VR-Based Vocational Education and Training

“Instructional Design Models and Programs Development”

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1. PRESENTATION

This booklet was prepared as part of *the VRinVET (Virtual Reality in Vocational Education and Training)* project to empower vocational high school teachers not only in practical terms but also in theoretical and pedagogical foundations.

Its purpose is to help teachers gain a holistic perspective on curriculum development, instructional design, learning theories, and technology integration in VR-based vocational education.

VR technologies are ushering in a new era in vocational training:

- Students can experience complex production processes without taking risks,
- Teachers can bring sectoral innovations to the classroom through virtual environments.

This booklet provides teachers with the theoretical foundations to answer the questions “How can I teach?” and “Why should I use this model?”

VR-based education is not just a technological integration; it's also a pedagogical transformation. At the heart of this transformation lies *knowledge of instructional design. The VRinVET Project is an innovative vocational education project implemented within the European Union's Erasmus+ program.* The project's primary objective is to enhance learning experiences using VR technologies, increase the compatibility between the labor market and education, and develop teachers' digital pedagogical skills.

Project Goals:

1. Developing VR-based teaching contents in vocational education,
2. Building capacity for teachers on “VR pedagogy”,
3. Supporting skills-based learning in collaboration with the industry,
4. Strengthening the quality of vocational and technical education and its link to employment.

instructional design theories such as ADDIE, Kolb VR applications are powerful technological tools, effective learning only occurs when supported by the right pedagogical models (4C/ID, ASSURE, etc.) and provide teachers with:

- Clearly defining learning objectives,
- Structuring the content,
- Planning the evaluation,
- increase student motivation

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Education Element	Technology-Focused Approach	Theory-Supported Approach
Learning experience	Limited to audiovisual effect	Active, deep and permanent learning
The role of the teacher	Technology operator	Learning designer
Student role	Audience	Participant and producer
Conclusion	Smattering	Skill and competency acquisition

The European Union views vocational education as the "heart of the green and digital transition." In this context, policy instruments such as the European Skills Agenda, Pact for Skills, ESCO, and the Microcredentials Framework support strengthening the link between education and the labor market. In line with these policies, the VRinVET project promotes the integration of digital technologies into learning processes. Furthermore, the project aligns with CEDEFOP's emphasis on "Digital and Green Skills." The success of the digital transformation in vocational education depends on teachers leading the pedagogical transformation. VRinVET is designed to enable this leadership.

The booklet is organized into 10 interconnected chapters for step-by-step learning for teachers. This booklet helps teachers working in VR-based vocational training:

- Approach the educational design process consciously,
- To be able to turn theory into practice,
- to enable them to create innovative learning experiences in coordination with the sector

“Technology cannot replace a good teacher; but with the right instructional design, it can carry a good teacher into the future.”

2. INTRODUCTION TO CURRICULUM DESIGN

2.1 What is Curriculum?

The "curriculum" is not merely a list of course content; it is a comprehensive educational roadmap that determines the knowledge, skills, and attitudes students will acquire and through which methods. In short, the curriculum is a systematic plan that answers the questions of "what will be taught, how will it be taught, and when and how will it be assessed." In vocational education, the curriculum aims to equip students not only with knowledge but also with applicable skills. Therefore, an effective curriculum must balance both theoretical knowledge and practical learning opportunities.

“A well-prepared curriculum prepares students not only for exams but also for life.”

2.2 Components of the Curriculum

For a curriculum to be effective, the following five key components must be designed and constructed in a balanced manner:

Component	Definition	Example
Objectives	General objectives of the training program	To improve occupational safety awareness
Contents	Knowledge, skills and values to be taught	Electrical circuits, welding techniques
Methods and Strategies	How learning will take place	Demonstration, simulation, project-based learning
Measurement and Evaluation	How to measure learning	Performance task, rubric, post-VR scenario test
Feedback and Revision	Feedback for program improvement	Student and employer surveys

In VR-based training, the "Method" component is redefined through technology. Virtual environments offer students active participation, repetition, and error-free application.

2.3 Relationship between the European Qualifications Framework (EQF) and the Curriculum

The European Qualifications Framework (EQF) offers an eight-level structure defined by individual **learning outcomes .** This system is based on the question "what can the student **do?" rather than "what does the student know? "** 4

EQF Level	Definition	Example
Level 3–4	Post-secondary technical skills	Technician with a vocational high school degree
Level 5	Short-term higher education (Vocational School)	Applied technician
Levels 6–8	Bachelor's degree to doctoral degree levels	Engineer, expert

The curricula developed within the VRinVET project focus on competencies **at EQF level 4** , i.e., vocational high school level. At this level, students are expected to access information, understand processes, and **perform tasks responsibly.** Learning outcomes for each course should be written according to the EQF level; for example, "student can" statements are preferred. *(Example: "Student can safely operate a welding machine using VR simulation.")*

2.4 Competency-Based Curriculum Approach

Modern vocational training aims **to develop competence rather than simply memorize information** . Competence is the sum of the components of knowledge, skills, and attitude.

Element	Explanation	VR Example

Knowledge	Shows what you know	Identify welding machine parts
Skill	Shows what you can do	Performs welding operations in VR environment
Attitude	It shows how you behave	Works in accordance with safety rules

In this approach, success is measured not only by theoretical tests but also by student **performance on tasks** . Therefore, VR-based scenarios are one of the most powerful tools for competency-focused learning.

