BUNG

Developing nearly zero energy building skills through game-based learning

Project n°2020-1-FR01-KA202-079997

IO 2 - BUNG learning game: technical and content specifications

Co-funded by the Erasmus+ Programme of the European Union

Table des matières

Co-funded by the Erasmus+ Programme of the European Union

Introduction

The BUNG is an Eramus+ project with the aim of delivering knowledge, developing zero energy building skills, and encouraging energy-efficient behavior amongst building occupants through the development of an nZEB (nearly Zero Energy Building) learning game (BUNG game) that maximizes the learning effect of individuals, as well by introducing innovative pedagogies and learning approaches.

Many vocational education and training centers (VECs) struggle to retain students and to engage them in a meaningful way. It is agreed that VEC student retention may be due to methods used for teaching. Students may have a low self-esteem, feel uncomfortable asking for help in a physical classroom, and prefer a media that leverages the technologies that they are familiar with (e.g., gaming). Gaming technologies seem to be able to address many of these challenges and offer players different means to solve problems with a precise feedback and reward system.

In this direction BUNG Consortium Partners decided to develop a game-based learning methodology and devote IO2 to the development of a serious game: BUNG with a twofold aim:

- Encourage construction workers to improve their zero energy building skills
- Motivate VET educators to make a shift in their didactic approach and start experimenting with innovative methods and digital based tools.

Within the development phase, the consortium elaborated the technical and content specifications guidelines (feasibility study). More specifically, this activity includes the development of the components of the BUNG platform and the definition of the platform's functional requirements, considering the target audience learning characteristics and good practices for game platforms design and development.

Co-funded by the Erasmus+ Programme of the European Union

Technical specifications

The BUNG game presents the player with an opportunity to learn about the construction of an nZEB, from project finance, constructive materials, and European regulations you can explore and receive feedback on the 3 short levels presented by the game. The challenge will be making the correct choices and balancing costs against benefit in terms of energy consumption.

The game uses elements commonly found in strategy games to structure its gameplay, but it's intended as an educational serious game. With mechanics that involve resource management and building monitoring the logical consideration was using PC as the main platform for playing of the game, due to the easiness that a keyboard and mouse would provide to the average user of the game. Since the game was thought to be delivered to different actors of the construction industry: teachers, trainers, learners, construction professionals and construction workers, it was decided that the game should be available for windows, due to the large share of the market that has windows as it's main operating system for PC.

One of the challenges of the game design was putting together many different topics of knowledge belonging to the construction industry, which by itself is already an immensely extensive objective, the goal was however, to extract some of the main ideas that apply to nZEB and fuse them together in a narrative and interactive experience that was fun and educational at the same time, for that reason the game has two different gameplay approaches, one in 2D with dialogue based scenes and one in 3D with an isometric Sim-like strategy mechanic. We have divided it in the following sections: Project finance (2D), Building envelope (3D) and energy performance certificate (2D). each level visually and mechanically designed to be accessible and appealing to a wide range of users.

The choice of a game engine in which our developers had previous experience and that could provide us with enough versatility to develop any scenario was fundamental, for that reason the game was developed using the engine Unity (version 2021.3.7f1).

Regarding the user interface the objectives included:

- An intuitive Ui, optimized for easy navigation and object placement if required.
- Detailed tooltips and feedback that guides the player.
- Comprehensive menu with visually identifiable variables for managing resources.

Co-funded by the Erasmus+ Programme of the European Union

Minimum system Requirements:

Operating System:

Windows 7/10

Processor:

1.2GHz processor

RAM:

2048mb

Storage:

850 MB

Content specifications and game design

According the given LOs, the different game scenarios were required to include:

- Informing learners of the objectives (expectancy): Information about the objectives of the game and description of how to 'win'.

-Providing feedback: in the form of communication messages, prompts, scores, and character conversations. The game will have to provide players with a sense of progress.

-Assessing performance: informing the player about assessment methods and criteria.

The game was divided in 3 levels that completed the experience according to que requirements, this was intended to represent 3 main phases in a construction project, project finance, building envelope and finally energy certificate. Each one of this levels presents introductory information, a gameplay challenge, feedback and some form of assessment.

