APPLYING GAMIFICATION MECHANICS IN AN ENVIRONMENTAL EDUCATION SPOC

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Abstract

This paper presents an application of gamification mechanics in a Small Private Online Course (SPOC) aiming to raise environmental awareness among students of primary and secondary education, which was developed in the framework of the Erasmus+ KA203 project titled TEASPILS: Teaching Environmental Awareness with Smart IoT Planters in Learning Spaces. Project TEASPILS engages young people and their teachers towards ecological learning spaces via the SPOC, with actions aiming to promote awareness of environmental issues in an educational context, by utilising advanced technologies and gamification methods in its teaching and learning methodology. The course initially targeted 30 learners in order to strengthen environmental awareness and to build responsibility among them, show connections in the natural sciences, and improve the social and indoor climate through plants in classrooms.

Keywords: Gamification, IoT, Environmental Education

1 INTRODUCTION

In this paper we present our work for applying gamification mechanics for a Small Private Online Course (SPOC) in Environmental Education, which was developed in the framework of the Erasmus+ KA203 project titled TEASPILS: Teaching Environmental Awareness with Smart IoT Planters in Learning Spaces (agreement 2020-1-ES01-KA203-082258). The TEASPILS project focuses on creating environmental awareness towards plants and greenery, educating young people and their teachers towards ecological learning spaces, and its actions aim to promote and to foster awareness of environmental issues in an educational context. The project team designed a SPOC for 30 learners to introduce the project goals and strengthen environmental awareness, build responsibility among students, show connections in the natural sciences, and improve the social and indoor climate through plants in classrooms. The SPOC is structured in 5 online sessions of 2 hours each and a final session with physical presence. These sessions cover a range of topics such as Smart Planters, the connection of plants with Humans and society in general actions research, and sensors and visualisation technology. The SPOC is delivered using the Moodle Learning Management System (LMS) and includes multimodal content and activities. In particular, the course includes content in the form of video presentations, reading material, links to relevant websites, discussion forums for learners to introduce themselves and promote collaboration on topics related to the project. Moreover, it introduces a self-evaluation quiz for each session and various activities, such as to prepare a learning scenario for a plant education course.

A practice that finds increasing usage in the educational domain is *gamification*, which refers to the application of game design elements in non-game contexts (e.g., classroom, training, marketing, fitness apps). Gamification is used to engage and motivate users, provide the element of fun, challenge, competition, and provide meaningful feedback to learners. To increase participation and engagement for the SPOC, we proposed certain gamification mechanics such as badges, leaderboards, a level up system and certificates which were implemented and fully integrated in the LMS and applied in the specific group of learners. We present these gamification elements and how these are applied in the aforementioned SPOC. A badge system is incorporated in the course and is connected to the self-evaluation quizzes and collaboration activities. In addition, a number of badges are designed in that context and manually assigned to learners when they complete a certain task. Since the group of learners is diverse, we also proposed additional gamification mechanics to accommodate the needs of different types of learners, such as leaderboards which are more suitable for learners who are competitive.

This paper also includes some early measurements on how the learners interacted with the course. To conclude, we provide pointers to our future work for designing a more general gamification approach for the different activities and components of the TEASPILS project.

2   COURSE DESIGN AND THE ELEARNING PLATFORM

One of the central outputs of the project is the delivery of a Small Private Online Course (SPOC) which focuses on promoting environmental awareness using plants and ambient technologies in schools. In the first instance, the SPOC supports the participants in their tasks during the pilots. Accompanying material is provided for the participants, especially for the supervisors of the pupils (e.g. class teachers). As seen in Figure 1, a user-friendly SPOC webpage makes it easy for learners to choose a session and interact with its content as well as with other learners.

