Article

Implementation Pathways for Continuing Education through the Integration of the OBE Concept and Virtual Simulation Technology

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Abstract: Continuing education must accommodate adult learners' fragmented study time while maintaining the quality of practical and occupational training. This study develops an implementation pathway integrating Outcome-Based Education with virtual simulation technology. A design-oriented approach is used to connect occupational needs, learning outcomes, simulation tasks, teaching organization, achievement assessment, and continuous improvement. The proposed pathway begins with occupational task analysis and outcome decomposition, followed by the development of progressive scenarios and flexible learning resources. Teaching is organized through preparation, guided practice, independent operation, reflection, and workplace-oriented transfer. Multidimensional evidence, including operational records, task products, decision explanations, reflective reports, and transfer assignments, is used to evaluate achievement. The study also identifies the organizational, technological, instructional, and ethical conditions required for sustainable implementation. Rather than treating a digital platform as an independent innovation, the pathway positions technology as a means of achieving observable professional outcomes. It provides an applicable reference for vocational colleges and other institutions seeking to improve the accessibility, occupational relevance, and quality assurance of continuing education.

Keywords: adult learners; occupational competence; scenario-based instruction; learning analytics; formative assessment; workplace transfer; digital pedagogy

1. Introduction

Continuing education plays an important role in lifelong learning, workforce development, professional qualification, and industrial transformation. Technological change and the continuous updating of occupational standards require employees to renew their knowledge and skills throughout their careers. Initial education alone is no longer sufficient to support long-term professional development. Educational institutions must therefore provide flexible learning opportunities that enable adults to improve their competence while remaining employed. Adult learners differ from conventional full-time students in several respects. They frequently balance learning with employment, family responsibilities, commuting, and other social obligations. Their available learning time may be fragmented, and participation may be interrupted by changing work schedules or temporary assignments. Learners in the same course may also have different educational backgrounds, occupational experiences, learning motivations, digital skills, and levels of confidence.

These characteristics create particular challenges for practical instruction. Many continuing education courses require learners to operate equipment, interpret technical information, identify hazards, diagnose faults, follow professional procedures, and make decisions under realistic constraints. Such competencies cannot be developed adequately through lectures and written examinations alone. Learners need opportunities to perform

Received: 09 September 2026
Revised: 21 October 2026
Accepted: 05 November 2026
Published: 10 November 2026

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tasks, observe consequences, receive feedback, reflect on errors, and improve their performance.

Conventional practical training is frequently limited by equipment availability, fixed laboratory schedules, high material costs, safety risks, and insufficient opportunities for repeated operation. Adult learners may find it difficult to attend laboratory sessions at predetermined times. Equipment may need to be shared among many participants, while dangerous or unusual incidents cannot be reproduced solely for instructional purposes.

Virtual simulation technology provides a possible response to these problems. It can represent equipment, procedures, work environments, information flows, and decision situations through an interactive digital platform. Learners can repeat procedures, observe system responses, compare alternative actions, and experience abnormal situations without damaging physical equipment or creating an actual safety incident. Research has shown that well-designed virtual environments can support knowledge development, skill practice, learner engagement, and contextualized problem solving, although learning effects depend substantially on instructional design .

However, technology does not automatically produce meaningful learning. Some virtual activities require learners only to follow prompts and click controls in a predetermined sequence. Learners may obtain a completion score without understanding the professional principles behind their actions. In such cases, the platform becomes an electronic demonstration rather than an environment for inquiry, judgment, and competence development.

Another problem concerns assessment. Digital platforms can record completion time, operational sequences, errors, repeated attempts, and prompt use. These data are useful, but they do not provide complete evidence of professional competence. A short completion time may indicate proficiency, guessing, or superficial participation. A correct operation may result from memorizing a sequence rather than understanding the system. Platform-generated scores should therefore be interpreted together with explanations, task products, reflection, and transfer performance.

Outcome-Based Education provides a useful framework for addressing these limitations. OBE begins with a clear description of what learners should be able to demonstrate after completing a course. Content, activities, resources, and assessment are then organized around those expected outcomes. The emphasis shifts from the amount of content presented by the instructor to the quality of performance demonstrated by the learner.