Co-funded by the Erasmus+ Programme of the European Union

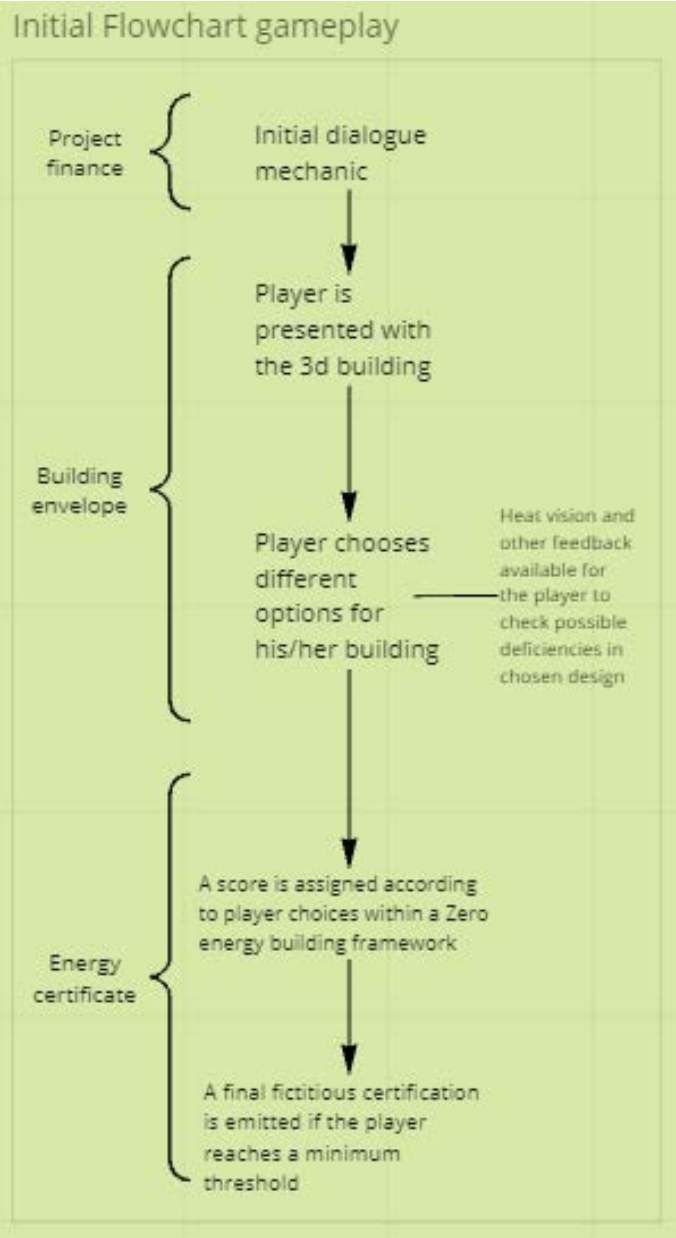

Figure 1. Game flowchart

General narrative design

The player assumes the role of a construction contractor and his client is a family from the Mediterranean area of Spain, composed of a couple with one kid, his objective will be to guarantee high levels of comfort are reached while maintaining a low impact on the environment.

Though keeping a simple approach, the narrative had to comply with a minimum set of requirements to be able to set the player in the right direction that was desired through the game, we strived to achieve a simple yet consistent dialogue that followed the academic content and was kept in line with the gameplay mechanics and the scenarios presented.

Co-funded by the Erasmus+ Programme of the European Union

Figure 2. level 1 Dialogue scene

Level 1

In this initial phase of the game the player assumes the role of a contractor that is hired by a family to remodel their house. In here the player is presented with a dialogue mechanic that contains questions involving the project finance, and according to the player answers an amount of money will be allocated to his resource bar for the next level. The effect is cumulative since bad responses here will mean less money to spend making him compromise his choices affecting his overall score.