2.5 Curriculum Types and Areas of Use

Type	Feature	Area of Use
Comprehensive Curriculum	General framework covering all modules	Institutional level planning
Modular Curriculum	A specific structure for each skill	Vocational modules, short courses
Micro-Curriculum	Focused on a single learning outcome	Micro-credential programs

2.6 Principles to Consider in Curriculum Design

1. **It should be based on real needs** – The current and future demands of the industry should be analyzed.
2. **It should be student-centered** – Methods that will ensure active participation of the student should be preferred.
3. **It should be practice-oriented** – It should support students to learn by doing.
4. **It should be flexible and updatable** – It should be able to adapt quickly to technological changes.
5. **Must be linked to evaluation** – Each goal must have measurable indicators.

2.7 Curriculum Design in the Context of VRinVET

VR-based curriculum differs from the traditional classroom environment by:

- **Action-based learning** (learning by doing),
- **Experiential cycle** (Kolb),
- It focuses on **learning from errors** (fail-safe simulation) approaches.

This model enables teachers to redefine the learning environment:
The classroom is now the virtual production line; the laboratory is the simulation space; and assessment is digital performance analysis.

3. CURRICULUM PREPARATION PROCESS

3.1 Purpose and Scope of the Process

The curriculum development process is the phase in which educational institutions design new curriculum programs tailored to target audience needs, sectoral demands, and technological

advancements.
This process is not merely a document production process; it is also a quality cycle that continuously collects, evaluates, and updates data.

“Curriculum is not a plan that is prepared once and then abandoned, but a living organism that is constantly updated.”

3.2 Stage 1 – Needs Analysis
The first step in curriculum development is to answer the question , " **What knowledge and skills are actually needed? " This analysis should be conducted in three dimensions:**

Type of Analysis	Aim	Application Method
Educational Needs	What knowledge and skills does the student lack?	Pre-test, observation, survey
Institutional Need	Is the school's current curriculum adequate?	Program review, teacher meetings
Sectoral Needs	What are the expectations of the business world?	Employer interviews, professional chamber reports

In interviews with industry representatives, “which business processes can be taught with VR simulation” should also be questioned.

For example, high-risk processes such as “welding safety,” “machine calibration,” or “electrical fault detection” can be moved to a virtual environment.

3.3 Stage 2 – Learner Profile Analysis
An effective curriculum begins with knowing who students are, what they know, how they learn, and what motivates them to engage in learning.

Variable	Question to Ask	VR Example
Age group	What is the cognitive maturity level of students?	Interactive scenarios for ages 15–18
Preliminary information	What topics do they have basic knowledge on?	Determined by preliminary tests
Learning style	Is he a visual or kinesthetic learner?	VR environments are suitable for multisensory learning
Access to technology	How do they access VR hardware?	School laboratory infrastructure is examined

3.4 Stage 3 – Labor Market Analysis
business data should be included in the curriculum development process .

Information to be Collected:

- Most sought-after professions and skills
- New technological trends (e.g. automation, artificial intelligence, green production)
- Work accidents and security vulnerabilities
- What companies expect from interns and new graduates

Application Example:

A "VR occupational safety training" module can be created in collaboration with the local chamber of industry. This way, students can experience the risks they may encounter in the workplace in a virtual environment.

3.5 Stage 4 – Determining Learning Outcomes

Learning objectives indicate

what the student should be able to do by the end of the course . These objectives should be clear, measurable, and written with behavioral verbs.

A good learning objective:

1. **behavior** → "Defines," "Explains," "Applies," "Evaluates"
2. Indicates **the condition → "In VR environment", "Using simulation", "In real scenario"**
3. **success criteria** → "80% accuracy", "less than 5 minutes"

Target Level	Bloom Taxonomy Actual	VR Example
Information	Definitions	Identifies the welding machine components in the VR lab.
Skill	Applies	Applies the welding process in the correct order in the virtual environment.
Attitude	Warning	The VR scenario eventually detects and corrects the security rule violation.

3.6 Stage 5 – Content Selection and Ordering

simple to complex in a way that serves learning objectives .

Sorting Criteria	Explanation	VR Example
Difficulty level	First basic knowledge, then complex operation	"Material recognition" → "Assembly simulation"
Prerequisite relationship	A topic builds on a previous one	"Electrical safety" → "Wiring"
Order of application	Parallel flow to the actual business process	"Preparation" → "Application" → "Control"

Virtual scenarios reinforce student application skills as they transition between topics. Therefore, VR sessions should be included at the end of each unit.

3.7 Stage 6 – Evaluation Plan

Assessment determines whether learning has achieved its objectives.
In VR-based curricula, assessment and evaluation should be **performance-based** .

Evaluation Type	Aim	Example
Formative	Providing feedback during the learning process	Automatic scoring after VR scenario
Summative	Measuring success at the end of the unit	Performance task + quiz
Self-assessment	Student awareness of their own learning	“What did I do well?” form after the VR task
Employer evaluation	Observation in a real work environment	Post-internship feedback form

"We can't improve what we don't measure. VR data makes the invisible aspects of learning visible."

3.8 Quality Cycle of the Process

Once the curriculum preparation process is completed, continuous improvement should be achieved through the following quality cycle:

Plan → Implement → Evaluate → Revise

The curriculum development process requires both scientific analysis and creative design.
VR-based learning adds dynamism and realism to this process, enabling teachers to become innovative leaders in education.