The integration of OBE and virtual simulation has strong practical potential. OBE can provide clear direction for technology selection and task development, while virtual simulation can offer flexible and repeatable learning experiences through which intended outcomes are developed and demonstrated. Their integration can connect professional requirements, course outcomes, simulation tasks, performance evidence, and curriculum improvement.

Nevertheless, implementation involves more than combining an educational concept with a digital platform. Institutions need an operational pathway explaining how occupational requirements are analyzed, how learning outcomes are decomposed, how scenarios are developed, how teaching is organized, how achievement is assessed, and how evidence is used for improvement. Without such a pathway, the integration may remain at the level of general principles.

2. Theoretical Logic and Practical Demands

2.1. Outcome-Oriented Logic

Outcome-Based Education requires curriculum development to begin with a clear description of the achievements that learners are expected to demonstrate. A learning outcome is not merely a statement of the content that an instructor intends to cover. It should describe an observable performance through which learners demonstrate integrated knowledge, practical skills, professional judgment, and responsibility. Recent

studies have indicated that outcome-oriented curriculum design can strengthen the relationship among occupational requirements, learning activities, assessment evidence, and competency development [1].

A meaningful learning outcome normally includes three elements: an observable action, a performance condition, and a quality standard. For example, the statement "learners will understand equipment operation" is too broad to guide teaching and assessment. A more operational statement would require learners to complete a standard procedure under specified conditions, explain the purpose of critical steps, identify potential hazards, and correct errors in accordance with professional requirements. Such statements make it possible to determine whether learners have achieved the expected standard.

Outcome orientation follows a backward design logic. Curriculum developers first identify what learners should be able to accomplish at the end of a course. They then determine what evidence is required to demonstrate those achievements and finally design learning activities and resources that enable learners to produce the required evidence. This sequence prevents curriculum implementation from being determined primarily by textbook structure, platform functions, or the personal preferences of individual instructors.

Constructive alignment further requires consistency among intended outcomes, learning activities, and assessment tasks. If a course expects learners to diagnose an abnormal condition but provides only routine operating exercises, the intended outcome lacks sufficient instructional support. Similarly, if learners are expected to demonstrate practical competence but assessment is limited to factual recall, the assessment cannot provide valid evidence of achievement. Recent research on constructive alignment emphasizes that curriculum quality depends on the systematic consistency among expected outcomes, learning experiences, and assessment evidence [2].

This alignment should be established at several levels. Occupational standards and social needs provide the basis for program outcomes. Course outcomes should contribute to those broader expectations, while individual tasks should support course-level achievements. Assessment should then generate evidence showing whether learners can perform according to the expected standards. The results should be used not only to judge individual achievement but also to improve subsequent teaching.

The outcome-oriented logic is especially appropriate for continuing education. Adult learners generally expect instruction to be relevant to current or future professional responsibilities. Explicit outcomes help them understand the purpose of each activity and allocate their limited study time more effectively. They also allow experienced learners to identify specific areas requiring improvement instead of repeating familiar content without a clear professional purpose.

2.2. Functional Value of Virtual Simulation

Virtual simulation can provide access to practical experiences that are difficult to organize through conventional instruction. It enables learners to repeat professional procedures without consuming physical materials and allows them to practice independently of fixed laboratory schedules. It can also represent dangerous, rare, costly, or difficult-to-observe situations that cannot be created safely in a physical classroom. Recent research has shown that appropriately designed virtual environments can support practical skill development, learner engagement, decision making, and contextualized problem solving [3].

The educational value of virtual simulation depends on instructional design rather than technological novelty alone. Functional authenticity is often more important than visual complexity. Functional authenticity refers to the extent to which a learning task represents meaningful professional relationships, information, constraints, decisions, risks, and consequences. A visually simple environment requiring learners to interpret evidence and justify decisions may have greater educational value than a highly realistic environment requiring only passive observation.

Virtual simulation can support a progressive learning process. Early activities may provide demonstrations, prompts, checklists, and immediate explanations. These forms of support can help learners understand the interface and identify important information. Later tasks should gradually remove the support, introduce changing conditions, and require independent decisions. This progression enables beginners to participate while preventing permanent dependence on step-by-step instructions.

Repeated practice is another important advantage. In conventional practical training, equipment and scheduling limitations may provide learners with only one opportunity to perform a procedure. A virtual platform can allow multiple attempts and generate information about errors, repeated actions, and correction behavior. However, repetition should not be limited to completing an identical sequence several times. Effective repetition should include feedback, reflection, changing conditions, and increasing levels of independence.