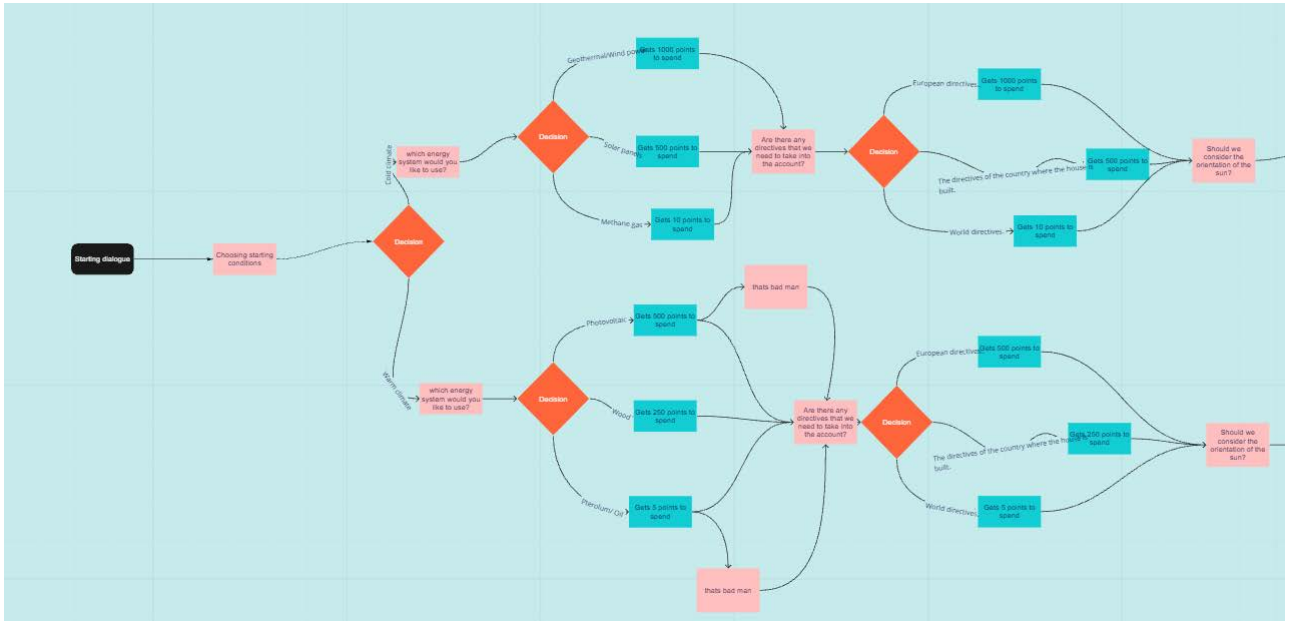

Figure 3. Sample of player decision options on level 1 (project finance)

Co-funded by the Erasmus+ Programme of the European Union

Level 2

In the second level the player is presented with an isometric view of his map that includes the building and an UI with all the available choices. He will have tools at hand to evaluate how the building behaves, to be able to monitor and control variables such as the temperature and amount of light, he can visualize how they behave by using the Heat Vision option.

The game intended to follow the content guidance provided by the different actors involved in the project, according to their specialization the topics included: building envelope, HVAC and lighting, financing, energy certificates.