Instructions for actions in inquiry-based learning, such as plant care, are also made available in this online course, as well as instructions and guidelines on how to use the provided technology (hardware & software). Teaching materials to introduce young children to the Internet of Things (IoT) in combination with engaging with learning and ambient technologies are developed to support the exploitation by the pilot schools. In addition, the exchange within and between pilot groups can be enabled and promoted on the online platform, and direct support from the project team can be requested.
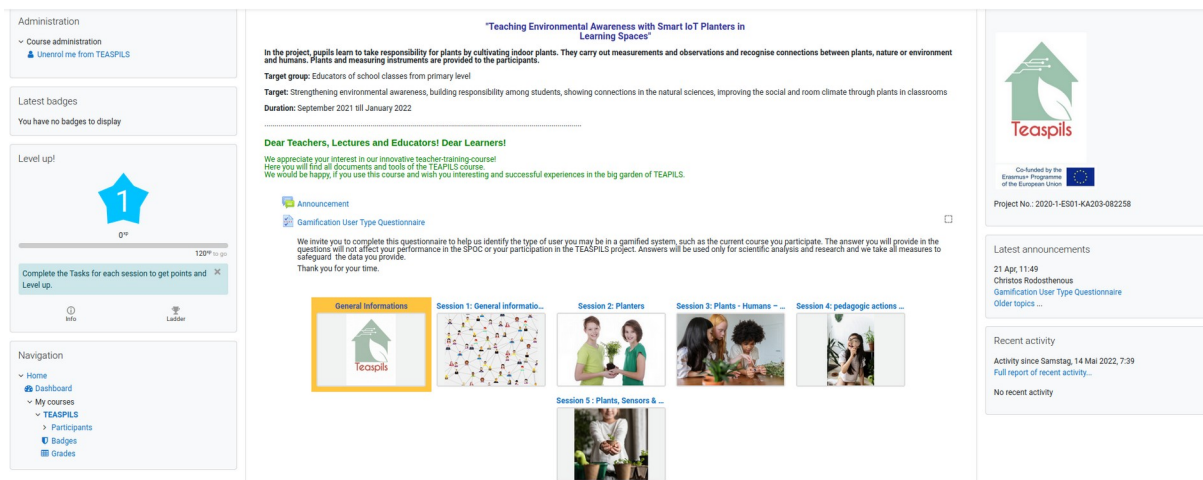

Figure 1: A screenshot of the TEASPILS SPOC homepage depicting the main area where learners can choose a session and interact with its content.

The second phase of the TEASPILS project foresees the transformation of this SPOC into an unguided self-study open online course, to be released as an Open Education Resource (OER). This means the current content of the SPOC will be shared openly through an open licence and access to the course will be opened up to everyone. This online course not only serves the continued exploitation of the developed materials and methods, it also enables self-study and deep learning of the topic area. Teachers will be able to use the provided OERs in their own settings and adapt them to suit the learning needs of their students or pupils, focused on digital skills and environmental awareness.

2.1   Syllabus and Activities

The SPOC is composed of 5 units/sessions, each of which includes a 2 hour synchronous lecture while the educational content is also made available to learners asynchronously. Each session is recorded and can be viewed at any time. The 5 Sessions are briefly described In the next paragraphs.

Session 1 - General information & getting to know people: In this session we welcome learners to the SPOC and to the TEASPILS project in general. We also explain the learning goals and the requirements for the course, i.e., tasks, procedures, expectations. In this session we expect learners to introduce themselves and to get to know each other. The presentations touch topics such as the influence of plants on learning behaviours, plants and room climate, plants and the classroom community and provide the opportunity for brainstorming on common/country-specific indoor plants.

Learners are encouraged to use the course forum to introduce themselves and start a discussion on their interests. Moreover, learners are introduced to the ILDE+[1] community portal where they can explore, find, and share learning activities for teaching environmental awareness.

Session 2: Plants/plants requirements/planters: In this session we discuss input criteria and/or work out criteria for plants in classrooms and considerations for selecting plants. This discussion extends to which plants are recommended for classrooms and initiates a dialog with the participants on which rooms/classrooms in their school may be used for placing the plants. Learners are presented with recommendations for soil, watering, fertilisation, light and indoor plant care, signs of health and plant growth, and photosynthesis.

In terms of activities, learners are introduced to a "Plant Diary'' which is used to record when the plant was bought/ brought into class, the location of the plant in the classroom - light/ shade, how often it needs water and how much, and how much the plant grew in the last month. They are asked to select and buy a plant for their school/ classroom and create a 2 minute video explaining why they have chosen the specific plant and their video is uploaded to a course forum and made available to other learners for viewing it.