4. CURRICULUM DEVELOPMENT AND IMPLEMENTATION

4.1 Purpose and Scope

Curriculum development is the process of **transforming a prepared outline into a learning process** .
The goal in this process is to equip students with the knowledge and skills defined in the objectives through appropriate teaching methods and materials. “Curriculum development is the transformation of a paper plan into a live learning experience in the classroom and in a VR environment.”

4.2 Pedagogical Foundations

An effective curriculum implementation takes shape at the intersection of three pedagogical axes:

The axis	Focus	Role in Application
Cognitive	Structuring of information	Student learning through understanding
Affective	Attitude and motivation	Professional awareness and self-discipline
Psychomotor	Skill practices	Manual dexterity, reflexes and coordination

VR technology activates these three axes simultaneously: the student thinks, feels and does.

4.3 Teaching Strategies and Methods

The methods to be used in implementing the curriculum should be selected according to the level of learning objectives.

Method	Definition	VR Application
Show and Make	Teacher demonstrates model, student repeats	Welding simulation – modeling
Problem-Based Learning	A solution is sought to a real problem	“Fault detection scenario”
Project-Based Learning	Student develops products	Mini design project in VR lab
On-the-Job Learning	Application in real/simulated environment	Completing a work task in a virtual workshop
Paired Learning	Cooperative learning	VR multi-user sessions

A lesson plan should include at least one “active learning” method (e.g., problem solving, discussion, simulation).

4.4 Integration of VR-Based Learning Environments

VR integration isn't just adding technology; it's redesigning the learning experience.

Step 1 – Selecting Appropriate Content

- Topics that will transform theoretical knowledge into practice are determined.
- Operations involving high risk or cost are prioritized for VR.

Step 2 – Script Writing

- Actual business process steps are defined.
- The goal, input, expected output and feedback are designed.

Step 3 – Pilot Implementation and Improvement

- It is tested with a small group of students.
- The scenario is developed through observations and feedback.

VR Integration Area	Aim		Example
Workshop Simulation	Gaining skills		Virtual welding workshop
Security Training	Reducing risk		Electric shock scenario
Maintenance and Repair	Teaching step order		Engine removal procedure
Social Skills Training	Communication and teamwork		Customer communication VR drama

4.5 Teacher Roles and Competencies

The modern teacher is no longer a transmitter of knowledge but **a learning designer and facilitator.**

Traditional Role	New Role (VRinVET)	Explanation
Source of information	Guide and coordinator	Guides the student
Grader	Evaluation designer	Creates performance rubrics

Narrator	Interaction designer	Manages VR scenario
Controller	Feedback coach	Interprets student learning data

A teacher's VR pedagogy skills are more important than their hardware knowledge. Learning design, not technology, determines success.

4.6 Strategies to Increase Student Participation

1. **Task-based learning:** Give each student a measurable task.
2. **Gamification:** Add points, badges, level systems.
3. **Pair work:** Create team tasks in VR groups.
4. **Real feedback:** Show student success instantly.
5. **Reflection:** Have them fill out a "what did I learn?" form at the end of each session.

4.7 Implementation Plan and Piloting

Every curriculum should be piloted before full implementation.

Stage	Duration	Responsible	Output
Planning	2 weeks	Teacher team	Pilot lesson plan
Pilot Application	3 weeks	Teacher + student group	Observation report
Evaluation	1 Week	Coordinator	Revision suggestions
Dissemination	Continually	School administration	Final curriculum

In VRinVET pilot studies, the "Virtual Safety Workshop" module was first tested with 20 students, and the scenarios were redesigned based on the feedback results.

4.8 Conclusion

The curriculum development and implementation process transforms theory into practice, planning into experience, and education into production.
VR technology is a tool that accelerates, visualizes, and measurably enhances this process.
Successful VRinVET implementation is possible with teacher leadership and active student participation.
"The value of the developed curriculum is measured by what the student can do in real life."

5. EDUCATION-EMPLOYMENT MATCH: BRIDGE BETWEEN SCHOOL AND WORKPLACE EXPECTATIONS

5.1 The Importance of Compliance

One of the fundamental goals of vocational and technical education is to develop **students with the knowledge, skills, and attitudes demanded by the labor market.** However, sometimes there can be a discrepancy between the knowledge taught in school and the qualifications sought in the workplace. This reduces graduates' employability and makes it difficult for employers to find qualified employees.

is critical
not only for individual employment success but also for **a country's economic efficiency, innovation capacity, and sustainable development goals .** Therefore, the principle of " **responsiveness to the needs of the business world** " should be at the heart of curriculum development processes.
The success of an education system is measured not by how well students learn, but **by how effectively they can apply what they learn in the workplace** .

5.2 Labor Market Signals

Education systems' ability to remain agile and up-to-date depends on **regularly collecting signals from the labor market** . These signals illuminate which skills will be prominent in the future, which technologies will gain priority, and which areas require the development of new competencies.

Source of information	Data Provided	Use in the Curriculum
Chambers of Industry and Commerce	Sectoral skill needs, technological trends	Adding a new module or updating it
İŞKUR / TÜİK / CEDEFOP Reports	Employment data, occupation-based statistics	Curriculum design based on demand analysis
Employer Interviews	Current professional expectations	Rewriting learning outcomes
Alumni Tracking System	Employment rate of graduates, job compatibility	Program effectiveness evaluation

Conducting focus group discussions with industry representatives at least once a year during the curriculum development phase ensures that workforce signals remain up-to-date.

