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CHALLENGE

S4L

Deliverable 2

Phase 1 - Activity 2

CHARACTERISTICS DESIGN REPORT

Author: Virginia Rodés

Objectives:
Determine the ideal characteristics for the design architecture, information flow and programming particularities of the platform

Coordinator: Virginia Rodés
Participants: Ernesto Pacheco,Leonardo Glasserman, Carolina Alcántar, Martina Carlos, Laura Icela González, Alejandra Ruiz, Gerardo Ibarra

1. Objectives

To design an efficient and effective logistics simulation platform, several characteristics should be considered. Firstly, the design architecture should be modular and scalable, allowing for easy modifications and expansion as the needs of the users and the platform evolve. The architecture should be flexible enough to accommodate different types of users, from students to entrepreneurs and researchers, and allow for the customization of user profiles and interfaces. It should also support the integration of open educational resources (OERs) and other educational materials.

Secondly, the information flow within the platform should be smooth and transparent. Users should be able to access the data they need quickly and easily, and the platform should provide real-time feedback and support to users during the simulation process. The platform should also be able to generate data and reports on user performance, decision-making, and other key metrics to aid in assessment and evaluation.

Thirdly, the programming particularities of the platform should prioritize the use of realistic and relevant logistics scenarios and data. The platform should incorporate demand forecasting and other relevant metrics, as well as allow for the simulation of different supply chain scenarios and logistics network designs. The platform should also incorporate features that promote complexity, systemic thinking, and problem-solving, such as randomized labyrinth structures and decision-making assistant tools.

Overall, the ideal characteristics for the design architecture, information flow, and programming particularities of the platform should prioritize flexibility, scalability, and relevance to real-world logistics scenarios. The platform should also prioritize user experience and engagement, incorporating features such as microlearning videos and gamification elements to enhance learning outcomes.

2. Evaluation of the existing platform by the interdisciplinary team.

In 2017, the GOAL Project was launched to support undergraduate students in their learning of supply chain management and to increase their engagement with learning. The project offers various innovative learning materials such as videos, notes, quizzes, simulators, and games, all accessible through an online portal. One of the most significant products of the project is the Logistics Simulation LOST, which is a serious game designed to help students understand the complexity of logistics systems and the decision-making process involved. LOST involves using forecasting techniques, designing production plans, selecting suppliers, choosing raw materials, and establishing quality levels. The simulation generates new conditions for further decision-making, and students can compare their performance with peers using a dashboard. The game promotes critical thinking and collaboration, with databases and software, and collaborative activities to encourage peer-to-peer learning. One advantage of LOST is that it provides indicators to help participants identify their primary areas of improvement and enables teachers to focus their teaching efforts accordingly. Students can also receive feedback and suggestions from teachers to progress towards their learning objectives.
Previous studies (Pacheco-Velazquez & Aguilar-Avalo, 2019; Pacheco-Velazquez & Viscarra-Campos, 2019; Salinas Navarro, Pacheco-Velazquez, Arana-Solares & Palma-Mendoza, 2020; Pacheco & Palma-Mendoza, 2021; Pacheco-Velazquez, 2022).show that LOST received positive evaluations regarding critical factors such as perceived usefulness, behavioral intention, student satisfaction, enjoyment, and resource efficiency. The game also shows a positive impact on skills development, such as reflection on learning and self-directed learning. There are significant correlations between the development of

these skills and student engagement, reflection, and self-directed learning, and student motivation significantly influences their development.
By evaluating the GOAL Project platform and LOST simulation, it is possible to identify the strengths and weaknesses of these resources and understand the needs for the development of simulators for specific fields and contexts. This information could be used to extend, adapt and improve the GOAL platform's resources and develop more targeted simulators to promote complex thinking and self-regulation in the logistics field, as part of the current S4L Project.

a. Current state of the platform: description, architecture, database, software.

Technical Architecture of the Logistics Simulator LOSTv1

Technical Information: Backend Framework: Laravel v6 (Programming language: PHP)
Frontend Framework: Vue2 (Programming language: JavaScript)

Design Pattern: The system uses the Model-View-Controller (MVC) design pattern. MVC is a technique used in software development to separate the presentation logic from the business logic and data management.

In simple terms, MVC divides the application into three main components: the Model, the View, and the Controller. Each component has a clearly defined responsibility and communicates with the other components in a structured and well-defined manner.

Model: The Model represents the data layer of the application, which may include object definitions, business rules, and data access logic. The Model is responsible for handling and storing data and has no direct knowledge of the user interface or presentation logic.

View: The View is the presentation layer of the application and is responsible for the visual representation of the data that has been processed in the Model. The View is responsible for displaying data in a user-friendly manner and has no direct knowledge of the business logic or data management.

Controller: The Controller acts as an intermediary between the View and the Model and is responsible for receiving user requests from the View, processing them, and sending the response back to the View. The Controller is responsible for the business logic of the application and makes decisions based on the data received from the Model.