Session 3: Plants - Humans – Society: In this session we discuss the influence of plants on humans and society, focusing on generating awareness of the meta-physical impact of plants on humans and society, and providing ideas for learning activities based around human-plant relationships. In addition, we present possible threats to plants, biodiversity and Sustainable Development Goals (SDGs).

Learners are asked to answer a questionnaire to prepare for Session 4 of the SPOC. In case some learners did not complete the activity of buying a plant in Session 3, they are asked to do so.

Session 4: Pedagogic action research: In this session we reflect on the teaching-learning goals and their circumstances. We analyse the answers from the questionnaire, and we discuss inquiry-based and exploratory learning. During this session we also present research and Citizen Science possibilities and discuss the development of teaching-learning settings.

Session 5: Planters, sensors and visualisation technology: In this last session we discuss sensors and measurement technologies, providing information on handling sensors and main issues for handling parameters. This session focuses on sensor data for learning activities, dashboards, and more specifically the TEASPILS dashboard.

Learners are presented with learning activities using the data visualization dashboard and they are asked how the dashboard could be used in different learning activities, providing the means for a brainstorming & sharing of ideas activity.

It is noted that gamification mechanics are built within all Sessions' activities in ways that encourage the participants to increase their engagement and their understanding of the underlying materials. Participants who complete the SPOC activities will also attend (in physical presence) a workshop where we will discuss and exchange experiences on the project and walk through the design of learning activities.

2.2   SPOC and Content Design

To host the SPOC, the project team setup a course on the Moodle Platform. That course is not accessible by everyone, but only from the SPOC participants which were selected by each of the participating institutions. Each member of the project team was responsible for a section of the SPOC, its contents and its activities. The layout of the course comprises six sections, one section for each session and an always visible section which includes general information on the SPOC and an area for announcement forums and questionnaires. To present a unified output to all sessions, the project team decided to use the following design: 1) At the start of each section the tasks and objectives of the session are visible along with the syllabus, 2) Next, comes the educational material in the form of presentations, videos, and useful links, 3) Following are the activities for the particular session, and 4) the self-evaluation activity.

For preparing the content, presentation templates created by the project team were used. All presentations were converted to pdf files and uploaded to the corresponding section. Tasks and activities were materialised using either a forum type activity in Moodle which allows collaboration or a quiz type of activity.

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1 https://ildeplus.upf.edu/teaspils/

After each Session, a self-assessment quiz was provided to allow learners to identify their progress. These quizzes included questions relevant to the presentations and content of the particular session. Each quiz could be attempted unlimited times and the highest grade of these attempts was recorded. The quiz activity was marked as complete when the learner achieved 50% of the required score.

3   APPLYING GAMIFICATION MECHANICS IN THE SPOC

Gamification [1,2,3] is the process of applying game design elements in non-game contexts (e.g., classroom, training, marketing, fitness apps) with the purpose to engage and motivate users towards a task, by providing the element of fun, challenge, and competition. Current research has shown that gamification is indeed a good approach in the educational domain [4,5] as long as it is focused on the specific learning needs of the learners. In line with these results, the TEASPILS project will develop a gamification framework to utilise digital sensor evidence for pedagogic environmental awareness purposes. Gamification has been used as a pedagogic strategy for student engagement for some time, and it is the objective of this work package to integrate this into the TEASPILS pedagogic model, especially the collected datasets from the various ambient technologies and sensors offer themselves for devising quantitative gaming strategies, such as leaderboards, points, levels and other comparative competitions between plants, pupils and at inter-school level.

