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Integrated Simulation Training for Surgical Skill Development in Ukrainian Medical Universities During War

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Abstract

In difficult times of war, total unity in all areas of activity is necessary. Medicine is particularly important during martial law. As part of the development of an integrated military field surgery curriculum, the use of simulation-based learning is challenging due to limited resources at the university level. The aim of this paper is to propose a model for the conceptual design and implementation of an integrated simulation training programme with competency assessment for the development of surgical skills in medical students in the subject of military field surgery. Methods: an educational curriculum development method, specifically tailored for military field surgery training. The method involved defining a context-appropriate goal, which in this case is the integration of a simulation curriculum into the military field surgery curriculum. The results evaluated the logic model methodology that was used to identify learning objectives, available resources and describe the process of implementation and evaluation of the simulation training programme. The logic model methodology was used to develop the logic model methodology, which consisted of five steps: 1) defining the goal, considering the context; 2) using resources; 3) conducting activities; 4) targeting groups; 5) obtaining results in the short, medium, and long term. The model for the conceptual design and implementation of an integrated simulation training programme will allow to integrate simulation into the process of military field surgery education with a realistic approach, considering local resources and continuous evaluation (student satisfaction, activation of competencies in the provision of medical care and impact on the organisation of care). In conclusion, following the approach to competencies in the military field surgery programme, the logic model will lead to the design, implementation, and evaluation of the simulation training programme with the potential for change throughout the project.

Keywords

Simulation, integration, resource, training, military field surgery, logic model.

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1. Introduction

Simulation has been shown to be a potentially useful tool for developing professional skills in medical students compared to traditional approaches to clinical education. It develops clinical skills and follows the principle of "see, do, learn" (Wan, Doty, Geraets, Nix, Saitta & Chini, 2021). It successfully complements skill-based curricula, and scientific research supports its effectiveness (Tsekhmister, Konovalova & Tsekhmister, 2021). In 2012, the American Board of Emergency Medicine and the Accreditation Council for Graduate Medical Education proposed the use of simulation to assess students who have completed a competency-based curriculum (Colmers-Gray, Walsh & Chan, 2017). In France, the emergency medicine (EM) curriculum has evolved to focus on the development of skills needed to practice in this field (Motte, Aiguier, Van Pee & Cobbaut, 2020).

Simulation is an effective tool for teaching and assessing skills, and it plays a significant role in education and assessment (Philippon, 2022). In the context of studying military field surgery and medical emergencies, it is advisable to study in more detail the role of simulation in higher medical education institutions in Ukraine. The integration of a national curriculum based on simulation can be challenging, especially due to the variability of resources required for its successful implementation, such as human, material, and financial resources (Maciej, 2023). The dissemination of a single simulation-based curriculum across Ukraine may also prove challenging, especially given the diversity of universities and their capabilities.

In order for a competency-based simulation learning programme (ISP) to be relevant and effective, it is important to agree on the objectives, resources, learning activities, and assessment criteria for each university. This paper proposes to use a methodology based on a "logic model" for the development of simulation-based learning within a competency-based approach. Using this approach, the paper proposes a model of the ISP on the example of simulation training in the subject of military field surgery integrated into the curriculum. In these terms, the research questions were the next:

1. How can simulation-based learning be effectively integrated into a military field surgery curriculum to address the challenges posed by limited resources at the university level?

2. What are the learning objectives and available resources for the development and implementation of an integrated simulation training program for surgical skills in medical students within the subject of military field surgery?

3. How can the logic model methodology be applied to identify learning objectives, utilize available resources, and guide the process of implementing and evaluating a simulation training program for military field surgery?

4. What are the short-term, medium-term, and long-term outcomes of implementing the proposed model for the conceptual design and implementation of an integrated simulation training program for military field surgery?

5. How does the implementation of the simulation training program impact student satisfaction, activation of competencies in the provision of medical care, and the organization of care in the context of military field surgery education?

6. How does the logic model approach contribute to the design, implementation, and evaluation of the simulation training program for military field surgery, and what potential changes can be anticipated throughout the project?

