be capable of supporting individualized development paths and assessing and improving learners' abilities such as concentration.
- A good simulation should be easily **integrated into the education system**. The manufacturer should have experience in the world of vocational education and be able to support the implementation of the tool, including online assistance if needed. The software should be suitable for measuring student performance and generating useful feedback for instructors.
- Finally, a good simulation is **a financially sound investment**. The focus should not be solely on the purchase price but on the total cost over its lifecycle: servicing, updates, and training costs are also important factors. The ideal solution ensures long-term stable and predictable operation.

In summary, a good simulation is not only a technically advanced tool, but a pedagogically, financially, and integration-wise well-thought-out, learner-centered system that provides genuine added value in vocational training.

Professions Supported by Simulation

As part of Work Package 3, we selected professions that fit the scope of the project. A joint decision was made regarding which of these professions would be supported through simulation. Below is a brief explanation of why these specific professions were chosen:

Welding:
Simulations in this area enhance manual skills as much as they develop concentration—an essential foundation for many other professions. Welding requires attention to detail and precision, which are strengths many autistic individuals possess. In such work environments, structured tasks and predictable workflows can support the successful integration of autistic employees.

Car Painting:
Car painting requires a high level of precision and attention to detail, which may align with the strengths of autistic workers. The structured nature and predictability of this type of work are advantageous.

Logistics:
We divided the logistics field into physical and cognitive tasks. Within logistics, precise data handling, organizational ability, and sensitivity to processes are especially important. These are skills many autistic individuals already possess, and they can be further strengthened through forklift operation training.

Logistics / Forklift Operation:
The physical processes—transportation and loading—can be effectively covered through forklift simulation.

Truck / Bus Driver:
Truck driving requires independence and commitment to routines. For autistic individuals, this work environment can be beneficial, as it involves fewer direct social interactions and highly predictable daily routines.

Heavy Machinery Operator:
Included for similar reasons as truck driving. This category includes cranes, agricultural machines, dump trucks, combines, and tractors.

Lab Assistant:
Laboratory work demands precision, attention to detail, and strict adherence to rules. These are areas where autistic individuals can excel. A structured work environment and clear expectations contribute to successful job performance.

In addition to the above, we consider the professions of **Auto mechatronics** and **Production Line Control and Maintenance** to be worthy of consideration.

Professional Criteria for Selecting Simulators Used in the Project

The goal of our project was to map the simulation-based educational systems and solutions available in various professions, and within this framework, we compared different simulators to identify the most suitable ones for the training and development of individuals with autism.

Industrial training holds particular importance today, as these sectors face severe labor shortages. However, traditional hands-on training methods come with several challenges: high costs, difficult-to-monitor learning processes, challenges in evaluating completed tasks, and measuring learners' progress.

Fortunately, digital solutions based on XR (Extended Reality) technology are now available. These systems can significantly shorten practice time, reduce training costs, improve the quality of training, and offer greater flexibility for instructors. In industrial vocational training, there are already many successful examples of the application of these simulation-based educational systems.[*Benus & Da Dalto*]

Selection Criteria

When selecting the most supportive system for autistic learners, we considered numerous unique aspects that helped us align with the specific needs of the learners as closely as possible.

Gradual Progression

A simulation that offers gradual progression should ideally allow learners to move at their own pace, with clearly defined stages and the ability to revisit earlier steps as needed. This pacing is especially important for autistic learners, who may require more time to process new information or feel comfortable before moving forward. Having visual or auditory cues that indicate progress can also help structure the experience and reduce uncertainty. Flexibility in pacing creates a learning space where the individual feels in control, which supports autonomy and self-confidence. Additionally, the presence of micro-level goals within each step can reinforce a sense of achievement and motivation, especially when tied to immediate, non-intrusive feedback.