Gamification in TEASPILS aims to make sensor data and the use of technology in plant care interesting and engaging also to younger pupils (primary level). Gaming theory will be used to create a framework of pedagogic models that can be used in environmental teaching activities. The output is divided into two timelines: At the outset of the project, based on the equipment used and the teaching materials being developed, a first plan to integrate gamification elements in the pilot study will be generated and implemented. This also contains a personal dashboard based on learning analytics from the evolving datasets. The second phase is started as a follow-up to the pilots and evaluation. It will generate a theoretical framework based on the analysis of the experiences with learning analytics from the pilots and its pedagogical usage. This framework will be consolidated into an Open Online Course as a sustainable pedagogic model including assessment models to outlive the project period and inform future adoptions.
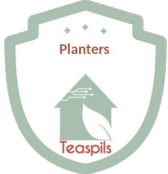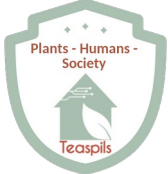
In this work, we present the gamification mechanics chosen for the SPOC and how these are applied in the Moodle eLearning platform used to increase the engagement and participation of the learners on the SPOC. The objective of the gamification approach used is to increase the participation of learners to the activities of the SPOC and to the delivered content throughout the duration of the course and not only within the 2 hours per session for synchronous learning.

The application of gamification in the SPOC approaches learners using a badge system where learners are awarded a badge when they complete all tasks and self-evaluation quizzes of a session, a point system where learners acquire points for performing certain tasks in the SPOC, a leaderboard and a level up system which are directly connected to the point system and provides learners the means to compete with other learners on getting higher in the leaderboard and getting to a higher level. This is in line with similar approaches used by others in the field [6,7]. Moreover, at the end of the course and when all conditions are met, i.e., a learner gets all session badges, learners receive a certificate of completion.

3.1 The Badge System

To implement the badges we used Moodle integrated badge system and provided a set of completion conditions for the activities. There are seven badges available, five of which correspond to one badge per session and two badges which are awarded when certain activities are completed at the eLearning platform. In Table 1 we present all the badges available and the conditions for awarding them.

Table 1. A detailed presentation of the badges available to learners of the TEASPILS SPOC.

Badge	Title	Conditions
Intro to Learning Spaces — Teaspils	Intro to Learning Spaces	Learners start a discussion at the "Welcome and introduction" forum Complete the Session 1 - Self-Assessment quiz
Planters — Teaspils	Planters	Complete the Session 2 - Self-Assessment quiz
Plants - Humans - Society — Teaspils	Plants - Humans – Society	Complete the Session 3 - Self-Assessment quiz Answer the Preparation for Session 4 Questionnaire
Inspired by Citizen Science — Teaspils	Inspired by Citizen Science	Complete the Session 4 - Self-Assessment quiz
Dashboards in my teaching — Teaspils	Dashboards in my teaching	Complete the Session 5 - Self-Assessment quiz
Activity Platform User — Teaspils	Activity platform user	Manually awarded to participants who register to the ILDE+ platform and view the activities already shared by other learners. Learners also need to add a comment at least to one of the existing activities.
Classroom Plant Shopper — Teaspils	Classroom-plant Shopper	Automatically awarded to participants who buy a plant and post the reasons they chose the particular plant in the forum.

To automatically award a badge we use the Moodle activity completion feature and choose the criteria, i.e, a forum post, a minimum grade achieved on a quiz, etc.

3.2 The Point System - Leaderboard and Levels

Another popular game mechanic is the use of points. Learners get points when they successfully complete certain tasks. In the TEASPILS SPOC we used such a system based on the "Level Up!"

plugin[2]. For the purposes of the SPOC we setup the system for 10 Levels and each learner moves up a level when they reach a predetermined level of points. Learners get points for logging into the platform, viewing content and completing tasks using Moodle activities. The number of points given are chosen based on the importance of the task. For example, completing an activity gives more points than just logging to the platform.