Scenario variation is necessary to prevent mechanical learning. If every task uses the same conditions and sequence, learners may memorize interface operations without understanding the underlying professional principles. Later scenarios should modify available information, operating conditions, task constraints, or fault patterns. Learners should then determine which principles remain applicable and which procedures need adjustment.

Virtual environments can also support safe error-based learning. Learners can examine the consequences of inappropriate actions without causing actual equipment damage, environmental loss, or personal injury. Feedback should explain why an action is inappropriate and identify the relevant professional principle. Errors involving critical safety requirements should receive immediate and explicit feedback, while less serious errors may be used to encourage analysis and self-correction.

Another function of virtual simulation is the generation of process evidence. A platform can record operational sequences, selected information, time allocation, repeated attempts, use of prompts, errors, and recovery behavior. These data can help instructors identify common difficulties and provide targeted support. However, digital traces should not be interpreted as complete representations of competence because observable platform behavior does not always reveal the reasoning behind a learner's decision.

Virtual simulation also has limitations. It may not reproduce tactile sensations, face-to-face communication, environmental uncertainty, workplace pressure, or organizational culture. Performance in a digital environment should therefore not automatically be treated as complete evidence of occupational competence. Digital activities should be combined with physical practice, supervised workplace tasks, or mentor verification when intended outcomes involve elements that cannot be represented adequately online.

Therefore, virtual simulation should function as a means of achieving expected outcomes rather than as an independent curriculum objective. Its principal value lies in expanding access, increasing opportunities for repeated practice, representing difficult situations, supporting feedback, and generating evidence for instructional improvement. These functions become educationally meaningful only when they are aligned with explicit professional outcomes and appropriate assessment requirements [3].

2.3. Practical Demands of Continuing Education

The first practical demand of continuing education is flexibility. Adult learners need access to resources and activities that can accommodate employment, family responsibilities, and fragmented study time. Asynchronous learning can reduce dependence on a fixed place and schedule, while periodic synchronous discussion can provide social interaction and instructor guidance. Research on adult and continuing education indicates that relevance, flexibility, learner autonomy, and the effective use of prior experience are important conditions for sustained adult participation [4].

Flexibility should not be interpreted as the absence of structure. Adult learners still require clear milestones, concise instructions, manageable tasks, progress information,

deadlines, and access to support. Excessive freedom may contribute to delayed participation, while rigid scheduling may exclude learners whose professional responsibilities change unexpectedly. An effective continuing education course should therefore balance flexible access with structured guidance.

The second practical demand is differentiated support. Continuing education participants may have substantially different levels of theoretical knowledge, occupational experience, digital competence, and confidence. Experienced learners may progress rapidly through introductory activities and benefit from complex diagnostic scenarios. Beginners may require prerequisite resources, interface orientation, additional routine practice, and more explicit guidance.

Diagnostic activities can identify these differences before the main learning process begins. Learners who demonstrate the required prerequisite knowledge may proceed directly to core tasks, while those with identified gaps can use supplementary resources. Differentiation changes the amount and form of support but should not reduce the essential performance standards that all learners are expected to achieve.

The third demand is occupational relevance. Adults generally participate more actively when learning is connected with professional problems. Simulation scenarios should therefore be derived from representative occupational tasks, technical standards, safety requirements, common errors, and critical incidents. Prior workplace experience can be used as an instructional resource, but familiar practices should be compared critically with current professional requirements.

The sixth demand is an effective feedback mechanism. Digital platforms can generate information about learning progress, operational errors, repeated attempts, task completion, and support use. When this information is combined with instructor judgment and learner reflection, it can support formative assessment and personalized guidance. Recent studies have shown that timely, specific, and actionable feedback can help learners identify performance gaps and regulate subsequent learning activities [5].

Feedback should explain not only whether a response is correct but also why it is correct or incorrect. Learners should understand the professional principle involved, the potential consequence of an error, and the action required for improvement. Feedback becomes particularly valuable when learners have an opportunity to apply it in a revised attempt or a changed scenario.

Automated feedback is appropriate for clearly defined procedural errors, such as omitting an essential step or selecting an unsafe action. Instructor feedback is more suitable for diagnostic reasoning, professional judgment, communication, and transfer. Peer feedback can also support collaborative learning when learners are provided with explicit evaluation criteria.

