D.4.3 – Integration of Analytics and Dashboard

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SDK	Software Development Kit
JSON	JavaScript Object Notation
NOLB	No One Left Behind
PMD	Project Management Dashboard

EXECUTIVE SUMMARY

This deliverable presents the methodological and technical developments performed to link the visualization dashboard to the Create@School app.

On the one hand, a big data oriented architecture stores the data and supports the automatic real time gathering of data from tablets while students program. On the other hand, the Project Management Dashboard (PMD) gatherers and stores the management of students and classes, as well as the evaluation of cognitive oriented parameters.

A methodological framework has been developed to create and calculate behavioural measurements, which have been categorized in two types of behavioural constructs according to the definition approach used: top-down (based on results from WP1, WP2 as well as in experience from partners and the teachers/pedagogical team from the piloting schools in the different pilot countries) and bottom-up (based on the aggregation of events automatically detected by the big data platform). A behavioural matrix links both, the top-down and bottom-up approaches.

Visualization dashboards have been developed and linked to Create@School, to support the teachers 'framework and allow visualization of performance (representation of gamified academic content). Two types of visualization dashboards have been provided: online (big data software -Tableau- supported) and offline (excel sheets). Both dashboard can dynamically update the different behavioural constructs or categories when selecting different variables such as teacher, his/her class or a student.

1 INTRODUCTION

The present document contains a description of the integration of the Analytic Dashboard(s) in the overall architecture that holds the Create@School app, created in the context of the project *No One Left Behind* to show some of the data captured using the last of the Create@School app release. The Analytic Dashboard links observational data coming from the Project Management Dashboard (PMD), needed to have an overall insight of the students `cognitive and behavioural performance, with the automatic gathered data coming from the big data platform. All data is stored in a data mart which allow different kinds of analyses based in pre-defined behavioural constructs.

Data is captured through two processes:

- Top-down: which defines four behavioural constructs based on previous results and experiences of the participants:
    - Didactical/cognitive: comprising academic readiness and usage of Create@School.
    - Socio-behavioural: comprising confidence, creativity, interest, performance, positive affect and self-efficacy.
    - Self-regulatory: comprising concentration, effort, high thinking and persistence.
    - Engagement: comprising action, self and social engagement.
- Bottom-up approach: which supports the gathering of events and data through:
    - Observation. Data gathered from observation process comprises: Matching of the academic and gaming objectives, game originality, how well the game works, defence of the work done or submitted project, collaboration and teacher intervention.
    - Automatic gathering. Data automatically gathered comprises: app related parameters, coding skills oriented parameters, Look & Feel/Customisation / Aesthetics oriented parameters, time management parameters and support parameters.

To present the data visually, a process of automatically capturing the data from the tablets while students code has been performed. We have done this by including and SDK into the code of Create@School app. As described in subsequent sections this SDK performs the actions of "writing" or "registering" whatever actions the user performs while using Create@School, e.g., every time the user opens the program, uses a template, adds a new brick, modifies an existing component, explores what objects have been already created and uploaded the program to the web site, and so on, all this is registered in the Data Lake provide for this purpose (check below to understand this concept). Data coming from the PMD also will be integrated in the Data Lake.

All the data will then undergo a "transformation" process, following a standardized (gaussian/normalization methodology) to leave the data prepared for visual presentation by means of dynamically customizing the developed dashboards. These dashboards can then be navigated using several dimensions, although the most typical ones would be the students (either individually or as part of the group to which they belong), and the actions they have performed while using Create@School.

The present document is organized in four chapters. Following the introduction, chapter 2 comprises the methodology used to evaluate the behavioural constructs defined for assessing the performance of students while using Create@School to gamify academic content. Chapter 3 explains the infrastructure developed for supporting the data gathering and automatic evaluation process, while Chapter 4 shows the visualization dashboards developed to visualize the behavioural constructs from a school, class or student.

2 COGNITIVE AND BEHAVIOURAL MEASUREMENTS

2.1 Data collection processes

Cognitive and behavioural measurement in No One Left Behind has been handled through two data collection processes: observation and automatic collection of data from the usage of Create@School by students in the tablets.