2. Literature Review

A logic model is a way of visually representing the links between resources, activities, and outcomes of a programme to avoid plagiarism and to confirm the scientific validity of the research (Kaba, Cronin, Tavares, Horsley, Grant & Dube, 2022). Building a logic model involves considering the chain of effects that need to be implemented to achieve the end result (Clement, Howard, Lyon & Molloy, 2023). This model can be used to design a variety of programmes and is particularly useful for planning, implementing, and evaluating training programmes. The logic model is also part of a socio-constructivist approach that supports dialogue between different stakeholders to develop a shared understanding of the programme's capacities and optimal use of resources (Navarro-Bringas, Bowles, & Walker, 2020). It consists of five elements: purpose, resources, activities, groups, and short-, medium-, and long-term outcomes.

Context and assumptions can be changed to improve coherence and understanding of the bigger picture. The logic model uses an “if... then...” sequence to link different parts of a programme (Lowe, Woolfield, Matulich & Brazil, 2023). It is used in programme planning, implementation, execution, management, and evaluation.

The model helps to identify inconsistencies in the programme logic and helps to align the roles and responsibilities of all stakeholders (Dadario, Bellido, Restivo, Kulkarni, Singh, Yoon & Jafri, 2022). It is also a simple and visual tool for communicating and promoting the programme. Once the indicators are used to check the planned actions, the goals are achieved, and the effectiveness of the programme is demonstrated. Changes can be made throughout the programme to ensure consistency of implementation (Chicco, Spolaor & Nobile, 2023).

Thus, based on the logic model, the paper presents its own model for the development of a simulation programme that considers the available resources within the subject of military field surgery and describes the process of its implementation. To simplify the management and supervision of the programme, the teaching activities and their structure are described in detail. The impact of each activity is analysed separately, considering previous actions.

3.Materials and methods

The method described was an educational curriculum development method, specifically tailored for military field surgery training. The method involved defining a context-appropriate goal, which in this case was the integration of a simulation curriculum into the military field surgery curriculum. The curriculum was designed to cater to the needs of 5th-year medical students, with a focus on skills-based training to align with the requirements of the health system, medical advancements, clarity, and international standards for specialist training in war scenarios.The curriculum development process included the identification and description of macro-abilities and capabilities required for military field surgery practice, as outlined in the Competency Matrix. This included knowledge and understanding of data, problem-solving and clinical judgment, ethical attitudes, interpersonal relationships, and technical skills.

The curriculum was structured in three progressive stages: basic phase, intermediate modules, and consolidation phase. Each stage focuses on different aspects of knowledge and skill development, with the consolidation phase emphasizing interdisciplinary teamwork and autonomous practice.

The method emphasized a dynamic and progressive approach to training, incorporating various teaching methods such as simulation, flipped classrooms, and group projects. Additionally, it emphasized the importance of providing support for practice in hospital settings or dedicated training sites to allow students to gradually develop the necessary skills for safe and independent practice.

4. Research results

4.1 Stages of planning an ISP within the framework of the HLP using the logic model method

The first step is to define a context-appropriate goal, namely the integration of a simulation curriculum into the military field surgery curriculum. The WFS curriculum is part of the medical education for 5th-year medical students, which significantly changes the educational environment by using a skills-based approach to better meet the needs of the health system, medical developments, the need for clarity, and the need to meet international standards for specialist training, especially in war.

The Competency Matrix, published in 2012, identified and described the macro-abilities and capabilities that are required for the practice of military field surgery (Mayer, Yaremko, Shchudrova, Korotun, Dospil & Hege, 2023). These abilities include: knowledge and understanding of data, problem-solving and clinical judgment, ethical attitudes, interpersonal relationships, and technical skills.

The course is based on a dynamic progressive approach, which includes three stages. The first stage is the acquisition of basic knowledge and the initial development of skills necessary for professional activity during the basic phase, which lasts during the first intermediate module. The second stage is the further development of the knowledge and skills acquired during the basic phase, which lasts for the duration of the second intermediate module. The third stage is the consolidation of all professional knowledge and skills, including participation in interdisciplinary teamwork during the consolidation phase. This stage lasts for one month and is carried out in conditions of controlled autonomy (practice).

The professional practice programme should follow this stepwise progression and be organised in conjunction with other teaching methods such as simulation, flipped classrooms, and group projects. In addition, it should include support for practice in hospitals or at dedicated training sites so that students can gradually and dynamically develop the necessary skills for safe and independent practice.