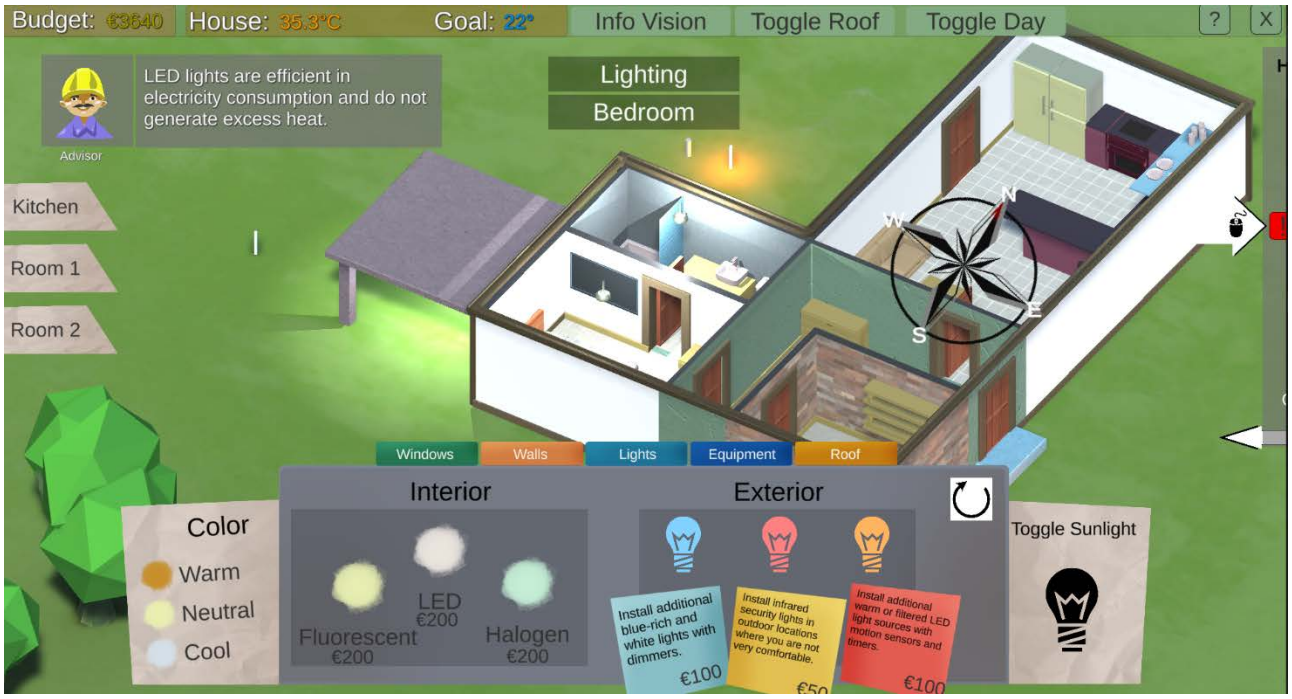

Figure 4. level 2 Isometric building scene

Each partner was in charge of providing an accurate academic background to the different challenges the player is presented in the game, as presented here:

•1 Project Finance - SCVAP

•2 Building envelope - PETRA PATRIMONIA CORSICA

•3 Heating, Ventilation and Air Conditioning (HVAC) - BZB

•4 lighting - GSZ

•5 Energy performance certificate - PEDMEDE and SOCIAL MIND

Co-funded by the Erasmus+ Programme of the European Union

Some of the topics that were discussed to be included in building envelope level were:

- Knowledge of the type of materials and their performance.
- The elements on which to make choices could be:

  Insulation materials

  Where to place the windows.

  Typology of windows.

  Type of walls.

  The structures of the buildings.

  Distribution of interior spaces (max. three rooms to be defined)

Regarding the mechanics of the game the effect of the different decisions reflected in value changes of the main resource variables that we use to control how the player uses the game, when the player makes a choice he gets either a raise or a reduction in his resource variables as is shown in the figure below:

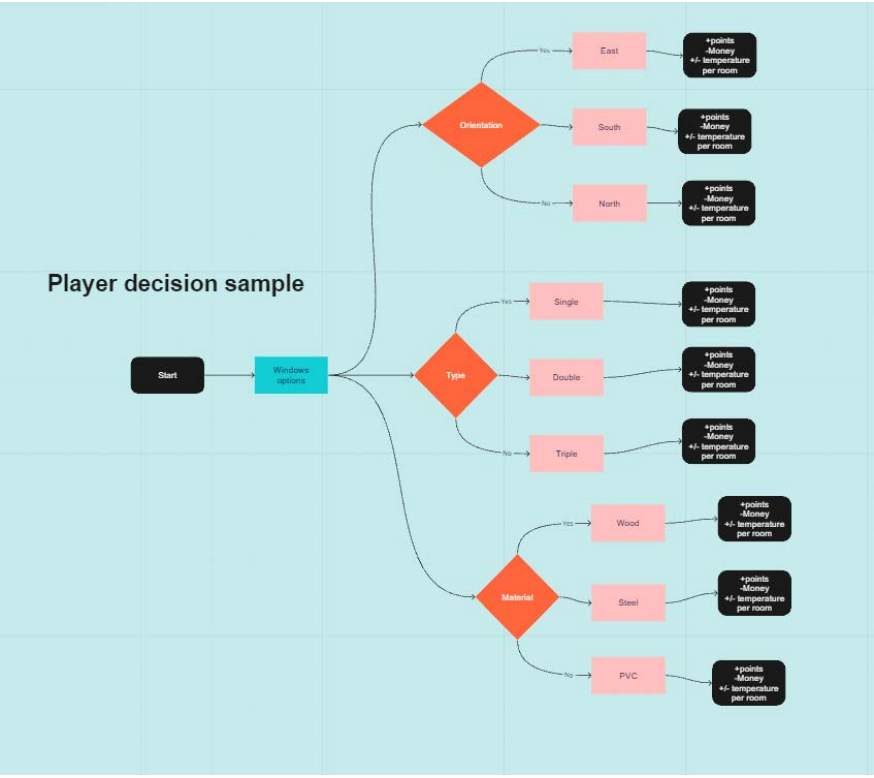

Figure 4. Sample of player decision options on level 2 (project envelope)

Co-funded by the Erasmus+ Programme of the European Union

Special systems or equipment

Daylight tubular devices, Air conditioning unit, evaporating cooling system, mechanical ventilation with heat recovery, all these elements provide benefits in terms of light and temperature (counted in points and temp value changes according to table 1.), the player will choose if using them or not in the building envelope menu.