Quality of the Evaluation System

An effective evaluation system should be transparent, consistent, and supportive of learning rather than judgmental. It must clearly communicate progress and areas for improvement in ways that are non-threatening and constructive. For autistic learners, evaluations that are tied to observable behaviours rather than abstract outcomes are often more meaningful. The use of visual feedback, progress bars, or simple affirmations like "You're improving!" can reinforce a sense of competence. Furthermore, a good evaluation system should offer opportunities for self-assessment and reflection, allowing the learner to be part of their own developmental journey. Minimizing pressure while still maintaining direction is key to maintaining both engagement and emotional well-being.

Modularity

A modular system supports adaptability by allowing educators and learners to tailor the content to their specific needs, interests, or abilities. For autistic learners, this means skipping overwhelming sections, repeating areas where mastery is needed, or even introducing certain modules in a preferred order. Modularity also supports a more personalized learning path, which can be crucial in fostering motivation and relevance. Additionally, educators can use the modular structure to scaffold learning over time, building on previously acquired knowledge or skills in a logical manner. The ability to insert new or updated modules without disrupting the whole system increases long-term sustainability and supports continuous development.

Gamification Features

Gamification can be a powerful motivational tool when used appropriately. For autistic learners, the key is to ensure that game elements like points, levels, and rewards provide positive reinforcement without adding pressure or overstimulation. Customizable gamification settings can help tailor the experience: for instance, turning off competitive elements or adjusting reward intervals to match individual preferences. When thoughtfully integrated, gamification can transform repetitive tasks into engaging challenges and provide tangible markers of progress. However, it's important that these features never distract from the core learning content or create anxiety—simplicity and consistency in design are often more effective than flashy or fast-paced elements.

Visualization

The visual presentation of a simulation plays a major role in user experience, particularly for autistic learners who may be sensitive to clutter, color contrasts, or visual noise. Clear, structured layouts that prioritize relevant information help maintain focus and reduce cognitive overload. Avoiding unnecessary animations or flashing elements is important, as is ensuring that characters, environments, and symbols are designed with realism or clarity in mind. Customizable visual settings—such as adjusting brightness, contrast, or background elements—can enhance accessibility. A visually calm environment does not mean dull; rather, it offers clarity and predictability, which in turn supports better attention and learning outcomes.

Nature and Strength of Developer Support

A supportive and accessible development team can make a major difference in the long-term usability of a simulation system. Regular updates, clear documentation, and responsive help desks contribute to reliability. For autistic learners, it's particularly helpful if developers can offer or support customization—whether that's adding new content, adjusting difficulty levels, or modifying sensory elements. Developers who engage with educators and users to co-design features tend to create more inclusive and effective tools. Moreover, strong support reassures educators that technical issues won't derail implementation, and that there's room for growth as institutional or learner needs evolve.

Resource Requirements

The more accessible a system is from a hardware and software standpoint, the more likely it is to reach diverse learners and educational settings. Systems that require high-end computers, VR headsets, or complex installations might be out of reach for many schools or families. Lowering resource requirements can democratize access, particularly in rural or underfunded areas. It also simplifies logistics for educators who may need to deploy the simulation across multiple devices or locations. When possible, web-based systems or lightweight applications reduce the dependency on physical infrastructure and make it easier to integrate into existing setups without additional investment.

Installability / Placement

Flexibility in where and how a simulation can be used opens up more opportunities for inclusive learning. Mobile or easily installable systems can travel between classrooms, therapy settings, or even homes, allowing for consistent practice in various environments. For autistic learners, familiar settings can reduce anxiety, so the ability to use a tool outside of a rigid, institutional space is valuable. Compact systems that don't require a lot of physical space or special accommodations also increase the likelihood that educators will adopt them. The easier it is to "plug and play," the more often and effectively it can be used.

Environmental Calmness

A simulation should be designed with sensory sensitivity in mind—this means avoiding loud, unexpected sounds, excessive background noise, or overly stimulating visuals. For autistic learners, a calm digital environment can reduce stress and support sustained engagement. Soundscapes should be adjustable or optional, and visual cues should be smooth and predictable. Providing control over sensory elements allows learners and educators to tailor the experience to individual comfort levels. The absence of distracting stimuli helps keep attention focused on the task and contributes to a feeling of safety, which is essential for effective learning.