The final demand is sustainable quality assurance. Virtual resources require continuous review because occupational standards, software, equipment, and professional practices change over time. Institutions need clear responsibility for content updating, technical maintenance, learner support, teacher development, assessment review, data protection, and accessibility.

Digital learning data should be collected only for legitimate educational purposes. Learners should understand what information is recorded, why it is collected, how it contributes to assessment, who can access it, and how long it will be retained. Automated judgments should remain subject to instructor review, especially when assessment involves professional reasoning or contextual decisions.

These practical demands demonstrate that the integration of OBE and virtual simulation cannot be achieved through platform construction alone. Effective implementation requires the coordinated design of outcomes, scenarios, learning support, assessment, feedback, transfer, and institutional quality assurance.

3. Framework of the Implementation Pathway

3.1. Principles of Pathway Design

The implementation pathway is based on six principles. The first is outcome priority. Technology, content, activities, and assessment should be selected according to their contribution to expected professional performance. Platform availability should not determine course outcomes.

The second principle is occupational authenticity. Learning outcomes and simulation scenarios should be derived from representative professional tasks, standards, constraints, risks, and decisions. Authenticity should be judged by the professional logic of the task rather than by visual realism alone.

The third principle is progressive support. Activities should progress from diagnostic preparation and guided practice to independent performance and transfer. Scaffolding should be sufficient to support initial participation but should gradually decrease as competence develops.

The fourth principle is evidence diversity. Achievement judgments should use multiple sources of information. Digital records, task products, explanations, reflection, observation, and transfer performance should complement rather than replace one another.

The fifth principle is learner adaptability. The implementation pathway should accommodate differences in prior knowledge, professional experience, available study time, digital access, and support requirements. Flexible access should be combined with common minimum standards.

The sixth principle is continuous improvement. Evidence should be used not only to evaluate individual learners but also to identify weaknesses in content, activities, support, assessment, and technology. Improvement should be documented and reviewed in subsequent teaching cycles.

3.2. Components of the Implementation Framework

The overall pathway consists of six interconnected components: occupational needs analysis, learning outcome decomposition, simulation resource development, integrated teaching implementation, multidimensional achievement assessment, and evidence-based improvement.

Table 1 presents the overall framework and identifies the principal purpose, actions, and outputs of each component.

Table 1. Overall Framework of the Implementation Pathway for Continuing Education

Implementation component	Principal purpose	Core actions	Main outputs
Occupational needs analysis	Determine what professional problems the course should address	Analyze occupational standards, representative tasks, critical incidents, learner characteristics, and available resources	Occupational task map, learner profile, prioritized training needs
Learning outcome decomposition	Translate professional requirements into assessable course expectations	Define conceptual, operational, problem-solving, and professional outcomes	Outcome statements, performance standards, outcome–task map

Simulation resource development	Create activities that support the intended outcomes	Develop progressive scenarios, learning resources, prompts, feedback, and transfer tasks	Scenario packages, support materials, technical specifications
Integrated teaching implementation	Organize flexible and progressive learning experiences	Conduct preparation, guided practice, independent operation, reflection, and transfer	Process records, task products, decision explanations
Multidimensional assessment	Determine whether expected outcomes have been achieved	Apply rubrics, examine process evidence, assess independent performance, and verify transfer	Achievement profiles, feedback records, reassessment decisions
Evidence-based improvement	Improve resources, teaching, assessment, and support	Analyze common difficulties, identify causes, implement revisions, and review results	Improvement records, revised scenarios, updated criteria

As shown in Table 1, implementation is not a linear transfer of content from an instructor to a learner. It is a connected process beginning with professional needs and ending with evidence-based revision. Each component produces outputs that become inputs for the next component.

The first two components define the direction of the course. Occupational analysis establishes relevance, while outcome decomposition converts broad requirements into assessable performances. The third and fourth components transform outcomes into resources and learning experiences. The final two components determine whether outcomes have been achieved and whether the course itself requires improvement.

3.3. Relationships among the Core Components

The relationship between occupational needs and learning outcomes is foundational. Occupational documents may describe broad responsibilities that cannot be assessed directly within one course. Curriculum developers must identify representative performances that can be developed within the available time while still contributing to broader professional competence.

