

# Adaptive Pathways within the European Platform for Personalized Language Learning PEAPL

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## ABSTRACT

The customization of learning pathways based on competency profiles and game-based learning are increasingly being adopted by education stakeholders because of their potential to maximize the effectiveness of instruction. However, actual learning can vary among individuals, particularly according to specific needs (e.g., L2 speakers learners, students with dyslexia, hearing-impaired children, etc.). In this article, we first present GamesHUB, the pedagogical games platform for primary school pupils, integrating the creation of playful and personalized learning paths. Secondly, we address the issue of adaptive learning, according to the different pupils' profiles, through the integration of pedagogical resources based on adaptive pathways in the framework of the European project PEAPL. We discuss the way these pathways are elaborated to get close to didactic sequences' frames that are proposed for the ordinary classroom.

## CCS CONCEPTS

• Applied Computing; • Education; • Interactive learning environments;

## KEYWORDS

TEL environment, game-based learning, adaptive learning paths

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## 1 INTRODUCTION

The availability of digital devices for K-12 students has paved the way for the emergence of numerous digital learning platforms or technology-enhanced learning (TEL). It has extended the possibilities of learning. Furthermore, their use is also coupled to questions about the possible adaptations to heterogeneous learner profiles in an inclusive school environment. Indeed, as the learning abilities can vary according to the profiles of the learners and to certain specific needs (e.g., dyslexia, L2 speakers, color blindness...), the design of these digital interfaces is particularly important because it provides access to the learning. The questions of accessibility and differentiated teaching are more important than ever now that spontaneous regulation of teaching practice is made more difficult by the digital medium.

To think about every user needs in the design of digital learning platforms, the Universal Design for Learning (UDL) model has been documented as a very supportive framework [1]. It invites instructional designers of TEL to vary means of engagement, of representation, and of action/communication. The first is often considered thanks to game-based learning (GBL). Indeed, GBL is increasingly used by teachers due to games' potential to foster learner engagement [2, 3]. The second is embedded in TEL, thanks to the multimedia digital assistive technology (DAT) it allows. So, instructional designs must include this diversity of resources from the outset of the conception. This is similar for the latter because it becomes much easier for a student to demonstrate skills by recording his or her voice or writing with speech-to-text for instance. These features should be implemented and available according to the UDL perspective.

The other gateway to respond to every student's needs is adaptive learning [4]. Knowing the profiles, skills and motivation of the learners [5], the digital learning environment can be designed to propose tailored paths. Adaptive learning is often based on a competency framework [6] but could also be based on an error framework [7].

As our interdisciplinary team is interested in the customization of digital learning environments and in personalization of learning pathways, we build GamesHUB that tends towards UDL in TEL. Indeed, GamesHUB was designed to help us to figure out how

can a digital platform with adaptive pathways support a UDL? In addition, we expect to find how can a digital platform with adaptive pathways support the teacher's action?

## 2 GAMESHUB PLATFORM

GamesHUB<sup>1</sup> is a digital learning platform oriented by UDL perspective, developed by the Center for research on teacher/learning supported by digital technologies<sup>2</sup> of the University for Teacher Education Fribourg<sup>3</sup>, in partnership with the Computer Science Department of the Fribourg Vocational School<sup>4</sup>.

### 2.1 Purpose

GamesHUB is designed for students ages 6-12 in French-speaking school, using game-based learning and customized learning pathways. Its purpose is to allow every student, including those with special needs, to develop skills as long as they can interact with the computer. The platform provides learning games related to various learning areas within the framework of the Plan d'Études Romand<sup>5</sup> which is the official competency framework in the context of GamesHUB implementation. It also supports the teacher in the continuous improvement of teaching and learning by recording tracks of students' activities in compliance with the European GDPR (General Data Protection Rules). The data of each learning game is recorded and can then be visualized and analyzed by the teacher in order to identify difficulties of students.

### 2.2 Functions of the platform

From a technical point of view, GamesHUB is currently based on four main components:

**2.2.1 Component 1: The Online Portal for Students.** The online portal for students allows teachers to login, manage their classes, choose a student, let him or her play to learn, and observe activity tracks. Students receive feedback, remediations and can use accessibility features (DAT) when they are free to evolve among the learning games. This portal also proposes administrative features to support developers or researchers, such as reporting of non-compliant exercises.