4.2 Identification of organisational, material, human, public, and financial resources

To ensure that simulation practice is integrated with the curriculum, a special "coordination" group should be established that is scientific in nature. This group should include a university coordinator of the simulation centre and a teacher of the subject - a practitioner of military field surgery. According to the criteria of the Ministry of Education and Science, each higher medical education institution in Ukraine needs to establish a basic simulation centre that provides scientific methods for reproducing various environments specific to the healthcare sector. Such a centre should be equipped with simulation technologies such as procedural simulators, patient simulators, and video equipment. In addition, such centres should expand their capabilities by introducing virtual environments, such as a "multi-user virtual world", to train residents in decision-making, care chain organisation, and team communication skills to improve their professional training (Hostiuc, Latifi, Poropatich, Sokolovich & Doarn, 2017). For faculty teaching students in simulation centres, the support of practicing EMS physicians and nurses as assistants is necessary. As part of a military field surgery course, 40 hours of training and skills acquisition in simulation curricula should be allocated, along with 88 hours of practical work. The costs of this programme are usually financed from the internal budget of the educational institutions and university hospitals (if any). The working time of doctors (teachers) and nurses (as assistants) is considered as part of their work activities. It is recommended to work in simulation centres in groups of 20 people.

4.3 Comprehensive educational activities

The steering group organises learning activities around issues that are considered to be of high priority in relation to different professional situations, as derived from the competence matrix. These issues are prioritised based on their representativeness, prevalence, and impact. Simulation learning activities are divided into three phases to facilitate students' progress in building the resources (knowledge, macro-, and micro-competences) (knowledge, macro-potential and potential) required to perform the skills (Mayer, Yaremko, Shchudrova, Korotun, Dospil & Hege, 2023). Simulation in the first stage allows the development of technical competencies necessary for the practice of military field surgery. They are practised on procedural simulators during a series of seminars (Table 1):

Table 1 Formation of competences within the discipline of HPC.

Competence	Abilities
Integral competences	The ability to effectively solve standard and complex specialised tasks and practical problems in professional activities in the field of health care or during training, including research and/or implementation of innovations, and is characterised by complexity and uncertainty of conditions and requirements.
General competence	Ability to apply the acquired knowledge in specific life situations. The ability to control oneself and maintain a healthy lifestyle, the ability to adapt and act in new circumstances. Competence in choosing an effective communication strategy, ability to work in a team, and interact with other people. Abstract thinking, analytical and synthetic skills, active and modern learning. Determination and perseverance in completing tasks and fulfilling responsibilities.
Professional (special) competence	Organising the work of medical company units and a military mobile hospital and planning their functions. Administration and execution of documentation in the field of medicine, work with regulatory documents. Providing immediate medical and pre-hospital care to the wounded during hostilities and in emergency situations, transporting the wounded to medical facilities.

Source: Shevchenko (2019)

The clinical cycle training begins during the fifth year of study in accordance with the recommendations of the Ministry of Health. This stage includes two-day seminars and a self-study programme using a procedural simulator. A fully recreated situation is used in the seminars to develop interpersonal and communication skills that are essential for establishing good relationships between patients and medical staff. Students are faced with a specific war trauma situation and discuss the limitations of patient care in the field. The participation of a simulated patient ensures that the situation is realistic. The workshop is followed by a collective discussion to support a reflective approach and integration of knowledge.

The advanced stage (intermediate module 2) includes one procedural simulation session and six practical sessions. The advanced stage (practice) includes one simulation session and six practice sessions reflecting the learning outcomes (Table 2):

Table 2 Learning outcomes in the discipline of MFS.

Know	Anatomical and physiological basics of the human body, pharmacological properties of the main emergency drugs and antibacterial agents, medical ballistics, modern weapons and the impact of warheads and traumatic agents on the body, methods of diagnosing acute surgical pathology, treatment of emergency conditions.
Be able to	Assess the situation, take anamnesis of the disease (injury), examine the victim at the scene and during the stages of medical evacuation, provide emergency care for injuries and traumas, perform wound care, assess the victim's condition using severity scales and predict the course of the trauma process.
Demonstrate	An integrated approach to solving complex problems of providing assistance in the foci of massive sanitary losses, drawing up a treatment regimen for complex injuries, exhaustively analysing the indicators of laboratory and instrumental research methods, and analysing the quality of medical care.