Temperature system and humidity

Each element sums or reduces a value of temperature to each room, in a way that the player can see through the heat vision system if the temperature is adecuate or not. Base temperature in each room for warm weather: 32 degrees Celsius.

In the special equipment the player is offered a more costly option of using an air conditioner unit, MVHR or an Evaporative cooling system, each of which will change temperature in the whole building by the following values:

MVHR====+5 degrees celsius

Evaporative cooling system==== -3 degrees Celsius

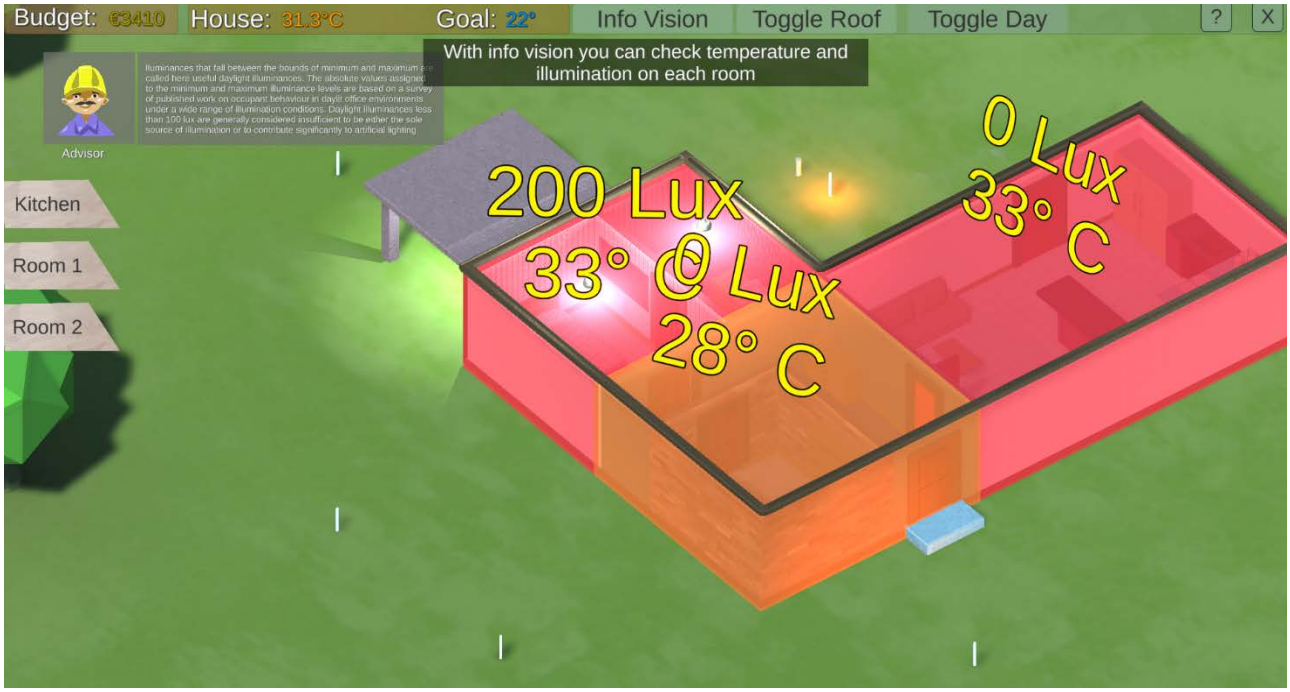

Figure 5. Info vision in level 2

Co-funded by the Erasmus+ Programme of the European Union

The house will have a random humidity starting point, that follows the possible ranges presented in the graphic for relative humidity. Being the ideal humidty beetween 40 to 60 the player will be presented with the option of choosing or not to have a evaporating cooling system that will take the humidity to those ranges. He can visually have feedback on how the humidity inside the house is behaving with an Hygrometer on the UI or just add it into the upper bar as a value.