**2.2.2 Component 2: The Development Framework.** The development framework is a learning game development pattern using a regular template to allow the rapid integration of newly developed learning games to GamesHUB. The framework manages the display update of elements, as well as the players' activity tracks. From a technical point of view, its use requires that newly developed games respect a certain structure (inclusion of a canvas, a listener manager, and an enumerated game mode, related to the four game modes detailed in the next subsection). On the other hand, these games will be quickly deployed on the platform. The framework is based on the Type Script programming language and on the open-source library PixiJs.

<sup>1</sup><https://hep3.emf-infopro-test.ch/>

<sup>2</sup><https://blog.hepfr.ch/create/>

<sup>3</sup><https://www.hepfr.ch>

<sup>4</sup><https://www.fr.ch/emf>

<sup>5</sup><https://plandetudes.ch/>

## Profil de Erwan

EMF (Harmos 1)

Modifier le nom de l'élève:

Erwan

Modifier

Filtre jeux

25 mars 2021 - 25 mars 2021

Afficher toutes les dates

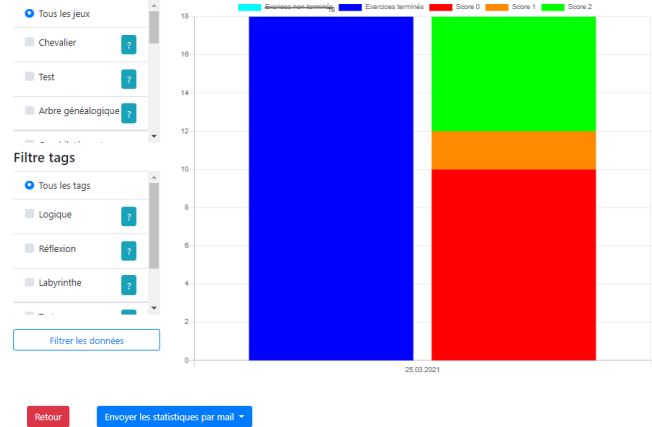


Figure 1: Example of activity tracks of a student on GamesHUB

**2.2.3 Component 3: The Learning Games.** Learning games are proposed on GamesHUB. They are developed according to the framework described above and are linked to school subjects (e.g., Mathematics, French, Natural Sciences, etc.). The games are optimized for running on digital tablets, but also on computers. The gameplay is divided into four different modes to vary the cognitive taxonomy:

- **Exploring mode:** the student learns step-by-step how the game works as well as the content targeted.
- **Training mode:** the student completes levels of the game and receives feedback. His/her activity is not recorded.
- **Evaluation mode:** very similar to the training mode except that the student will now be evaluated (0, 1 or 2, for failed, partially successful, or successful).
- **Creating mode:** students or teachers create new different levels of the game. These levels are then saved and validated by the administrator so that they can be played by other students.

The tracks of activity are recorded when evaluation mode is chosen, so teachers can access statistics on the progress and results of a student or a class. It allows them to identify difficulties and adapt their teaching. Indeed, as shown in Figure 1, the teacher can find data about the students' progress in the exercises as well as their scores over a given period.

**2.2.4 Component 4: the teacher's dashboard.** The teacher's dashboard includes access to the learning games, the students' activity tracks and the learning paths adapted to each student profile. Indeed, the learning paths feature is currently under development as part of the PEAPL project which we detail in the following section.

### 3 PROJECT PEAPL

#### 3.1 Overall goal

In a UDL perspective, and within the framework of the European project PEAPL<sup>6</sup> (European Platform for Personalized Language Learning), our interdisciplinary team develops articulated learning pathways, with an interface adapted to the different needs of the learners. This implies three critical components: 1) pedagogic resources; 2) DAT and 3) remediations.

In our case, *resources* are the learning games organized as parts of a learning pathway (specific objectives). The pathway is thought as a sequence of resources to target a general objective (like a usual didactic sequence). The DAT are available to enable access (e.g., speech synthesis, translator, lexicon, open dyslexic font, layouts) and relieve cognitive load [8]. The *remediations* are specific game levels used to work on a weak or missing prerequisite (according to the competency framework) or learning game modes that lower the taxonomic level. Thus, these three components meet the usual tools of the regular classroom where printed resources and tools are available (to help all learners and to differentiate work within the common general or specific learning objectives).