5.3 Forms of School-Workplace Collaboration

To ensure sustainable education-employment alignment, **institutional and ongoing communication mechanisms** must be established between schools and the business world. These mechanisms should not be limited to internships but should extend throughout the entire learning process.

The main forms of cooperation:

1. **Internships and on-the-job learning:** Students have the opportunity to practice their skills by working in a real production environment.
2. **Industry advisory boards:** Business representatives actively participate in curriculum committees.
3. **Virtual and real project partnerships:** Schools and businesses jointly produce VR scenarios or simulation-based solutions.
4. **Business teaching model:** Teachers directly experience technological innovations by working in workplaces for certain periods.

5.4 Strengthening Adaptation in the Context of VRinVET

The VRinVET project serves as
an innovative bridge to strengthen the education-employment relationship. Virtual reality (VR)

technology provides students with **risk-free and repeatable learning experiences that mirror real-world workplace environments** .

This way, students will:

- Can observe complex production processes,
- You can learn occupational safety protocols in practice,
- Can experience the working principles and maintenance processes of machines.

For teachers, VR environments become **a practical tool for integrating business technological innovations into their lessons** , thus synchronizing theoretical instruction with the real-world demands of the industry.

Application Example:
Through the “VR Welding Training Module”, students gain the manual skills required in the workplace while at school by repeatedly practicing the welding process in a virtual environment.

5.5 Conclusion and Policy Message

The alignment between education and employment determines not only the quality of education but also **the competitiveness of countries** . The VRinVET project uses virtual learning environments to establish
a measurable, data-based, and sustainable connection between schools and businesses .

In this context:

- Teachers should constantly interact with sector representatives in curriculum design,
- Reflecting the digital transformation processes of the business world into course content,
- Aligning VR-based learning scenarios with real workplace tasks
  forms the basis of the future of vocational education.

"No matter how modern the education, if graduates cannot find jobs, the success of the system must be questioned. True harmony begins when the bridge between the classroom and the factory is built."

6. MEASUREMENT AND EVALUATION OF LEARNING

6.1 Concept of Measurement and Evaluation

Measurement is the process of **determining student performance with numerical or qualitative data** ; evaluation is the comparison of these measurement results **with the set goals.**
In an effective vocational training program, measurement and evaluation are carried out not only to “test knowledge” but also to **understand and improve the quality of learning** .

“Assessment is not the end of learning, it is the beginning of improvement.”

6.2 Types of Measurement

Type	Aim	Time of Use	VRinVET Application
Formative	Guiding the student throughout the process	During the course	Instant feedback during VR scenario
Summative	Measuring the level of success	At the end of the unit or term	Performance testing or project presentation
Diagnostic	Determining the level of prior knowledge	At the beginning of the training	Preliminary VR module testing
Self assessment	Student monitoring of their own learning	At the end of each VR session	Digital survey or reflection form
Peer Review	Feedback between students	Group work	Scoring after VR team missions

Formative assessment is most effectively implemented in a VR environment; the system instantly points out student errors and reinforces learning.

6.3 Evaluation Process Steps

1. **Determining the goal** → What will be measured? (Knowledge, skills, attitude)
2. **Selection of measurement tool** → Test, observation form, VR scoring system
3. **Data collection** → Student performances, session recordings
4. **Data analysis** → Success rate, error type, duration, number of trials
5. **Feedback** → Student-specific development suggestions
6. **Improvement** → Update on curriculum and teaching strategies

Suggestion for Teachers:

An automatic report should be printed at the end of each VR module; the report should include the student's success rate, the number of errors made, and suggestions for improvement.

6.4 Measurement Tools and Methods

Vehicle	Explanation	Advantage	VR Example
Rubric (Graded Scoring Key)	Scores performance against specific criteria	Provides objectivity	"Did he follow the safety rules while welding?"
Checklist	Marks whether tasks are completed	Easy to apply	Step-by-step progress control in the VR session
Performance Task	Product or application is expected from the student	Measures real skill	"Circuit assembly" task in VR environment
Digital Tests	Measures the level of knowledge	Automatic scoring	Mini test after VR module
Portfolio	File documenting student development	Provides process evaluation	Student files VR reports

Assessment tools should be mixed, not uniform. Knowledge tests complement skills, and performance tasks complement application.

6.5 Rubric Design (Performance Evaluation Criteria)

Criterion	4 – Perfect	3 – Good	2 – Needs to be improved	1 – Weak
Preparation	All necessary equipment is ready	There are minor shortcomings	There are some deficiencies, completed with help	Unprepared
APPLICATION	Performed the operation in the correct order	He made small mistakes	Completed with help	He made a mistake in the process
Security	He followed all the rules	Corrected with warning	He broke some rules	He committed a serious violation
Time Management	Effective and planned	Small delay	He used too much time	Timeout

VR Example:
In the "Virtual Electric Panel Installation" scenario, the student is evaluated with this rubric; the system automatically calculates the score.

6.6 Learning Data Analysis in VR Environments (Learning Analytics)
VR applications enable digital tracking of learning progress.
The data collected gives teachers a new perspective on student progress.
Data that can be collected:

- Task completion time
- Number of successful attempts
- Error types and frequency
- Student's in-VR navigation behaviors

Areas of Use:

- Individual feedback to the student
- Adjusting the difficulty level of the curriculum
- Redesign of teaching strategies

Example: If 60% of students in the "VR Safety Training" session made mistakes on the same safety step, this indicates a conceptual gap in the content.