Source: author's own development

Thus, subject-specific technical skills are taught during a simulation session lasting 3 hours and 30 minutes. The training is conducted in groups of six students who practice for 45 minutes each. The practice covers the elements of Advanced Life Support: chest compression, orotracheal intubation and manual ventilation, intraosseous ventilation, intraosseous catheterisation, and critical care recognition. Students are also offered an additional procedural simulation session. The technical skills acquired during this session are determined by independent work and student assessment of their needs. The in-depth simulation practice allows students to mobilise their knowledge and clinical thinking, and to transfer learning by doing by exposing students to complex situations close to professional practice and repeated in different contexts (scenarios). Each student participates in seven one-day sessions covering advanced cardiopulmonary resuscitation (CPR), life-threatening emergencies, severe trauma, and upper airway management. The session provides students with the opportunity to take turns facing a clinical situation to independently mobilise their critical situation management skills (leadership, communication, situational awareness, and teamwork coordination) (Helitzer, Hollis, de Hernandez, Sanders, Roybal & Van Deusen, 2010).

The level of complexity is the content and consistency of scenarios modelled on real life situations (Table 3):

Table 3 Typology of problems to be solved in professional situations.

A simple problem	**A complex problem**
All tips are available at a glance	The hints needed to solve the problem are not immediately available
- The solution requires familiar tasks - Can be solved with a high degree of confidence - Experts agree on the nature of the right solution	- The problem evolves as it is researched - The solution is not standardised, but unique - Cannot be resolved with a high degree of certainty - Experts often cannot agree on the best solution, even when the problem can be considered solved.
The goal: to apply the "right" solution	Objective: to develop and argue for one of the reasonable solutions

Source: Cooke, Rytwinski, Taylor, Nyboer, Nguyen, Bennett & Smol (2020).

Each simulation situation includes a debriefing, which is described as "an organised process led by the instructor in which students actively participate to help them identify and address deficiencies in their knowledge and skills related to the experience" (Liubchak, Zuban & Artyukhov, 2022). Students are offered five different simulation situations in which they actively participate in debriefing and observation. Active participation in debriefing is of educational interest in simulation (Bayliak, Abrat, Shmihel, Lushchak & Shvadchak, 2023). At the third stage (practice), teaching activities are aimed at developing the necessary skills to manage in non-standard situations, as well as teamwork skills. Classes on communication and doctor-patient interaction introduce students to different patient reactions. To develop the interdisciplinary skills presented in the interprofessional simulation, students are given the opportunity to consider their collaborative practices, such as the role and responsibility of each team member and team communication. This type of training also allows them to experience the pressure and stress of working as a team in extreme situations. The students participate in two interdisciplinary simulation sessions as a lead physician or team member: one session simulates the complex management of a patient with polytrauma and barotrauma, and the other session focuses on the transfer of a patient with polytrauma between the prehospital team and the intensive care unit team. The aim of this session is to improve communication and information transfer in critical situations. The final interprofessional session lasts for two days and teaches how to manage healthcare emergencies. Procedural simulation is used to train technical skills such as dressing, undressing, and disinfection, while management and care management skills are developed in a virtual environment.

4.4 Production results

Programme effectiveness demonstrates the degree to which the target audience is reached in accordance with the planned intensity, expected quality, and limited time resource. In the proposed programme model, the results are processed based on the number of simulation sessions in which students participated. Each student must attend 17 simulation sessions during the course. In this way, skill acquisition is facilitated through repeated practice in different situations that vary according to the scenarios and adjustments made during the sessions. This repeated contextualisation approach promotes the development of practical skills. In terms of assessing the quality of the simulation sessions, students are evaluated through quizzes that are included in the micro-modules.