The learning paths are integrated into the teacher's dashboard on GamesHUB. In a second step, the idea will be to establish an automated diagnosis based on the student's activity to make the pathways self-adapting (see section 3.4). The goal is therefore to bring tools to help teachers of regular classes to manage the heterogeneity of their students and to allow each student to have a customized path adapted to his or her needs.

Project PEAPL brings together educational researchers from five European countries to use the new pedagogical potentialities offered by digital technology to help the teachers respond to the diversity of students in their classrooms.

#### 3.2 Embedding Learning Resources in GamesHUB and Competency Framework

The adaptive pathways are integrated into the GamesHUB platform, on the teacher's dashboard. The teacher can choose among the public pathways provided by the research team. Teachers can also create their own adaptive pathways and share them with the community (once they have been validated by the platform's moderators). The pathways are based on two competency frameworks.

The first framework used in GamesHUB is the Plan d'Études Romand as already stated. Its integration into the platform was done through the online API<sup>7</sup>, put in place by the Intercantonal Conference of Public Education of French-speaking Switzerland and Tessin. It allows to choose the general objective of the pathway (general competence).

The second is our own PEAPL competency framework which concerns skills and knowledges involved in the reading-comprehension in primary school. It has been developed using the COMPER project meta-model of framework<sup>8</sup>. It is used to guide the teacher in his or her choice of progression and articulation of specific objectives within the pathway. The pedagogical resources

(games and levels of games) are associated with skills and/or knowledges (specific objectives) constituting the target competence (general objective). The PEAPL competency framework<sup>9</sup> has been published<sup>10</sup>, as well as an excerpt from the praxeological organization that underpins this framework<sup>11</sup>.

#### 3.3 The Adaptive Pathways on GamesHUB

**3.3.1 Definition.** The Adaptive Pathways (AP) are done by selecting different levels of learning games within a series of filters: difficulty, tags, element of the competency framework, language of the game (GamesHUB is designed to be multilingual). The upper part of the screen allows to visualize the AP as an articulation of these elements. The teachers can also integrate an unplugged activity for which an instruction will have to be indicated. The goal is to invite for a rotation between digital and "paper and pencil" activities that promote embodied cognition [9] and to allow the platform to model the natural functioning of the classroom where the supports vary.

For the learning paths created in GamesHUB, remediations can be anticipated and added. They will be activated depending on the score the user obtained to one or several previous steps (in *evaluation* mode). The *exploring* mode is a possible remediation, sent to the learner to help to recover understanding. Another example of remediation may be a level from another game that would target a prerequisite (according to the competency framework).

In learning pathways, the *exploring* mode can also be useful to start the path. It can then model the discovery/observation phase of a usual didactic sequence. On the opposite, the *creating* mode appears valuable for extensions or reinvestments towards a higher taxonomic level, such as a last step in the learner's progress. The course is then designed in mandatory steps and optional steps (remediations) activated if the learner fails in one or more mandatory steps. These two types of steps allow to recreate on the platform the differentiation that a teacher would do in brick and mortar and help to tend to a UDL perspective.

**3.3.2 A Learning Pathways Example on GamesHUB.** Let's consider a learning pathway that targets a constitutive skill of reading-comprehension: the link between information in several sentences. More specifically, the understanding of location and time connectors (grammar) must be learned. The pathway is divided into 12 steps that are as many levels of different learning games, with the use of the games "Par ici ou par-là"<sup>12</sup> (PIL) (location connectors) and "Quand et comment?"<sup>13</sup> (Q&C) (time connectors) divided as follows:

PIL (explore) - PIL (train) - PIL (evaluate) - unplugged activity - PIL (evaluate) - PIL (evaluate) - Q&C (train) - Q&C (train) - Q&C

<sup>9</sup>The PEAPL competency framework: [https://traffic.irit.fr/comper/repository/viewframework\\_public?name=92](https://traffic.irit.fr/comper/repository/viewframework_public?name=92)

<sup>10</sup><http://doi.org/10.5281/zenodo.4462850>

<sup>11</sup><http://doi.org/10.5281/zenodo.4001381>

<sup>12</sup>"Par ici ou par-là" is a learning game of moving on a map from a text instruction. The map is made of X places (buildings, urban spaces, ...). In the *creating mode*, the player first chooses the number of places he wants to add to the map and then places them. S/he then writes the text that will be used as instructions for the future player

<sup>13</sup>Quand & Comment? is a learning game of filling a diary with a text that tells what a person has done for one day, several days, a week. In the *creating mode*, the player chooses the number of days in the agenda and writes the text that will be used as instructions.