6.7 Feedback Loop
Effective evaluation **is complemented by feedback.**

Feedback Type	The time	Effect
Immediate	During the VR scenario	The student corrects the mistake immediately
End of Process (Session feedback)	At the end of the session	Sees student overall performance
End of Term (Summative)	At the end of the unit	General development is evaluated
Peer Feedback	In group work	Develops cooperation and self-awareness

Feedback is not just a score, it is a “guidance tool” that directs learning.

6.8 Continuous Improvement Cycle

The VRinVET evaluation approach works with **the Plan – Do – Measure – Improve (PDCA)** logic.

1. Plan: Determine measurement criteria
2. Apply: Train student in VR environment
3. Measure: Collect data, evaluate performance
4. Improve: Update curriculum, close feedback loop

“Measurement in education is not just about giving grades; it is about making learning visible and development possible.”

7. USE OF TECHNOLOGY IN EDUCATION

7.1 The Importance of Integrating Technology into Education

on how that content is delivered through technology .

The use of technology in education allows students to not only hear information but also **analyze and reproduce it** .

“Technology doesn't replace the teacher, but it does make a good teacher much more effective.”

7.2 Evolution of Educational Technologies

Period	Technological Transformation	Impact on Education
1st Generation (1970–1990)	TV, video, overhead projector	Visually supported teaching
2nd Generation (1990–2010)	Computer, internet	E-learning, distance education
3rd Generation (2010–2020)	Mobile devices, LMS systems	Blended learning
4th Generation (2020–present)	VR, AR, artificial intelligence, digital twin	Experiential, data-driven learning

Fourth-generation technologies enable students to become **active participants , not just observers** . When learning through VR simulations is combined with AI-powered analytics, instruction becomes more personalized.

7.3 VR (Virtual Reality)

Definition: VR is a learning environment where students actively interact with each other in a computer-generated, three-dimensional environment, similar to a real-world experience.

Advantages:

- Teaches high-risk transactions safely
- Increases student motivation and attention
- Concretizes complex concepts
- Provides "Experiential Learning"

Application Area	VRinVET Example
Technical training	Engine assembly simulation
Job security	Security testing in a high-risk environment
Electrical-electronics	Circuit connection practice
Health and care	Patient care scenario

VR sessions should be short (10–20 min) and goal-oriented, followed by discussion/feedback.

7.4 AR (Augmented Reality)

AR is a technology in which digital elements (3D models, information, directions) are superimposed on the real world image.

Advantages:

- Combination of real environment and virtual information
- Direct interaction of the student with the environment
- Easy access with mobile devices

APPLICATION	Example
Introduction of mechanical system parts	Label parts by holding the phone camera over the engine
Laboratory training	3D visualization of chemical reactions
Technical drawing lesson	Layered 3D model review

7.5 MR (Mixed Reality) and Digital Twin Technologies

Mixed Reality is a hybrid environment where virtual and real objects interact simultaneously.

A Digital Twin is the creation of a virtual replica of a physical system.

💡 **Application Example:**

By creating a digital twin of a production line, students simulate line optimization in a VR environment. This allows them to analyze the production process and measure efficiency.

7.6 TPACK Model: Technological Pedagogical Content Knowledge

TPACK (Technological Pedagogical Content Knowledge) describes the teacher's integration of technology with **knowledge (content)** and **pedagogy (teaching)** .

Component	Explanation	VRinVET Application

CK (Content Knowledge)	Knowledge of the subject to be taught	Electrical safety, welding techniques
PK (Pedagogical Knowledge)	How to teach	Demonstration, project-based learning
TK (Technological Knowledge)	Knowledge of using technology	Managing VR simulations
TPACK	Combination of three pieces of information	Integrating the VR scenario pedagogically and technically

"Technology is not independent of pedagogy. VR is just a tool; the real impact is in how the teacher uses it.

7.7 Digital Competencies of Teachers (DigCompEdu Framework)

The European Commission's **DigCompEdu Framework** defines teachers' digital competences along six dimensions:

Dimension	Explanation	VRinVET Relationship
1. Professional Participation	Sharing in digital communities	Participation in the VR teacher network
2. Digital Resources	Creating and sharing digital content	VR scenario production
3. Teaching and Learning	Providing effective learning with technology	Simulation-based course
4. Evaluation	Measuring with digital data	VR learning analytics
5. Student Empowerment	Increasing participation and motivation	Interactive VR experience
6. Student's Digital Competence	Development of digital skills	Teaching safe digital behavior with the VR module

Every teacher developing a VR module should include these six dimensions in their personal development plan.

7.8 Learning Management Systems (LMS) and VR Integration

LMS (Learning Management System) are digital platforms that enable the planning, execution and monitoring of education (e.g. Moodle, Google Classroom, KUZEM, etc.).

With VR Integration:

- VR sessions can be assigned via LMS
- Student performance is automatically recorded
- Feedback reports are stored in the system
- A micro-certificate or "badge" may be issued automatically.