2.1.1 Observation process

The information observed by the teachers captures the perception of the teachers regarding the academic readiness and achievement of learning goals (e.g. reaching the academic goal) and some students 'abilities and social behaviours (such as creativity and collaboration). Tracked observational variables/parameters comprise:

- Matching of the academic and gaming objectives: evaluation of the game looking the achievement of the goal of the academic theme or content that needs to be learned by the student.
- Game originality: evaluation of originality of the game taking in account the creativity (e.g. the use of creative characters, backgrounds, type of game or concept used for applying the academic concept, etc); which from the gaming perspective also tell us how the academic concept "is gamified".
- How well the game works: this is evaluated through the Completeness of the Sequence/ Flow/ Narrative/ Story structure of the game. The teacher evaluates taking in account how the "academic concept" and its different areas/parts are represented in the game – "gamified"-, and if the flow of the game is linked to the overall and total academic concept.
- Defence of the work done or submitted project: evaluates how the student presents the project (game) to the teacher, "defends" the performed work and answers the teacher`s questions.
- Collaboration: scoring given to the student taking in account the observations of the teachers regarding the collaboration, support and interaction in classes with other students while coding the assigned project.
- Teacher intervention (positive intervention/mentoring): evaluates the needs of coaching, mentoring, answering questions regarding the project requested or Create@School. This takes in account the interest shown in class as well as the questions and interaction of the student with the teacher.

2.1.2 Automatic collection of data

The automatic collection of data through the SDK component of the analytic architecture provides evidences, as well as continuous tracking on the activities and usage of coding components handled by the student to develop games for their lessons. It captures "actions" (use of Create@School coding bricks and other functionality of the app, so called "events") as happening in the Create@School Development Environment (IDE), such as: program/template/object creation, clicks, additions, deletions, etc.

Tracked and App releated parameters: this comprise event creation, event deletion, coding skills, look & feel customisation and customisation of GPII settings. These parameters include the usage of the following commands:

- Coding Skills oriented parameters; this comprises the usage of: New/modify/edit/usage of variables and list, Simple bricks (e.g., coordination and synchronization: wait brick, x&y coordinates, broadcasting, etc.), Advanced bricks (New/modified/used conditional statements), use of advanced functionalities (backpack/object groups/physics engine), modify scenes- and/or scoring (formula change of the variable brick), add / merge of scenes, usage of templates.

- Look & Feel / Customisation / Aesthetics oriented parameters: this includes customisation of characters / images / backgrounds in templates / own programs, Look&Feel (graphics for buttons, colours, graphical user interface of the games, backgrounds), looks downloaded via Media Library, looks drawn with Pocket Paint, sound files and camera pictures and customizes / change GPII accessibility settings.
- Time management parameters: absolute time spent in Create@School, time spent with playing/testing the game, time spent in Pocket Paint, time spent in Web View, time spent on research/tutorials, time spent on programming (remaining time).
- Support parameters: uses brick help option, use of hints or accessibility setting usage from GPII.

2.2 Methodologies for defining the behavioural dimensions linked to the learning process

Two different approaches were used to define the behavioural dimensions linked to the learning process:

- **Top down approach**: During the first stage (first cycle) of the No One Left Behind project, research regarding different types of behaviours that impact the learning process have been performed in WP1 and WP2. A set of behavioural constructs were selected and customised (defined) for the NOLB project during this process and refined with teachers during 2-3 workshops and the pedagogical teams of the different pilot schools in each pilot country (Austria, Spain and UK).
- **Bottom-up approach:** This process started from the lowest level of coding (bottom), where all coding bricks and performed events from the Create@School app were listed. Therefore, the NOLB team integrated different "events" into the source codes` specific functions (e.g., in function addBrick). The SDK allows three kinds of events: custom events, init and end events and sends them to the BDS. We used mostly custom events because they allow to add additional data, e.g., brickname and brick category. The init event is defined to start a session (user logs in) and the end event for closing the session (user logs out). Further, we grouped the following events for the parameter coding skills in categories: Usage of variables and lists, broadcast messages, usage of simple bricks (which aggregates coordination and synchronization bricks; e.g.: wait block, x&y coordinates, etc.), advanced bricks (which comprises new/modified/use of conditional statements), use of advanced functionalities (such as backpack/object groups), capability of modifying the game scoring (such as formula change of the variable brick), adding or merging scenes, usage of templates and merge of programs.