Teacher Openness

The success of any educational technology depends significantly on the attitude of the educators implementing it. Teachers who are curious, open to innovation, and willing to learn are more likely to explore the full potential of the system and adapt it to their classroom needs. This openness also translates into better support for students, as teachers can model a positive attitude toward the simulation. If educators are sceptical or overwhelmed by the tool, its effectiveness may be compromised. Building in opportunities for teacher input, feedback, and shared practice can cultivate this openness and foster a stronger sense of ownership.

Expected Teacher Expertise During Training

A simulation system should be easy for educators to understand and operate without requiring a deep background in programming or educational technology. Clear instructions, intuitive interfaces, and minimal setup help lower the entry threshold, enabling a wider range of educators to use the system confidently. This is especially important in environments where professional development time is limited. When the system is easy to learn and use, teachers can focus more on guiding their students rather than troubleshooting or figuring out the technology. Optional advanced features can be provided for those who want to explore deeper functionality, but the basics should be straightforward and accessible to all. Option for trainers to be trained to enter their own working techniques into the simulator practice if possible. This allows the trainer to train his/her trainees with his/her own working techniques on custom training program during use the simulator.

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Explanation:
This allows the trainer to train the trainees with their own working techniques.

Excludability of Hazards During Training

Safety—both physical and emotional—should be a foundational design principle. Simulations involving movement or interaction must prevent physical strain or injury, particularly for learners who may have different coordination or spatial awareness. Equally important is psychological safety: the system should avoid exposing users to stressful, aggressive, or traumatic content, and should offer clear boundaries for participation. Including “pause” or “exit” options and allowing learners to take breaks without penalty can also contribute to a safer experience. By proactively minimizing potential hazards, the simulation becomes a more reliable and trusted tool for educators and learners alike.

Cost Savings Compared to Traditional Education

While the initial cost of simulation technology may be high, long-term savings can be realized through reduced material usage, less reliance on instructor-led sessions, and scalable deployment. Reusable digital content and automated feedback loops lower the demand for repeat instruction and printed materials. This makes simulation systems particularly appealing for institutions managing large groups or frequent training cycles. Over time, the investment can pay off not only financially but also in terms of learning quality and efficiency. It's also important to consider indirect cost savings, such as time saved in setup, reduced learner dropout, or quicker acquisition of key skills.

Environmentally Friendly Technology

Sustainability should be a key consideration in educational tools. Digital simulations that reduce the need for consumable materials (e.g., paper, chemicals, base metals, gases, wires, rods, sticks, row material, plastics, generally production oils, physical models, etc) naturally produce less waste. Energy-efficient systems that operate on low-power devices or through the cloud can also lower the overall ecological footprint. Thoughtful choices in hardware, packaging, and even software updates (e.g., avoiding bloated files or unnecessary upgrades) reflect an environmentally responsible approach. As awareness of ecological responsibility grows, having a simulation system that aligns with green values can be a compelling advantage for both funders and users.

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Support for Motor Coordination Development

Simulations that include physical interaction—whether through touch, motion sensors, or simple keyboard controls—can be valuable tools for practicing both fine and gross motor skills. For autistic learners, structured and repeatable motor tasks within a simulation offer a safe environment to develop confidence and coordination. Visual or auditory feedback on movement quality can reinforce learning and help track improvement. Additionally, because motor challenges often co-occur with autism, embedding developmentally appropriate physical tasks into cognitive learning can provide integrated support for multiple skill areas, enhancing overall functionality and independence.

Ease of Use

The interface of a simulation system should be clean, intuitive, and free from unnecessary complexity. For both learners and educators, ease of use reduces initial resistance and promotes longer-term adoption. Buttons should be clearly labelled, menus logically arranged, and instructions concise. For autistic users, the predictability and clarity of navigation can reduce anxiety and support greater independence. Help functions, tooltips, and guided tutorials can further lower the learning curve. A well-designed interface not only supports usability but also enhances learner confidence by enabling them to interact with the system successfully, even on their own.