7.9 Challenges in Technology Integration

Difficulty	Explanation	Solution
Lack of infrastructure	Hardware, internet or software inadequacy	Shared VR labs
Teacher qualifications	Lack of experience in using technology	In-service training, VR pedagogy workshops
Time management	Duration of VR sessions	10–15 minute mini scenarios
Lack of motivation	Student sees VR as a “game”	Increasing focus with educational feedback

7.10 Conclusion

Using technology in education isn't just about understanding digital tools; **it's about understanding them pedagogically and using them in a way that aligns with your goals.**

VRinVET teachers are pioneers of this transformation:

- They combine technology with pedagogical basis,
- They put the student in an active productive position,
- They transform education into a process that is not only watched but **also experienced .**

“Technology does not make learning easier; when used correctly, it deepens learning.”

8. INSTRUCTIONAL DESIGN MODELS AND THEORIES

8.1 Why Instructional Design Models?

Instructional design is the art of systematically planning, implementing, and evaluating the learning process.

Models allow teachers to manage this process on a scientific basis.

“The model is the teacher's road map; technology makes that map visible.”

8.2 ADDIE Model (Analysis–Design–Development–Implementation–Evaluation)

Scope: This is the most widely used systematic model.

Stages:

1. **Analysis:** Needs and goals are determined.
2. **Design:** Learning objectives, strategies and measurement tools are selected.
3. **Development:** Content, VR scenarios or materials are prepared.
4. **Implementation:** The training program is implemented.
5. **Evaluation:** The process is analyzed formatively and consequentially.

Strengths	Irritability	VR Application
Systematic, easy to follow	It may take a long time	VR resource module development plan

Each phase of ADDIE can be applied when developing a VR scenario: start with analysis, develop, test, evaluate.

8.3 Experiential Learning Theory (David Kolb, 1984)

Key Idea: Learning occurs through experience.

The cycle:

1. Concrete Experience
2. Reflective Observation
3. Abstract Conceptualization
4. Active Trial

Advantage	VR Application
The student is active in learning	Students learn by doing a task in VR (e.g. "welding practice")

Kolb's cycle perfectly matches the nature of VR: the student tries, observes, thinks, tries again.

8.4 Dick and Carey Model (System Approach Model)

views teaching as **a system ; each phase is dependent on the others.**

Stages:

1. Determining learning objectives
2. Student analysis
3. Transforming goals into performance indicators
4. Selection of teaching strategy
5. Preparation of teaching materials
6. Formative assessment
7. Summative evaluation

Strengths	Irritability	VR Application
Analytical and structured	It has low elasticity	Performance analysis design in VR curriculum

8.5 Cognitive Apprenticeship Model

Key Idea: This is the extension of the master-apprentice model to the cognitive dimension. Students learn complex tasks under the guidance of an expert.

Steps: Modeling → Coaching → Feedback → Reflection → Implementation

Advantage	VR Application
Learning is a social process	Students watch the expert role model in VR, then try it out

In the "Virtual Mentor" scenario, the student watches the master in VR and then practices the same process himself.

8.6 Rapid Prototyping Model

Scope: Designed to accelerate the development process.

The model adopts a "build first, fix later" approach.

Steps: Create a draft → Test → Feedback → Revision

Strengths	VR Application
It saves time	A rapid prototype version of the VR module is prepared and tested

Use Case: Ideal for short-term projects or testing new VR content.

8.7 4C/ID Model (Four Component Instructional Design)

Purpose: Effective in teaching complex skills.

Components:

1. Learning Tasks
2. Supporting Information
3. Process Information
4. Part Task Application

Strengths	VR Application
Structures complex skills	"Engine assembly" VR simulation: includes information + practice + support step

8.8 ASSURE Model

Focus: Emphasizes the appropriate use of media and technology in instructional planning.

Stages:

1. **A** – Analyze Learners
2. **S** – State Objectives
3. **S** – Select Media and Materials
4. **U** – Utilize Media
5. **R** – Require Learner Participation
6. **E** – Evaluate and Revise

Strengths	VR Application
Focused on technology integration	Planned selection and use of VR content

The ASSURE model can be used as the basic framework for VR lesson plans.

8.9 WISCOM Model (Wisdom–Skills–Competence–Motivation)

Philosophy: Emphasizes the impact of wisdom and motivation on learning beyond knowledge and skill .

Component	Explanation
Wisdom	Learning from experience
Skills	Application skills

Competence	Professional qualifications
Motivation	Intrinsic desire to learn

VR Example:
"Decision making with real scenarios" modules build professional wisdom and intrinsic motivation in the student.

8.10 TPACK–IDDR Model
This model combines **the Technological Pedagogical Content Knowledge (TPACK)** framework with **the Instructional Design Decision Reflection (IDDR)** process.

Stage	Explanation	VR Application
Determining Design Decisions	Which technologies serve which goals?	VR security module selection
APPLICATION	Testing decisions during instruction	Pilot VR lesson
Projection	Collecting feedback after implementation	Student reflection forms

8.11 5E Model (Engage–Explore–Explain–Elaborate–Evaluate)
Scope: Widespread in science, technology, and engineering education.
Stages:

1. **Engage:** Attract attention
2. **Explore:** Student discovers
3. **Explain:** The teacher explains
4. **Elaborate:** The application is done
5. **Evaluate:** Learning is evaluated

VR Application: In "VR Safety Simulation" the student first observes the problem (Engage), then tries the solution (Explore), the teacher explains (Explain) and the students are evaluated (Evaluate).