In summary, the MVC design pattern is used to separate the responsibilities of data presentation, data management, and business logic of an application. This makes the application easier to maintain, scalable, and allows for greater code reuse. It also allows developers to work on each component in isolation and focus on their area of expertise without worrying about the rest of the application.

3. Need Analysis

The definition of ideal characteristics that will be adopted for different sectors aligned with Sustainable Development Goals (SDGs) 4 and 9. SDG 4 aims to ensure inclusive and equitable quality education and promote lifelong learning opportunities for all. SDG 9 aims to build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation.

The instruments will be developed and applied specifically to the logistics industry, taking into account the LOST simulator as a case study. The main objective is to identify the strengths, weaknesses, and needs for the development of simulators that can provide specific and adaptable training in different fields and contexts, while also promoting complex thinking and self-regulation skills.

To achieve this, the interdisciplinary team conducted interviews and virtual panels with experts from different sectors. These activities will be essential in gathering information on the needs and demands of different fields, as well as obtaining feedback on the current simulator. Through this process, it is expected to gather valuable insights that will inform the development of simulators that can cater to the specific needs of each sector while contributing to the achievement of SDGs 4 and 9.

a. Semi-structured Interviews with experts

Two individual and one group interviews were conducted during the month of April. Following we include a summary on their recommendations for improvement and design.

Expert 1: She is a 54-year-old woman with over 20 years of experience in the industry and a postgraduate level of education. She provides insights into logistics and emphasizes the importance of considering transport providers as an additional element to be included in the simulation. She suggests evaluating the best transport option for a particular company, such as a chain of dairy products that require routes transshipment. Expert 1 highlights the importance of circular systems in the logistics network and suggests including e-commerce as a direct client. She suggests the key criteria for decision-making in logistics, such as logistics costs, fixed and variable costs, service level, delivery time, and quality.
She emphasizes the importance of understanding the effects of decisions on others and taking responsibility for the social impact of the supply chain. She suggests using the simulator to measure the individual effect of a decision on others and reduce carbon footprint. She suggests that the use of AI can help generate logistic chains that reduce carbon footprint.
She also commented that the LOST simulator is best suited for the sector of industrial commerce and academic institutions that offer undergraduate and postgraduate courses. She recommends considering e-commerce as an essential element of logistics and stresses the importance of a commercial sense and urgency in decision-making.
She also suggests that the simulator can help individuals understand the cost of their decisions and their impact on logistics. She proposes some indicators of performance, such as time, logistics costs, and order completion. She warns that the cost of selling against the forecast is quite complicated, and it should not be included in the simulation.
Overall, Expert 1 emphasizes the importance of including transport providers, e-commerce, and the social impact of logistics in the simulation. She highlights the need to consider the

impact of individual decisions on others and reduce carbon footprint. She also suggests that the simulator is best suited for the industrial commerce sector and academic institutions.

Expert 2: He is a 40-year-old man with over 15 years of experience in the industry and a postgraduate level of education. The Expert 2 discussed various elements of logistics that should be included in the simulator. The first version was considered complete, but he suggested additional elements such as different levels of suppliers or a richer network for a better experience. He emphasized the importance of understanding the complexity of production and decision-making for improving logistical skills.

The expert also discussed the importance of including the service chain in the simulator. The service chain is broad and includes factors such as demand, delivery capacity, and branding. He highlighted the potential for developing industry-specific competencies through the simulator.
He also emphasized the need to exercise the freedom to generate different alternatives and evaluate each one to find the best solution. He suggested that the simulator would help in making better decisions and communicating them effectively. The technology-driven world has led to a lack of depth in understanding decision-making processes, and the simulator could provide the necessary depth.
The Expert 2 believed that small business owners would benefit greatly from the simulator as they may not have access to the necessary technology to address logistical issues. The platform would be useful for universities and businesses alike, with a potential to offer a freemium model.
Finally, the expert discussed the need to include elements of Industry 4.0, such as artificial intelligence and e-commerce, in the simulator. He also stressed the importance of making the simulator realistic and complex enough to offer value to businesses.

Group Interview with Experts 3, 4, 5, and 6: During the virtual panel, the experts discussed various recommendations and suggestions for the logistics simulator. Expert 3 proposed incorporating different modes of transportation, including air, to enhance the user's experience. Expert 4 asked about the characteristics of the modules, and Expert 6 cautioned against making the simulator too complex, suggesting a table of complexity levels for decisions. Expert 5 emphasized the importance of defining the target audience and tailoring the complexity levels to each user.
When discussing decision-making, Experts 3 and 6 agreed that the type of decision should depend on the user and their objectives. Expert 4 suggested accompanying the simulator with an educational program, and Expert 5 added that the platform should include market analysis and a course on systems theory or value chains. The experts also discussed customer transportation, facilities, and maintenance.
Regarding learning and competencies, Expert 5 suggested analyzing data and strategic management, while Expert 6 emphasized the importance of understanding logistics and finance. The experts agreed that the simulator could benefit those interested in logistics, and Expert 5 offered to support the team in creating a model canvas and recommending a methodology for defining the project's target audience. Expert 4 added that the simulator's development should also consider environmental costs, and users should be trained to prioritize sustainability.