The relationship between outcomes and scenarios is equally important. Every major outcome should have sufficient learning support, while each major scenario should contribute to at least one outcome. An outcome–task matrix can make this relationship visible. If an outcome lacks corresponding practice, additional activities are required. If an activity has no meaningful connection with an outcome, it should be revised or removed.

The relationship between scenarios and assessment should also be aligned. Learners should not be assessed on performances they have had no opportunity to practice. At the same time, final assessment should not merely reproduce guided exercises. Independent and transfer tasks should change conditions sufficiently to evaluate understanding and adaptation.

Assessment evidence connects learner performance with continuous improvement. If individual learners experience different difficulties, targeted support may be appropriate. If many learners encounter the same problem, the instructional team should examine whether content, task information, interface design, scaffolding, or assessment criteria are responsible.

The pathway is therefore cyclical rather than strictly linear. Improvement evidence may lead to revised outcomes, scenarios, resources, criteria, or technical functions. Changes in occupational standards may also require the course to return to the initial needs analysis. This cyclical structure enables the course to remain relevant as professional requirements develop.

4. Key Procedures for Teaching Implementation

4.1. Occupational Needs Analysis and Outcome Decomposition

Implementation begins with occupational task analysis. Curriculum developers collect information from occupational standards, job descriptions, operating procedures, safety regulations, professional certification requirements, and representative workplace cases. Consultation with instructors and experienced practitioners can help identify tasks that are frequent, important, difficult, or high-risk.

The analysis should distinguish between routine tasks and complex situations. Routine tasks support the development of procedural accuracy and fluency. Complex situations require interpretation, diagnosis, judgment, communication, and adaptation. Both types should be included because professional competence involves reliable routine performance and an appropriate response to changing conditions.

Learner needs should be analyzed at the same time. Relevant information includes educational background, occupational experience, digital access, available study time, prerequisite knowledge, and support requirements. The purpose is not to label learners but to determine how flexible pathways and differentiated resources should be organized.

Resource and risk analysis should examine available equipment, digital platforms, teacher capacity, development costs, network conditions, accessibility, data protection, and technical support. If a high-fidelity environment cannot be accessed reliably, a simpler and more functional solution may be more appropriate.

The identified needs are translated into learning outcomes. Outcomes may be organized into four dimensions:

Conceptual outcomes, including the explanation of principles, standards, relationships, and risks;

Operational outcomes, including accurate, safe, and efficient completion of procedures;

Problem-solving outcomes, including evidence collection, diagnosis, comparison of alternatives, and decision justification;

Professional outcomes, including documentation, communication, responsibility, reflection, and transfer.

Each outcome should use observable verbs and indicate the expected standard. Terms such as “know,” “understand,” and “be familiar with” should be replaced by actions such as “explain,” “identify,” “complete,” “diagnose,” “justify,” “document,” and “apply.”

Broad outcomes should then be decomposed into supporting outcomes and task requirements. For example, the ability to respond to an abnormal condition may require learners to recognize warning information, interpret system relationships, identify possible causes, select a safe response, explain the decision, and document the incident.

The curriculum team should also specify the evidence required for each outcome. Conceptual understanding may be demonstrated through explanations. Operational outcomes require actual performance records. Diagnostic outcomes require analysis and justification. Transfer requires a changed scenario, workplace case, or physical task.

This process produces an outcome–task–evidence map. The map becomes the basis for resource development, teaching implementation, and assessment.

4.2. Simulation Resource and Task Development

Simulation resources should be developed around professional tasks rather than textbook chapters. Each scenario should include a learner role, task goal, initial conditions, available information, tools, constraints, critical decisions, and meaningful consequences.

A progressive task sequence can include orientation, routine operation, variable operation, abnormal situation, independent assessment, and transfer. The sequence enables learners to become familiar with the environment before facing complex decisions.

Orientation tasks introduce the interface, controls, symbols, and scenario rules. These tasks should be low-stakes because their purpose is to reduce irrelevant technical difficulty. Learners should not be judged professionally incompetent merely because they are unfamiliar with the platform.

Routine scenarios represent standard procedures. Prompts, checklists, and explanations may be provided during the initial attempt. However, feedback should explain the professional reason for an action rather than only indicate whether it is correct.

Variable scenarios change selected conditions while maintaining the same underlying principles. Learners must identify which information is relevant and decide whether the standard procedure requires adjustment. Such variation reduces dependence on memorized sequences.