8.12 Layer of Necessity Model
This model categorizes learning objectives
based on their priority and necessity . In VR content, it identifies which skills are "critical" and which are "supportive."

Layer	Definition	Example
1. Foundation	Mandatory knowledge and skills	Work safety rules
2. Supportive	Content that facilitates the main skill	Equipment introduction
3. Enriching	Advanced topics	Energy efficiency optimization

This model provides pedagogical prioritization in VR content sequencing.

8.13 SAM (Successive Approximations Model)

Philosophy: Agile version of classic ADDIE.

Small but rapid improvements are made with continuous feedback.

Stages:

1. Preparation
2. Design Cycle
3. Implementation Cycle

Strengths	VR Application
Rapid revision, agility	Each version of the VR module is updated based on student feedback

8.14 Randomized Controlled Trials (RCT)

Definition: A scientific research method used to measure effectiveness in education.

One group receives VR-based training while the other receives traditional training; the results are compared.

Aim	Advantage	Use
Measuring effectiveness	Provides scientific reliability	Testing the success rate of the VR module

RCTs are ideal for demonstrating the impact of the VRinVET project and establishing an evidence-based approach to dissemination activities.

8.15 Conclusion: Recommendation for Model Selection

Aim	Recommended Model
Systematic and classical processes	ADDIE, Dick & Carey
Experience-based learning	Kolb, Cognitive Apprenticeship
Rapid development	SAM, Rapid Prototyping
Complex skill teaching	4C/ID
Technology-focused planning	ASSURE, TPACK-IDDR
Based on wisdom and motivation	WISCOM
Effectiveness measurement	RCT

“The right model is one that serves the teacher's purpose; technology is just the bridge.”

9. MODEL SELECTION IN VR-BASED INSTRUCTIONAL DESIGN

9.1 The Importance of Model Selection

Each instructional design model addresses a specific need.

Choosing the right model directly determines the success of the curriculum and the impact of the VR application. Choosing the wrong model, however, can cause even well-planned content to fail to achieve the expected learning outcomes.

"Technology is not the key to success; the right pedagogical model makes technology meaningful."

9.2 Factors to Consider in Model Selection

Factor	Explanation	Model Suggestion
Learning Objectives	Will knowledge, skills or attitudes be imparted?	ADDIE for knowledge, 4C/ID for skill, WISCOM for attitude
Time Constraint	Is the training period short or long?	Short term: SAM, Rapid Prototyping
Technology Level	Does the school have a strong VR infrastructure?	If low, ASSURE, if high, TPACK–IDDR
Learner Profile	Experienced or beginner?	Beginner: 5E, experienced: Kolb
Content Complexity	Simple task or multi-component process?	Simple: ADDIE, complex: 4C/ID
The Need for Measurement	Are we looking for scientific effectiveness?	RCT, Dick & Carey

Note for Teacher:

Each model can be applied to a specific module or VR scenario, not the entire curriculum.

9.3 Model Selection Decision Matrix

Training Scenario	Targeted Output	Recommended Model	Reason
VR Welding Training	Application skills	4C/ID + Kolb	Complex skill + experiential learning
Electrical Safety	Correct application of the rules	ASSURE + SAM	Technology integration and rapid revision
Occupational Health and Safety	Risk awareness and attitude change	WISCOM + 5E	Motivation + experience cycle
Virtual Maintenance Simulation	Step by step procedure implementation	Dick & Carey	Systematic performance analysis
Developing New VR Content	Prototype testing	Rapid Prototyping + SAM	Trial–feedback loop
VRinVET Impact Analysis	Measuring learning outcomes	RCT	Scientific validity and effectiveness assessment

In the modules developed in the project, hybrid models were generally preferred: ADDIE + Kolb + ASSURE combination provides both systematic and experience-based learning.

9.4 Flow Diagram in Model Selection (Recommendation)

Start
↓
Educational Goal → Knowledge / Skills / Attitude?
↓
Time and Resource Situation → Limited?
↓
Infrastructure Analysis → VR / AR / Hybrid?
↓
Student Profile → Experienced or new?
↓
Model Matching → ADDIE, 4C/ID, SAM, Kolb, etc.
↓
Pilot Application → Feedback
↓
Revision and Final Model Decision

9.5 Hybrid Model Use

No single model is perfect for every situation, so **a mixed-model approach** is most effective for innovative projects like VRinVET.

Combination	Purpose of Use	Example
ADDIE + Kolb	Systematic + Experiential learning	VR Lab module
4C/ID + ASSURE	Complex skill + Technology integration	Engine assembly training
SAM + TPACK	Rapid prototyping + Technological adaptation	VR content test development
WISCOM + 5E	Motivation + Constructivist learning	Work safety scenario

At the beginning of each module, it should be stated which model(s) are used as the basis. This is also important for quality assurance and reporting.

9.6 Evaluation of Model Selection

The correctness of the model selection is evaluated by the following indicators:

Indicator	Interrogation Question	Assessment Tool
Effect	Have learning outcomes improved?	Student performance report
Applicability	Did the model fit the classroom environment?	Teacher feedback
Productivity	Is the use of time and resources balanced?	Time/output analysis
Sustainability	Is the model reusable?	Post-pilot review report

9.7 Conclusion: Guidelines for Model Selection

- Choose a model based on the purpose, do not determine the purpose based on the model.