Summary of recommendations.

Simulation Modules:
- New modules for the simulator
- Characteristics and complexity of the modules
- Decision-making within the simulator

Logistics Network:
- Elements of the logistics network
- Chains of services, including customer transportation, facilities, and maintenance
- Importance of considering transport providers and circular systems in simulation
- Criteria for decision-making in logistics and importance of e-commerce
- Social impact of supply chain and reducing carbon footprint

Target Audience:
- Defining target audience and tailoring complexity levels to users
- Competencies for using the simulator, including data analysis, strategic management, logistics, and finance
- Accompanying educational program for users
- Creating a model canvas and defining project's target audience
- Market analysis and courses on systems theory or value chains
- Small business owners could benefit greatly from the simulator

Simulation Technology:
- Incorporating different modes of transport
- Need to include different levels of suppliers and service chain in simulation
- Need to exercise freedom to generate different alternatives
- Need to include elements of Industry 4.0 in the simulator
- Making the simulator realistic and complex enough to offer value to businesses.

Sustainability:
- Environmental costs and sustainability

4. Evaluations of the students' perspectives

Evaluating the effectiveness of serious games can be challenging, and it is important to develop qualified serious games that ensure knowledge enhancement and learners' engagement and satisfaction.
As part of the research activities of the S4L Project, it was conducted a series of analyses of existing databases of responses to two different research instruments, since 2017 to 2022, from industrial engineering students of Tecnologico de Monterrey, evaluations of the simulator selected as case study, LOST.
The article currently in evaluation, "Pacheco-Velazquez, E., Rodés Paragarino, V. & Salinas-Navarro, D (2023) Developing learning skills through game-based learning in complex scenarios: a case in undergraduate Logistics education. Journal of Technology and Science Education, suggests that the serious game platform contributes to developing

self-management skills, openness to learning opportunities, initiative and independence in learning, self-concept as an effective learner, and enjoyment of learning.
The article currently in evaluation "Rodés-Paragarino, Virginia, Pacheco-Velázquez, Ernesto Armando & Ramírez-Echeverri, Sergio Augusto (2023). Students' experience in using simulators for the development of complex skills in logistics education: assessing enjoyment of learning. Journal of Education for Business, presents an evaluation of the Logistics Simulator LOST, using the EGameFlow scale to measure students' satisfaction and enjoyment of learning. The results show that LOST is highly valued by students for knowledge development in logistics and enjoyment of learning."IMPROVEMENT OF LEARNING", "GOAL CLARITY", and "AUTONOMY" are at the top dimensions of satisfaction, with a range that exceeds 65% and does not reach 75%. "IMPROVEMENT OF LEARNING" scores 72.7%.
Finally, the article currently under evaluation, "Rodés-Paragarino, Virginia, Pacheco-Velázquez, Ernesto Armando & Frango Silveira, Ismar. "Students' Perceptions of a Logistics Simulator: A Grounded Theory Conceptual Framework for Student-Centered Simulations for Learning. International Review of Research in Open and Distributed Learning", analyze the students' open responses regarding satisfaction, revealing various critical areas that students highlighted from the simulation-based learning experience, results that led to the construction of a Conceptual Framework for Student-Centered Simulations for Learning, a set of student-centered components, grounded in students' perceptions, with implications for research and practice in designing, executing, and evaluating student-centered simulation-based learning experiences in higher education..

5. Results and future activities

Recommendations of the logistics experts for future S4L simulator and platform allowed us to identify areas for development, with the objective of improving logistical skills and decision-making processes in different stakeholders.
The simulator should incorporate new modules to better represent the various elements of the logistics network, including different modes of transport and chains of services. The modules will be designed with characteristics and complexity levels tailored to the target audience to enhance their competencies in data analysis, strategic management, logistics, and finance.
Users of the simulator will have access to an accompanying educational program that includes courses on systems theory, value chains, and decision-making within the simulator. A market analysis will be conducted to define the project's target audience and create a model canvas for the simulator.
The environmental costs and sustainability of logistics will be a key consideration in the simulator, with a focus on reducing carbon footprint and considering circular systems and transport providers. Criteria for decision-making in logistics will also be emphasized, including logistics costs, service level, delivery time, and quality, as well as the importance of e-commerce in the supply chain.
Small business owners will benefit greatly from the simulator, which will also incorporate elements of Industry 4.0, such as artificial intelligence and e-commerce. The simulator will be best suited for the industrial commerce sector and academic institutions. It will be designed to be realistic and complex enough to offer value to businesses, while also allowing users to exercise their freedom to generate different alternatives.

In summary, the logistics simulator of the future will provide a comprehensive platform for enhancing logistical skills, decision-making processes, and competencies. It will take into account environmental costs, sustainability, and circular systems, and incorporate new modules and elements of Industry 4.0. The simulator will be tailored to the target audience and be designed to be realistic and complex enough to offer value to businesses.

Future need analysis activities involve the contrastation of these recommendations with insights from the entrepreneurs. The semi-structured group interview with these stakeholders will be developed during the month of May.