Abnormal scenarios introduce faults, hazards, conflicting information, or time pressure. Learners collect evidence, identify possible causes, compare responses, and justify a decision. Requiring an explanation before revealing the result can discourage random trial and error.

Independent tasks remove step-by-step support. They should require the integration of conceptual knowledge, operational skill, reasoning, and professional responsibility. The difficulty should be comparable with the practice scenarios but should not reproduce them exactly.

Transfer tasks present a different configuration or workplace-related case. Learners determine which principles remain applicable and which procedures need modification. If possible, the transfer stage should be connected with physical practice, workplace observation, mentor verification, or a professional improvement proposal.

Support materials should remain concise and task-oriented. Adult learners with fragmented study time may find large collections of unrelated resources difficult to use. Each video, diagram, checklist, or example should address a clear learning need.

Accessibility should be incorporated into resource development. Text should be readable, videos should include captions, essential information should not depend on color alone, and keyboard alternatives should be provided where possible. Low-bandwidth versions and downloadable materials can support learners with limited connectivity.

Before formal implementation, scenarios should be reviewed by subject experts, instructors, technical staff, and representative users. Review should examine professional accuracy, cognitive demand, interface usability, feedback quality, accessibility, and alignment with outcomes. Technical realism should not be accepted as a substitute for educational validity.

4.3. Teaching Organization and Learning Support

Teaching can be organized through five connected phases: preparation, guided participation, independent performance, reflection, and transfer. These phases can combine asynchronous access with synchronous discussion.

During preparation, learners receive the expected outcomes, task requirements, assessment criteria, and concise prerequisite resources. A diagnostic activity helps them identify strengths and gaps. Learners who meet prerequisite requirements can proceed, while those needing support use additional materials.

Guided participation begins with interface orientation and routine tasks. Instructors help learners recognize important information and connect operations with professional principles. Early feedback may be immediate and explicit, but assistance should decrease as learners develop confidence.

The instructor's role changes from content delivery to facilitation and diagnosis. Rather than providing the complete answer immediately, the instructor may ask learners what information is available, what evidence supports a conclusion, what risk is involved, and what alternative response could be considered.

Peer collaboration can support case analysis and professional communication. Adult learners may contribute workplace examples, but experience should be examined critically. Familiar practices should be compared with current standards rather than accepted automatically.

Independent performance requires learners to complete a task without step-by-step prompts. The platform records actions and outcomes, while learners provide explanations for critical decisions. Independent assessment should occur only after adequate opportunities for guided and repeated practice.

Reflection follows performance. Learners compare their work with the assessment criteria and identify a successful strategy, an important error, the probable cause of that error, and an action for improvement. Structured reflection prevents the activity from ending with a platform score.

Transfer extends learning beyond the original scenario. Learners apply principles to a modified case or workplace-related problem. Where appropriate, virtual practice is connected with a physical laboratory, workplace mentor, or professional project.

Learning support should be differentiated. Beginners may need prerequisite explanations, interface guidance, and additional routine practice. Experienced learners may move more quickly toward fault diagnosis and complex cases. Differentiation changes the form and amount of support without lowering essential performance standards.

Clear communication is necessary throughout implementation. Learners should know what is expected, when tasks should be completed, how evidence will be used, and how assistance can be obtained. Technical support should be available during periods when employed adults are likely to study, including evenings or weekends where institutional conditions permit.

5. Assessment and Implementation Support

5.1. Multidimensional Achievement Assessment

Assessment should determine whether learners have achieved the intended outcomes rather than merely whether they have accessed or completed a platform activity. It should follow the principles of alignment, authenticity, transparency, evidence diversity, and developmental use.

Alignment requires assessment tasks to correspond with intended outcomes. Authenticity requires learners to complete meaningful professional activities. Transparency requires criteria to be communicated before assessment. Evidence diversity requires several forms of information, while developmental use means that assessment should support improvement as well as judgment.

A balanced assessment portfolio can include prerequisite checks, guided practice records, independent operation, abnormal situation responses, decision explanations, professional documentation, reflection, and transfer tasks. Guided activities should normally have less weight because substantial support is available. Independent and transfer performance should provide the strongest evidence of achievement.

The principal dimensions, evidence sources, and criteria are summarized in Table 2.