4.5 Short, medium and long-term effects of simulation training

Skills that involve integration are assessed throughout the curriculum, both in simulated practice and in the workplace, following the following principle (Figure 1):

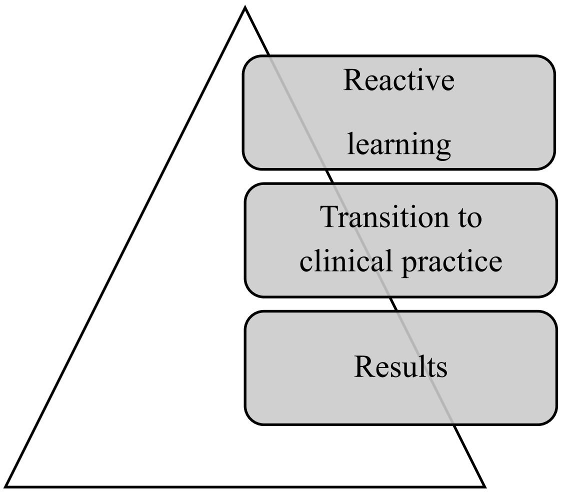

Figure 1 Author's own development

The number of hours of simulation practice required to master a skill depends on the student's personality and motivation (Bambini, Washburn & Perkins, 2009). The implementation of competency-based learning involves levelling all students to the same level of competence by adjusting the duration of the learning process (Zimmerman, 2023). This aspect indicates the need for systematic monitoring of each student's progress through the use of a learning curve and programme evaluation scale. The use of an electronic journal allows students to track their progress in developing technical and managerial skills in critical situations.

Student satisfaction assessment is planned to be conducted one year after completion of the course using a questionnaire that will determine the relevance of the skills acquired during the course of the medical field surgery subject to the needs at the beginning of their professional activity.

The integrative logic model approach refers to the method of conceptual design and implementation of an integrated simulation-based learning (SBL) programme with competency assessment in the development of surgical skills in medical students in the subject of medical field surgery (MFS). The main advantage of this method is to ensure curriculum coherence by coordinating educational objectives, learning resources, and pedagogical interventions. Simulation has its full definition according to which "a skill is a complex knowledge-action based on the mobilisation and effective combination of various internal and external resources, within a set of situations". Simulation provides favourable conditions for the development of conscious practice or reflective practice through the use of problem situations and tasks set in different contexts (scenarios), along with explicit and regular feedback (debriefing) (Kaminskyy & Viesova, 2022).

The logic model should integrate simulation exercises into the curriculum in relation to core issues contextualised in the form of different problem situations (Renau Renau, 2023).

L'Her, Geeraerts, Desclefs, Benhamou, Blanié, Cerf & Mossadegh (2020) described a simulation training programme in emergency medicine with a progressive approach in four stages: knowledge, decision-making, technical skills development, and teamwork. The first stage, knowledge, involves organising students' knowledge and developing it through experience. The second stage, decision-making, requires the adaptation of a diagnostic approach and the implementation of appropriate actions, taking into account the available resources, environment, and context. The third stage is the development of technical skills, which includes the understanding and ability to use the necessary tools and equipment to perform medical procedures effectively. Finally, the fourth stage is teamwork, where students have the ability to work together, make supportive decisions, and ensure interaction between team members. According to the authors, a student's ability to make decisions in emergency situations is linked to the gradual development of their knowledge, which is developed through experience (Potiy, 2023). This experience helps students to adapt their diagnostic approach and perform the necessary actions, considering the available resources, environment, and context (Tatarina, 2022). The final stage is reached when students make decisions adapted to the specific situation and implement the necessary actions as part of a team (Doyle, 2023).

In this context, in the model presented here, we aimed to use an approach that was both logical and scientific. We tried to achieve this by offering students gradually increasing levels of difficulty and by integrating simulation to ensure that the different teaching methods were complementary.

In our model, the student develops knowledge related to the organisation of pre-hospital care in a seminar (flipped classroom) at the basic stage, considering the professional situation. Skills related to good cardiopulmonary resuscitation practice, such as chest compression, ventilation, orotracheal intubation, peripheral venous tube, and catheter insertion, etc. are also taught.

During the procedural simulation, the student practices practical skills, such as the insertion of a peripheral venous line and intraosseous catheter, and the use of a massage board. These simulation sessions are focused on performing procedures.

The student then moves on to the ISP, where they work with an interprofessional team in a pre-hospital setting. During this session, the students are given all the information they need to solve the problem (simple and complex basic situations are presented to them).

5. Discussion

In continuity, the perspective of authentic assessment, which finds its place in the context of the curriculum, becomes important. The traditional distinction between formative and summative assessment used in competency-based programmes is becoming less and less relevant. In order to draw conclusions about a student, problem situations need to be assessed in terms of their complexity and the number of resources required. Assessment of student progress can be made based on changes in these indicators, as well as on the analysis of debriefings indicating skills that need improvement and strategies for achieving them, which the student records in the portfolio. The portfolio becomes a linking element in the development of skills between the student, tutors, and teachers in simulation training (Raza & Hussain, 2022). As a result, each student has the opportunity to progress in the simulation programme, develop at their own pace and be active in the learning process, adapting its pace to their own needs.