This plugin also allows learners to view their individual points and level, and also have access to the leaderboard where they can compare their achievements with those of other learners. In Figure 2, we present both the leaderboard (left) and the "Level Up!" block (right). The leaderboard presents the level of each user, the number of points accumulated and a progress bar depicting the number of points required to move to the next level.
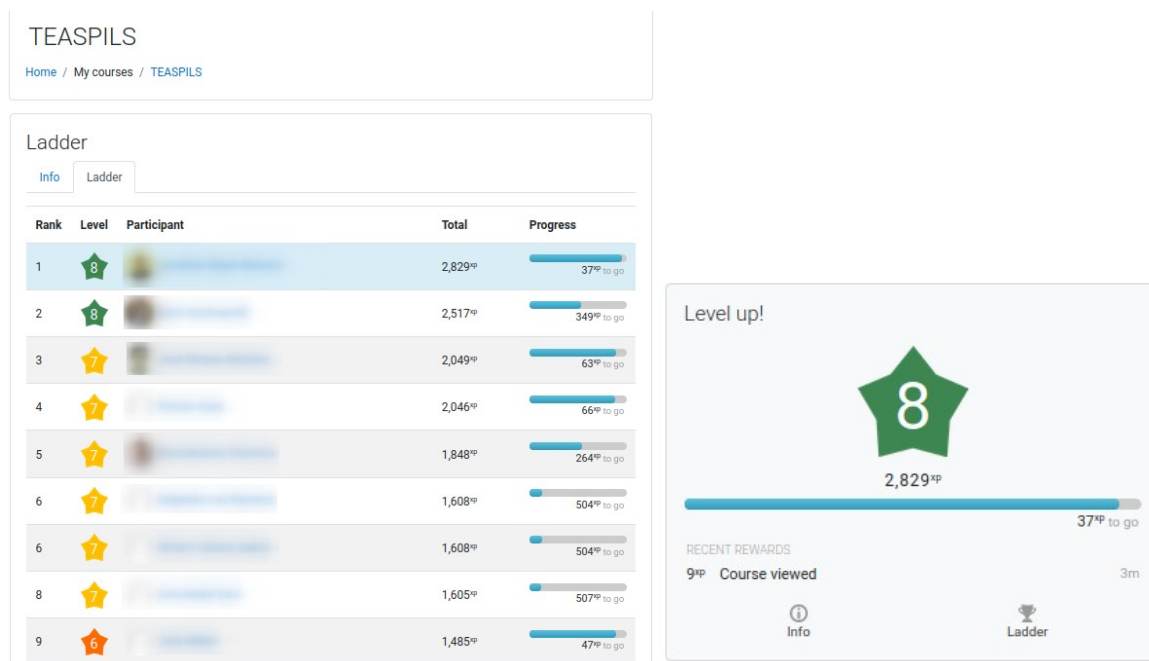

Figure 2. A screenshot of the leaderboard (left) and the "Level Up!" block (right).

3.3   Activity Statistics

The SPOC was available to learners from September 2021 to January 2022. Thirty participants registered for the course during that period. In this section we present some statistics on the self-assessment quizzes and other activities related to the gamification approach we integrated to the course, based on the current contributions by learners.

In Table 2 we present the number of unique and total attempts, the average grade of first attempts and the average grade of highest graded attempts per self-assessment quiz.

Table 2. In this table we present the number of unique and total attempts, the average grade of first attempts and the average grade of highest graded attempts per self-assessment quiz of the SPOC.

Session	Unique attempts	Total attempts	Average grade of first attempts	Average grade of highest graded attempts
1	26	40	70.44%	81.61%
2	23	41	84.82%	91.63%
3	22	34	80.57%	87.05%
4	10	16	81.67%	86.93%

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2 https://moodle.org/plugins/block_xp

| 5 | 13 | 18 | 83.08% | 86.92% |

On average, approximately 19 learners attempted each quiz achieving an average grade on the first attempt of 80.12% and an average grade of the highest graded attempt of 86,83%.

For the other forum based activities we recorded the number of participants who initiated a discussion (forum post). For the first activity where learners were asked to introduce themselves to the community 17 posts/discussions were recorded. For the "My plant" activity where learners were asked to present the plant they bought we recorded 12 posts/discussions.

In terms of badges, the "Intro to Learning Spaces" badge of Session 1 was awarded to 14 learners (~47%), the "Planters" badge of Session 2 was awarded to 23 learners (~77%), the "Plants - Humans – Society" badge of Session 3 was awarded to 15 learners (50%), the "Inspired by Citizen Science" badge of Session 4 was awarded to 10 learners (~33%), and the "Dashboards in my teaching" badge of Session 5 was awarded to 13 learners (~43%). The "Classroom-plant Shopper" which is linked to the "My Plant" activity was awarded to 12 learners (40%).