<sup>6</sup><https://blog.hepfr.ch/create/peapl/>

<sup>7</sup><https://bdper.plandetudes.ch/api/v1/>

<sup>8</sup><https://comper.fr/en/productions/wp1>

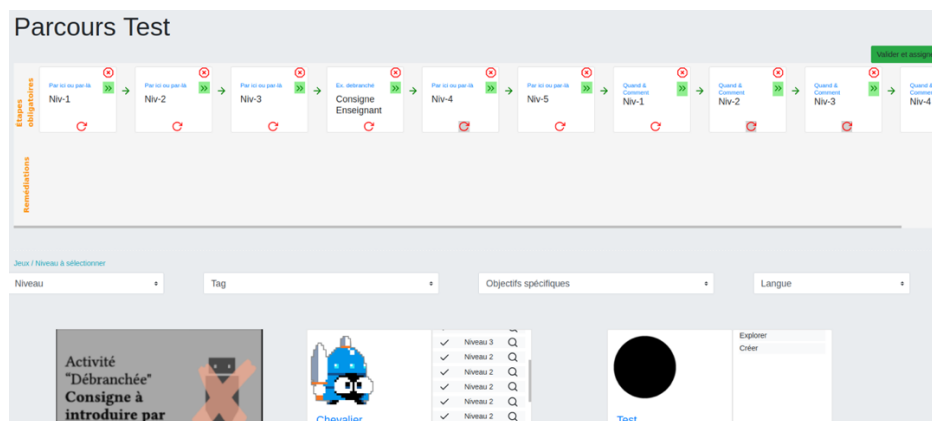


Figure 2: Example of an Adaptive Pathway composed from different game levels

(evaluate) – Q&C (evaluate) - PIL (evaluate) - PIL (create). Figure 2 shows what would be the dashboard view.

We distinguish a progression in the use of games and game modes: 1) the use of PIL in the *exploring*, *training* and then *evaluating* modes; 2) the use of Q&C to mobilize and add the understanding of time connectors; 3) the return to PIL with movement instructions that integrate one- or two-time indications (e.g., before, after, ...) in the *evaluating* mode and then the *creating* mode. The unplugged activity as fourth step is aimed to be an opportunity to institutionalize what is being worked with students after observation and training phases (steps 1 to 3).

**3.3.3 The Pathways Variables and Difficulty Indicator.** The progression of the pathway cannot only be related to the game modes, it must also be correlated to different didactic and linguistic variables: the length of the text; its layout; the frequency of targeted vocabulary (frequency of connectors used); the frequency of overall vocabulary in the text; the use of different genres and numbers or not; the verbal tense(s) used; linear spatial/temporal information or not; the number of items (places present on the map in PIL or days involved in Q&C); the presence of useless information or not; the presence of linguistic disrupters or not.

All these variables are associated with values (for example 1 for the exploring mode; 2 for the training mode, ...). Table 1<sup>14</sup> shows the possible values of the different variables. These values allow to compute a *difficulty index* named “D” for each level of the game according to linguistic and didactic constraints (table 2<sup>15</sup>). The progression within a pathway should then ensure a progression of this index. This corresponds to the ordinary progression within a didactic sequence built by the teacher with different traditional materials.

The index D is for the moment calculated according to the sum of the values of the different variables. The first phase of experimentation with the platform will make it possible to verify whether all the variables are relevant or any missing. It will also allow us to verify if different coefficients should be added to weight each

variable, for instance when one variable might appear more or less important than another.

## 4 CONCLUSION

In this article, we presented GamesHUB, an online platform of learning games designed for primary school students. We presented the different possible game modes within the platform and the action support for the teacher including learning analytics. Then, we presented how the learning pathways can be designed within GamesHUB to get close to a usual didactic sequence design, with a progression in specific objectives and in difficulty. This would be achieved with Data Assistive Technology (DAT) embedded within the platform and remediations based on the competency framework. Then, the learning pathways can offer a didactic starting point that can be customized to the individual needs of learners whether to foster access to the activity or to work on weak or missing prerequisites.

Next step will allow us to carry out experiments in ordinary classes at the primary school level, evaluate the user experience and collect data from learners’ use. The evaluation of the data collected and their analysis to define learning pathways according to the students’ profiles is the subject of a specific funding request.

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