In a related study, Schumacher, Martini, Sobolewski, Carraccio, Holmboe, Busari & Lingard (2020) emphasise that the portfolio should evolve to include other dimensions of assessment, such as analysis of an emergency department discharge report or clinical case report. To scientifically analyse the impact of learning, Orhak (2023) proposes an extension of Kirkpatrick's model (Kirkpatrick & Kirpatrick, 2011). The author proposed to evaluate the impact of training using indicators such as the relevance of training activities to the needs of professional practice, achievement of learning objectives, use of knowledge in professional practice, and application of knowledge in professional activities by participants. According to Saunders, Vega, Ianelli, Cross & Attoe (2021), the impact of simulation training can be assessed using a learning effectiveness curve, assessing the match between needs and professional practice using a remote questionnaire, and assessing professional transition through the assessment of care effectiveness and workload of senior staff involved in the supervision of interns in care situations.

Let’s consider the conditions for the development of integrated simulation training programmes for the comprehensive development of surgical skills of students of medical HEIs in Ukraine in the conditions of war.

First and foremost, the capabilities and conditions in time of war are important task that can be solved with the use of modern technologies and tools and, of course, funding. First, you need the right software to conduct simulation exercises. In addition to the software, it is necessary to have special equipment for conducting simulation exercises. In addition to simulators, practical on-the-job training is an essential element of integrated simulation training programmes (Rad, Rad, Maier, Demeter, Dicu, Popa & Mărineanu, 2022). Students can learn under the guidance of experienced surgeons in a real operating theatre environment. This allows students to apply their theoretical knowledge and skills in practice, as well as receive feedback from teachers and experienced surgeons. It is also important to ensure systematic assessment of students' learning achievements during simulation training (Tsoli, 2023). Thus, the development of integrated simulation training programmes for the comprehensive development of surgical skills of students at medical universities in Ukraine is an important step in the training of qualified specialists in the field of surgery. Such programmes help students to acquire practical skills and masterfully perform surgical procedures, which contributes to improving the quality of medical education and training of qualified surgeons.

6. Conclusions

A logic model was a useful tool for designing and developing a simulation training programme. It took into account the integration objectives, the necessary complementarity of simulation with other teaching methods, and the main limiting factors, such as the availability of equipment and simulation-trained teachers. The logic model made it possible to adapt to the conditions of each institution and to develop a process for assessing what is important for students' learning progress and the impact of training on the quality of care.

6.1. Research limitations

Although the logic model contributed to the efficiency and consistency of the model presented, it did not ensure full quality. Therefore, each project should identify its weaknesses to evolve the logic model. Thus, there are several limitations of the logic model methodology. The first limitation is the incomplete coverage of the audience. The development of the training system began during the war, which led to funding problems and limited opportunities to conduct simulation training in various fields.

The second limitation of the presented model is the approach to the project. The creation of a learning system provides a fragmented vision of the curriculum within the competence-based approach. Using existing resources to develop competences through specific professional situations allows for the integration of a holistic learning system into the curriculum but does not allow for its full integration. There is a risk that some skills will not be covered by any learning system.

6.2. Suggestions for future research

Further work with a global approach to all interdisciplinary and interprofessional learning resources is necessary. This will allow the curriculum to be mapped to competency frameworks and assessed. This work should identify the professional activities that can be delegated to an intern who demonstrates sufficient competence in the area. Usually, each delegated activity has intermediate outcomes or skill markers that can be observed during development. Decisions regarding the student's progress and assumption of responsibility will be based on observations with feedback.

Taken together, these limitations remind us that the main risk of a logic model is that it remains unchanged and does not adapt over time. Logic models aim to describe planned activities and expected effects - the means to achieve the desired effects. This approach does not consider unforeseen and unintended effects, as well as uncoordinated resources (new teachers, new tools such as e-portfolios or new learning devices) or new partners in the system (representatives of students, users, and other disciplines). It is important to change the entire framework according to changes in the variables during the project period so that the project remains coherent and effective over time.

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