Building envelope menus

Windows

Select orientation	Points	T change	Select Type	Cost	Points	T change	Select material	Cost	Points	T change
East	500	0,5	Single	10		-0,5	Wood	25	500	0,5
South	1000	0	Double	20		0,5	Steel	35	500	-0,5
North	10	-0,5	Triple	30		0	PVC	20	500	0

Main material (Walls)

			Primary insulation				Main material			
			Select Type	Cost	Points	T change	Select material	Cost	Points	T change
			Metal insulation	50	10	-3	Brick	80	500	-2
			Wood insulation	40	500	-1	Concrete	100	500	-1
			Air insulation	20	1000	0	Wood	30	200	1

Secondary materials (Walls)

Color			Secondary insulation				Finishing material			
Select Color	Points	T change	Select Type	Cost	Points	T change	Select material	Cost	Points	T change
Black	10	0,5	Raw earth	50	10	-1	Straw	200	1000	-2
Brown	500	0	Glass	80	500	-1	Mud	100	500	-2
White	1000	-0,5	Paper	80	1000	-3	Granit	320	200	-2

Roofs

Select Color	Points	T change	Select Type	Cost	Points	T change	Select material	Cost	Points	T change
Black	10		Gable and valley ro	200	1000	-2	Concrete	100	500	-2
Brown	500		Flat roof	200	1000	-2	Clay Tiles	30	1000	-2
White	1000						Asphalt shingles	30	1000	-2
							Polyuretane foam	100	500	-2

Lighting

Select Color of lights (interior)	Cost	Points		Select Type of ligh	Cost	Points	Lux	Select type of light (exteri	Cost	Points
warm white (2,500-3,000K)	200	10		LED lamps	200	1000	200	Install additional blue-rich and white lights with dimmers. (Blue/white lights plus dimmers)	100	500
neutral white (3,000-3,500K)	200	500		Fluorescent lamps % CFLs	200	500	100	Install infrared security lights in outdoor locations where you are not very comfortable. (Infrared lights)	30	1000
cool white (3,500-4,500K)	200	1000		12V halogen lamps and 230V halogen lamps	200	500	100	Install additional warm or filtered LED light sources with motion sensors and timers. (Led lights with motion sensor)	100	500

Figure 6. Internal variables change on level 2 and different menu options (project envelope)

Co-funded by the Erasmus+ Programme of the European Union

Level 3

In the third and last level the player will be presented again with a dialogue mechanic, this time he needs to present his achieved solution to a building inspector, that will evaluate first if he is an expert on the topic, and second the choices made in the previous phase. This level was intended to assess the player.

Finally, he will be issued a fake energy certificate, in which the player can receive feedback of some bad decision he made in the previous phases.

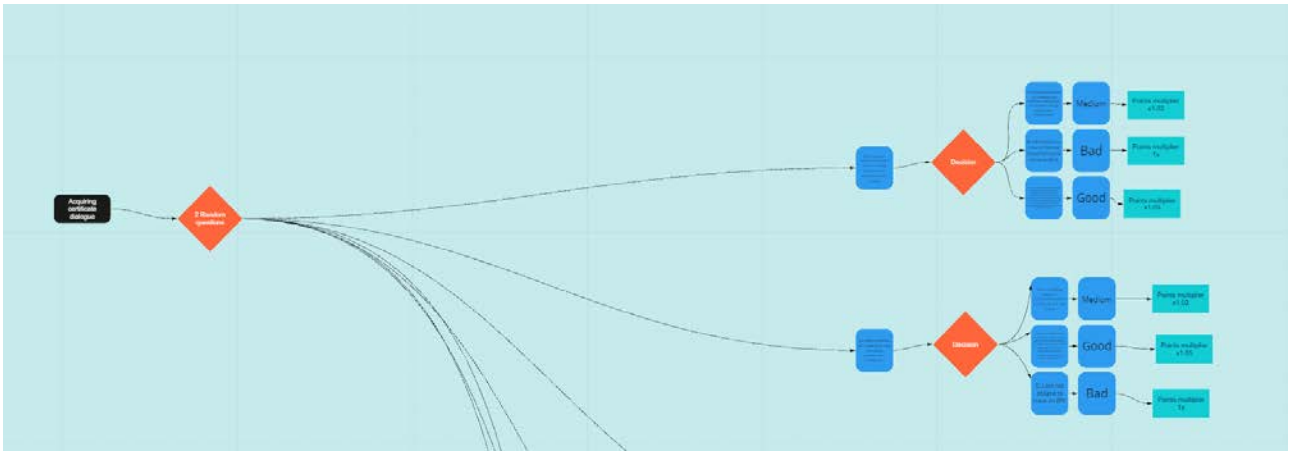

Figure 7. Sample of player decision options on level 3 (Energy certificate)

Co-funded by the Erasmus+ Programme of the European Union