Rental or Purchase Only

The availability of both rental and purchase options creates financial flexibility and can encourage institutions to try a system before fully committing. Renting may be more accessible for smaller organizations or pilot projects, while purchase options can offer better long-term value for high-use scenarios. Short-term rental can also be useful for testing different systems and gathering feedback before large-scale implementation. Offering both models respects the varying financial capacities and risk appetites of users, supporting broader adoption and experimentation, which is especially important when working with specialized learner populations.

These criteria are not strict rules, but serve as flexible, guiding frameworks for exploring development opportunities and solutions. In some cases, certain criteria may conflict with each other—for example, a system might offer strong modular development, but require significant resources to implement.

Selection Process

Our selection criteria were based on our valued project partners knowledge shared among us during the partner meetings and when selecting simulators suitable for autistic individuals we followed the procedure below:

We compiled the available and high-quality solutions within each professional field and ranked them based on the criteria described above. Each simulation was assigned a score, with the first five criteria receiving a higher weight. The Slavonski Brod Industrial and Commercial School in Croatia, with its 15 years of experience in training novice and professional welders with VWTS (Virtual Welding Training System) provided great assistance in mapping and selecting suitable welding simulators.

We used a rubric similar to the table shown in the image below for the analysis.

✅ **Simulation System Evaluation Checklist for Autistic Learners**

Each criterion includes a brief description and space to rate or comment on how well a given simulation meets it. You could use a scale (e.g., 1–5), checkboxes, or simple Yes/No/Partially ratings, plus a notes section.

Criterion	Description	Rating (e.g., 1–5 or ✓/✗/~)	Notes / Comments
Gradual Progression	Supports step-by-step learning at an individual pace; reduces anxiety with structured progression.		
Quality of Evaluation System	Provides clear, objective, and encouraging feedback that supports development.		
Modularity	Allows skipping, repeating, or customizing modules for flexible learning paths.		
Gamification Features	Engages learners with balanced game elements without overwhelming.		
Visualization	Clean, calm, and interpretable visual design free from unnecessary stimuli.		
Developer Support	Accessible, responsive technical and pedagogical support with openness to customization.		
Resource Requirements	Operates on accessible hardware with minimal technical demands.		
Installability / Placement	Can be used flexibly across locations; not tied to one fixed site.		
Environme			

The result of this process is the following list of simulators.

Simulation Tools Overview

Profession	Simulator	Description
Welder	Wave NG z'Space virtual welding motion learning system	An entry-level motion-based virtual welding motion learning system focusing on fine motor skill development and welding basics, ideal for foundational training.
Welder	Apolo WeldTrainer welding simulator	A VR welding simulator offering real-time feedback and multiple welding positions to improve technique and safety awareness.
Heavy Machinery Operator / Transport Vehicle Driver	TENSTAR Combination simulator	A modular platform supporting various vehicle types, including construction, agriculture, forestry and transport, all on one hardware setup.

Painter / Car Body Painter	SIMSPRAY painting/coating/abrasive blasting simulator	A VR training system for spray painting and coating techniques, with performance analytics to track paint thickness and coverage.
Forklift Driving / Logistics	Apolo Forklift simulator	Simulates realistic forklift operation scenarios, focusing on manoeuvring, safety, and load handling in warehouse environments.
Truck Driving	TENSTAR Truck simulator	Trains users in long-haul and city driving with customizable traffic and weather conditions to improve decision-making skills.
Tractor and Agricultural Heavy Machines	TENSTAR Tractor simulator	Offers realistic agricultural tasks like ploughing and harvesting, enhancing coordination and efficiency in farming operations.
Auto Mechatronics	MIMBUS Discover Car maintenance	Covers basic tasks like oil and tire changes, teaching learners how to use tools properly and follow eco-friendly practices.
Production Line Control and Maintenance	Virtual Indus Production line operator	Simulates a full-scale production environment where learners monitor processes, use control charts, and manage workflow interruptions.
Carpenter	WOOD-ED Table carpentry simulator	A tabletop simulator for woodworking safety and machine operation, ideal for teaching tool handling and precision cutting.
Logistics	MIMBUS Discover Logistics	Immerses users in warehouse operations—receiving, scanning, sorting, and dispatching parcels—while building navigation and workflow skills.
Lab Technician	MIMBUS Chemistry	Trains users in PPE, weighing, and handling hazardous materials through realistic virtual lab tasks like distillation and mixing.