From the "Level Up!" plugin we present the number of participants per level (see Figure 3) from the SPOC. 60% of the participants reached level 5 and above

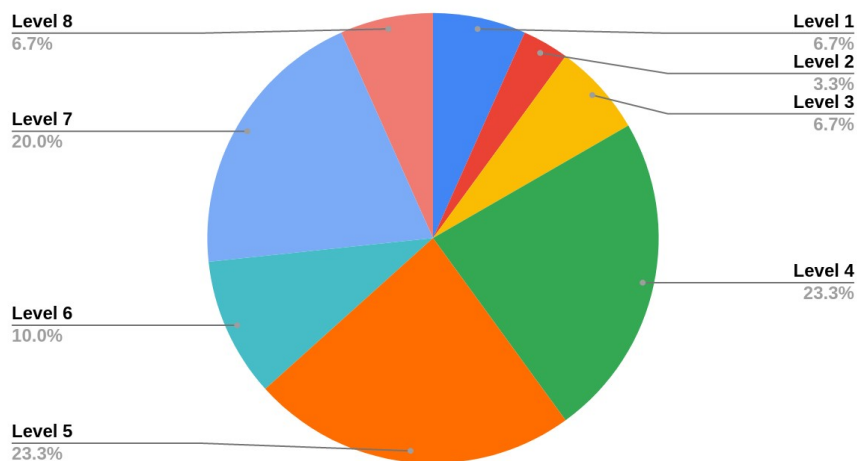

Number of learners per level

Figure 3. A pie chart of the number of participants per level. Data acquired from the "Level Up!" Moodle plugin.

3.4   Gamification User-Types

An important element in choosing the correct gamification mechanics for the SPOC is to identify which elements are appropriate for each type of user. Marczewski's user type hexad [8] is a gamification user types model that attempts to map a user's personality to a design element. Based on Marczewski's user-type hexad, there are 6 types of users: 1) **Socialisers** who are motivated by relatedness and want to interact with others and create social connections, 2) **Free Spirits** who are motivated by autonomy and self-expression and they are more interested on creating and exploring a system, 3) **Achievers** who are are looking to learn new things and improve themselves and need challenges to overcome, 4) **Philanthropists** who are not interested in rewards but are motivated by purpose and meaning, 5) **Players** who are motivated by Rewards, and 6) **Disruptors** who are motivated by change and are interested in finding ways to disrupt a system.

An early study was performed in the SPOC using the standardised questionnaire to map the SPOC participants to their respective user type. The questionnaire was accessible to all SPOC participants to complete it. A small sample (n=9) was examined identifying the Philanthropist (n=7) as the dominant user-type, followed by Achiever (n=3), Socializer (n=2), Player (n=1) and Free Spirit (n=1). Some participants have more than one user-type based on the answers they provided in the questionnaire.

To accommodate the needs of the Philanthropist user-type gamification mechanics such as collection and trading, gifting, knowledge sharing, and administrative roles are appropriate. For the Achiever

user-type appropriate gamification mechanics include challenges, certificates, learning, quests, levels or progression and boss battles.

4   DISCUSSION, CONCLUSIONS AND FUTURE WORK

In this work we provided a general overview of the Erasmus+ TEASPILS project which aims to build environmental awareness towards plants and greenery and educate young people and their teachers towards ecological learning spaces. More specifically, we presented our work on designing and delivering a Small Private Online Course (SPOC) in Environmental Education, using the Moodle learning management system and a number of gamification mechanics to increase participant engagement.

We presented how we designed the SPOC, the syllabus and the content available to learners, with main emphasis on the activities provided and not so much on the static content of the course. We explained that initial data and feedback from the SPOC participants indicate that the approach we took to gamify the course, appears to have a positive effect on increasing their engagement with the SPOC content, the activities and with other participants. The fact that we used several different game mechanics which are interconnected with each other, addressed the needs of more than one user-types. Of course, the results we discuss in this work are preliminary and further investigation is needed to further examine the results of the gamification mechanics used in terms of engagement.

In the future, we plan to develop the SPOC further and release it as an OER Open Online Course in order to benefit everyone interested in learning about raising environmental awareness and about ways to incorporate the TEASPILS project outcomes to an educational context.

ACKNOWLEDGEMENTS

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