Table 2. Assessment Dimensions, Evidence Sources, and Evaluation Criteria

Assessment dimension	Principal evidence	Core evaluation criteria	Primary function
Conceptual understanding	Knowledge checks, explanations, and principle-based questions	Accuracy, clarity, and understanding of professional relationships	Diagnostic and formative
Operational performance	Platform records, observation, and completed procedures	Correct sequence, accuracy, efficiency, and appropriate tool use	Formative and summative
Safety awareness	Responses to hazards and behavior in critical situations	Hazard recognition, compliance, risk control, and corrective action	Essential achievement threshold
Diagnostic reasoning	Fault analysis, decision explanation, and case report	Evidence use, cause identification, alternative comparison, and justification	Formative and summative
Professional communication	Operational records, reports, and collaborative products	Completeness, clarity, accuracy, and professional format	Formative and summative
Reflection and transfer	Reflective reports, changed scenarios, and workplace-related tasks	Self-evaluation, improvement planning, adaptation, and application	Summative and developmental

As shown in Table 2, professional competence extends beyond procedural accuracy. It includes conceptual understanding, safety, diagnostic reasoning, communication, reflection, and transfer. These dimensions should be evaluated through complementary evidence rather than reduced to a single platform score.

Rubrics can describe four performance levels, such as exemplary, proficient, developing, and insufficient. Descriptors should focus on observable characteristics. An exemplary diagnostic response may integrate multiple sources of evidence, distinguish symptoms from causes, justify the selected action, and anticipate consequences. A developing response may identify a possible cause but use incomplete evidence.

Certain outcomes should be treated as minimum thresholds. A learner who completes a task quickly but violates an essential safety requirement should not be judged competent because strong performance in another dimension compensates for the violation. Safety, independent performance, and transfer can therefore be established as non-compensatory requirements.

Reassessment should be available when appropriate. Learners who do not initially meet the standard should receive specific feedback and an opportunity to improve. The reassessment task should be comparable in difficulty but different in content so that it measures application rather than memorization.

5.2. Evidence-Based Feedback and Improvement

Feedback should help learners understand the expected standard, evaluate their present performance, and identify the next action required for improvement. Research on educational feedback indicates that its influence depends on the content, form, timing, and conditions under which learners can use it

.

Automated feedback is appropriate for clearly defined procedural errors. It can identify an omitted step, unsafe action, or incorrect sequence. Instructor feedback is more suitable for reasoning, communication, and transfer because these performances require contextual interpretation. Peer feedback can support collaborative analysis when explicit criteria are provided.

Feedback should not end with a general score. It should indicate what was done effectively, what requires improvement, why the problem matters, and what action should follow. Learners should then have an opportunity to apply the feedback in a revised attempt or changed task.

Digital process data can support feedback but must be interpreted cautiously. Completion time, error frequency, prompt use, and repeated attempts are indicators rather than direct measures of competence. A short completion time may result from proficiency or superficial action. Repetition may reflect productive persistence or random trial and error.

Triangulation is therefore necessary. Platform records should be interpreted together with task products, decision explanations, observation, reflection, and transfer performance. This combination provides a more credible account of learner achievement.

Evidence should also be aggregated by outcome to support course improvement. An overall average score may conceal the fact that learners perform well in routine operation but poorly in diagnosis or transfer. Outcome-level analysis reveals where additional support or redesign is required.

When many learners experience the same difficulty, instructors should avoid assuming that the problem is insufficient effort. The cause may be missing prerequisite content, unclear task information, excessive interface complexity, premature removal of support, weak feedback, or ambiguous assessment criteria.

The improvement process should be documented. A course improvement record may include the identified issue, supporting evidence, probable cause, proposed revision, responsible person, implementation schedule, and expected result. Evidence from the next teaching cycle should be used to determine whether the revision addressed the problem.

Recent reviews have also noted that digital simulation should be integrated systematically into curricula rather than added as an isolated technological experience

. Evidence-based improvement helps maintain this integration by connecting platform use with curriculum outcomes and quality assurance.

5.3. Organizational and Technical Support

Sustainable implementation requires institutional support. Scenario development involves occupational analysis, outcome design, resource production, technical testing, assessment construction, and evidence interpretation. It should not be treated as an unsupported additional responsibility for an individual instructor.