Moving onward

Based on our cooperation and experience, training with simulation starts with a flat-screen simulation to develop coordination and concentration—essential skills for all professions. This tool is already used in Hungarian vocational schools and suits autistic learners through gradual, extended learning. In welding, a basic motion simulation is paired with a profession-specific simulator. Beginning with flat-screen formats allows smoother progression before using immersive VR. Broad adoption of XR tools supports cost-efficiency, sustainability, and safer training—especially important in hazardous fields—without increasing institutional costs, even when repetition is needed.

We Start by Developing Concentration

As a first step, we selected an entry-level, flat-screen welding training simulation to develop concentration skills. This game-like tool supports the acquisition of fine motor movements, makes progress in motor coordination measurable, and is already successfully used in several vocational schools across Hungary—not only for welding training but also as preparation for other professions. Coordination and concentration are fundamental in all trades—yet there are very few tools available to measure and monitor them.

This is why the selected simulation system offers an effective solution to this problem.

While simulation tools are already well-established in industrial vocational training, a slower and more gradual introduction is needed for autistic learners. This means that mastering the workflows may take more time, and the use of simulators should be planned for a longer duration compared to neurotypical learners.

For the field of welding, we recommend the combination of two tools:

- A **flat-screen welding motion development simulation** for developing basic skills (manual dexterity, coordination)
- A **welding simulator** for practicing profession-specific knowledge

We strongly believe that the flat-screen simulation designed to develop basic skills can be applied across all occupational groups. Therefore, we recommend using this solution as the first step in preparing autistic learners in every profession studied—before moving on to job-specific simulations.

The Principle of Gradual Progression

Whenever possible, we recommend starting simulation-based training in a flat-screen format. This ensures a gradual transition and helps learners move smoothly from basic skill development to more complex, profession-specific training. An additional advantage is that in a flat-screen environment, learners can spend more time practicing compared to intensive, immersive XR experiences, which place more strain on the eyes and brain and may lead to faster fatigue.

If a flat-screen version is not available for a specific profession, VR-based training can also be introduced—but this requires significantly more time, preparation, and careful planning.

A Few Thoughts on Sustainability

The more broadly we can integrate XR-based simulations into vocational training, the more sustainable the system becomes for training institutions. This not only helps reduce costs, but also lowers the ecological footprint of the training—for example, by reducing harmful emissions.

In the training of autistic learners, workplace safety is of particular importance. Occupational safety education can often be delivered in a simulated environment, which is especially important in hazardous professions. In this area, we must place special emphasis on raising awareness of things that might otherwise seem self-evident—such as the mandatory use of personal and collective protective equipment during welding, since the materials become extremely hot and can cause burns.

Last but not least, it is important that the training of autistic learners should not result in additional costs for the training institution, even if certain processes need to be repeated more often than usual in order to ensure successful learning.

Conclusion

In line with WP2 and TPM3, WP4 identified simulation tools tailored to selected professions—including lab technician, welder, carpenter, driver, and painter—aligned with future labour market trends. Simulation-based training offers autistic learners a safe, gradual, and effective path to vocational development. Flat-screen simulations help build concentration and motor skills and should precede immersive XR, which can cause fatigue due to sensory load. Training must balance simulation with real practice; optimal ratios range from 60–80% simulation, depending on the field. For autistic learners, longer simulator use and detailed, phased transitions to real environments are essential—especially for hazard awareness. Proper selection and pacing create inclusive, cost-efficient, and sustainable training that meets learners' individual needs without burdening institutions.

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