- Think of technology as a complement to the model, not as the center of it.
- Mixed approaches are often most effective.
- Piloting and feedback are a mandatory part of the selection process.
- View model change as continuous improvement, not failure.

"Every student is different, every learning is unique; the teaching model is the bridge that makes these differences meaningful."

10. SAMPLE APPLICATIONS IN VR-BASED CURRICULUM

10.1 Purpose of Section

This section aims to demonstrate VR-based teaching practices to teachers **through real-world scenario examples** .

Each example is described along with the curriculum objectives, teaching model, technology used, and assessment method.

"Real learning happens when the learner 'does' it—VR makes that possible."

10.2 Application 1: Virtual Welding Workshop

Learning Objective	**Students can safely practice different welding techniques in a VR environment.**

Scope: Application designed for metalworking and welding students.

Duration: 20-minute VR session + 10-minute feedback.

Model Used: 4C/ID + Kolb Experiential Learning

Technology: VR glasses, hand sensors, welding torch simulator.

Pedagogical Flow:

1. **Engage:** The student is introduced to the resource scene.
2. **Explore:** The student tries out the torch movements in a VR environment.
3. **Explain:** The system shows correct/incorrect steps.
4. **Elaborate:** The student repeats the practice without errors.
5. **Evaluate:** Scoring is done based on rubrics.

Evaluation Criteria:

- Welding angle (% accuracy)
- Welding time
- Compliance with safety rules

Thanks to this module, students experience the process of learning by making mistakes safely, without experiencing the risks of real welding processes.

10.3 Application 2: VR Electric Safety Simulation

Learning Objective Students can practice electrical safety rules in a virtual factory.

Scope: Electrical and electronics students.

Model: ASSURE + SAM.

Technology: VR glasses + smart control software.

Pedagogical Steps:

1. The student enters the factory environment virtually.
2. The system prompts to detect incorrect behavior (bare wire, open panels, etc.).
3. The student flags unsafe situations.
4. The final step applies the correct procedure in VR.

Evaluation Type	Vehicle
Formative	Instant system alert
Results Oriented	Security score (%)
Self assessment	"Security Awareness" reflection form

💡 **Advantage:**

Students gain awareness and develop safe behavior reflexes without the risks of a real electrical workshop.

10.4 Application 3: Industrial Maintenance Simulation

Learning Objective	Students can disassemble and reassemble a machine in accordance with maintenance procedures.

Model: Dick & Carey + Rapid Prototyping

Technology: VR assembly platform (engine, gear, valve simulation)

Stages:

1. The student is given a safety checklist before maintenance.
2. Disassembly is done step by step in the VR environment.
3. The system gives feedback on incorrect steps.
4. All parts are assembled in the correct order.
5. At the end of the process, the student receives a score for time, accuracy, and safety.

Evaluation Criteria	Success Criteria
Part order accuracy	Over 90%
Time management	Must be completed within 15 minutes
Security compliance	Number of errors ≤ 2

VRinVET Contribution:

Learning is achieved on a real machine without the cost of errors. It improves performance on the second trial by analyzing student errors.

10.5 Application 4: Soft Skills Simulation (Communication and Teamwork VR Scenario)

Learning Objective	Students can practice effective communication, conflict management, and teamwork skills in a business environment through virtual scenarios.

Model: WISCOM + 5E
Technology: VR drama simulation + voice interaction system
Pedagogical Flow:

1. **Engage:** The student enters a scene of speaking with a client in VR.
2. **Explore:** Manages interactive dialogues.
3. **Explain:** The system explains the correct communication rules.
4. **Elaborate:** The student tries out the conflict resolution scenario.
5. **Evaluate:** Empathy, language use and solution skills are scored with the rubric.

Skills	Measurement Tool
Empathy	Observation rubric
Teamwork	Group VR mission score
Communication	Scenario evaluation form

Advantage:
Students experience the social dynamics of a real-world workplace with low stress. This module is an effective tool for training emotional intelligence.

10.6 Practice 5: Virtual Machine Setup and Calibration

Learning Objective	Students can set up the CNC machine correctly and adjust calibration parameters in a virtual environment.

Model: 4C/ID + SAM
Technology: VR CNC laboratory
Stages:

1. Introduction of machine parts (Supporting Information)
2. Implementation of calibration steps via VR (Mission Information)
3. Experiment with different parameter scenarios (Part Task Application)
4. The system gives visual warnings in case of incorrect parameters.

Evaluation:

- Calibration accuracy
- Process order and duration
- Learning from failure report

This app uses the safe benefits of VR to teach a common but risky operation in the industry.

10.7 Summary Table: Application – Model – Output Relationship

APPLICATION	Model(s)	Targeted Skill	Evaluation Method
VR Welding	4C/ID + Kolb	Technical Skills	Performance Rubric
Electric Safety	ASSURE + SAM	Job security	Scoring + Reflection
Maintenance	Dick & Carey + Rapid	Business Process	Task Analysis

	Prototyping	Management	
Soft Skills	WISCOM + 5E	Communication – Teamwork	Observation and Feedback
Machine Setup	4C/ID + SAM	Calibration and Analytical Thinking	Error Analysis Report

10.8 Conclusion

VR-based curricula have the potential to *transform student knowledge acquisition* into skill . These examples offer guidance to teachers not only in technology use but also in **instructional design, assessment, and pedagogical leadership .**

"The vocational training of the future begins with virtual experiences but yields results in the real world."