A multidisciplinary team can distribute responsibilities. Subject specialists ensure professional accuracy. Instructors organize learning and feedback. Instructional designers support alignment and task progression. Technical staff develop and maintain the platform. Assessment specialists assist with rubrics and evidence interpretation. Workplace experts can review authenticity and transfer requirements.

Teacher development is essential. Instructors need more than basic platform operation skills. They should understand outcome specification, scenario design, scaffolding, formative feedback, digital assessment, learning analytics, accessibility, and data ethics. Professional development should combine conceptual preparation with actual course development.

Reliable infrastructure is another basic condition. Platforms should be tested on devices commonly used by learners. Institutions should provide technical guidance, account support, system maintenance, data backup, and low-bandwidth alternatives. Technical difficulties should be resolved promptly so that they do not become unnecessary barriers to learning.

Data governance must be established before implementation. Learners should know what information is collected, why it is collected, how it contributes to assessment, who can access it, and how long it will be retained. Only information required for legitimate educational purposes should be collected.

Automated assessment should remain open to instructor review. Algorithms may privilege behavior that is easy to record while overlooking contextual judgment, communication, ethics, or creativity. Learners should have an appropriate process for requesting clarification or review of assessment decisions.

Accessibility and equity should be included in institutional quality standards. Adult learners differ in devices, networks, digital experience, language, and possible disabilities. Accessible design, orientation, flexible support, and alternative resources can reduce participation barriers.

Resource maintenance should also be planned. Professional standards, software, and equipment change over time. Institutions need a review schedule for scenarios, learning resources, feedback, criteria, and technical functions. An outdated simulation may reinforce inappropriate professional practice.

Continuing education policy should recognize that adult learning contributes to individual development, social participation, and workforce resilience. International reports have emphasized the need to improve participation, relevance, inclusion, and quality in adult learning systems . Integrating OBE with virtual simulation can contribute to these goals only when instructional innovation is supported by appropriate organizational arrangements.

6. Conclusion

The integration of the OBE concept and virtual simulation technology provides a practical direction for improving continuing education. OBE clarifies what learners should be able to demonstrate, while virtual simulation provides flexible, repeatable, and contextualized opportunities for developing and assessing those performances.

This study developed an implementation pathway comprising occupational needs analysis, learning outcome decomposition, simulation resource development, integrated teaching implementation, multidimensional assessment, and evidence-based improvement. The pathway begins with professional and learner needs rather than with available technology.

Occupational requirements are translated into conceptual, operational, problem-solving, and professional outcomes. These outcomes guide the development of progressive scenarios involving preparation, guided practice, variable conditions, abnormal situations, independent performance, reflection, and transfer.

Assessment uses multiple sources of evidence, including platform records, task products, decision explanations, professional documentation, reflective reports, and transfer assignments. Digital trace data are treated as useful indicators rather than complete representations of competence. Safety, independent performance, and transfer can be established as minimum achievement thresholds.

Evidence serves both learner evaluation and curriculum improvement. Common difficulties are examined in relation to prerequisite knowledge, scenario information,

scaffolding, interface functions, feedback, and assessment criteria. Improvement measures are documented and reviewed in subsequent teaching cycles.

The pathway also recognizes the limitations of virtual environments. Digital activities cannot reproduce every tactile, interpersonal, environmental, or organizational element of professional work. Virtual learning should therefore be combined with physical or workplace practice when such elements are essential to the intended competence.

Sustainable implementation requires multidisciplinary cooperation, teacher development, accessible resources, reliable infrastructure, data governance, and continuous maintenance. Technology should remain a means of achieving professional outcomes rather than becoming an independent objective.

The study is design-oriented and does not report experimental results. Future research should apply the pathway in specific continuing education courses and collect actual evidence concerning learner achievement, engagement, transfer, accessibility, and instructional workload. Comparative and longitudinal studies may further determine which combinations of simulation, feedback, and workplace activity provide the most effective support for adult professional learning.

Funding: This research was supported by the Chongqing Vocational Education Teaching Reform Research Project entitled Innovation and Practice of Continuing Education Teaching Model Based on OBE Educational Concept and Integration of Virtual Simulation Technology (Grant No. Z233247X). Acknowledgments: The author gratefully acknowledges the support of Chongqing College of Architecture and Technology and the teachers and educational technology professionals involved in continuing education reform.

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