To link the top-down approach and bottom-up approach, the concept of the behavioural constructs was used to relate them with the categories created in the bottom-up approach; this relationship has been represented in a behavioural oriented matrix.

2.2.1 Behavioural constructs from the top-down approach

The following behavioural constructs were selected and customised (defined) to evaluate the teaching-learning process in the NOLB project. These constructs were refined with teachers and pedagogic team of the pilot schools, so they could be used as indicators for teachers to improve their teaching-learning process (indicators to be used in the teaching framework). These constructs were categorized in four types: didactical/cognitive, socio-behavioural, self-regulatory and engagement. Each construct has been defined through a set of factors (categories) that build or link to a set of behaviours that support learning. The following table shows the schema of the constructs and its related behavioural factors.

Table 1: behavioural constructs and related behavioural factors

Didactical/Cognitive	**Socio Behavioural**	
• Academic Readiness • Usage of Create@School Coding	• Confidence • Creativity • Interest	• Performance • Positive Affect • Self-efficacy
Self-Regulatory	**Engagement**	
• Concentration • Effort/dedicated time • High Thinking • Persistence	• Action-Engagement • Self-engagement (over average in positive affect) • Social Engagement	

2.2.1.1 *Didactical/cognitive construct*

This construct measures the alignment of the learning objectives and assess the developed games from the students. These construct is measured through two categories:

- The academic readiness and achievement of learning goals (learning achievement): this measures the progressive increment of knowledge of the student over its initial baseline (when the academic theme was started to be delivered). The rational of this category is to balance the goal of the game vs the achievement of the academic oriented goal. Overall, the teacher looks for answering to the question: Does the game responds/integrates to the academic challenge/question/goal to be gamified?
- Use of Create@School coding: this category evaluates the program design; its evaluation comprises the assessment over the usage of different coding concepts: sequence, event handling, conditional statements, threads, variables, coordination and synchronisation, iteration, x/y coordinate or usage of formulas. This information is automatically gathered by the Create@School SDK.

2.2.1.2 *Socio behavioural construct*

The social and behavioural dimension goes beyond academic readiness and cognitive ability, and according to teachers, it is crucial to influence success in school. To define categories that conceptualize this dimension, we have used the NTU experience, information gathered in WP1 and WP2 that integrated experience and the insights from the teachers/pedagogical team from the NOLB pilots; as well as the literature comprised in the "References" chapter. Overall, we have divided the social/behavioural in six categories:

- Confidence: we take it as having control over the outputs to be provided in the project, from the academic and gaming perspectives.
- Interest: it relates to the organisation and selecting main ideas and effort.
- Creativity: this parameter will link with self-expression, and representativeness of the academic theme, linking with the narrative, type of game, use of backgrounds, characters and other assets.
- Performance: this is take as the self-efficacy of the gamified experience; for example, using blocks that are not common or for advanced programs, objects, scenes, groups, formulas, etc.
- Positive Affect: links with the excitement, enjoyment within reaching goals
- Academic self-efficacy: this is taken as academic readiness and having the academic capability to reach the goals of the academic theme that supports the gamified experience.

2.2.1.3 Self-regulatory construct

This construct relates with the self-effort needed to reach the goals. These efforts could be effective but have impact in academic performance and learning process, as it links with the following behavioural factors:

- Concentration: capacity of being working on the app vs the time logged in.
- Effort/ dedicated time: time spent in Create@School
- High thinking: it relates with synthesis of ideas high order thinking and representativeness of the academic theme, such as the flow of the program to reach the goals.
- Persistence: is the effort to reach the challenge of matching the academic goal and game goal. It will link with time spent on Create@School, dropped relatedness, to interact positively.
- Learning goal orientation: learning new knowledge and skills, new challenges, like new worlds or levels, rewards, etc.

2.2.1.4 Engagement and collaborative construct

The engagement and collaborative construct comprises those factors that affect the connection between the learner and the learning activity or the school environment/class. It is determined by experiences to see the students' degree of interaction with social (e.g., peers), and academic systems. Engagement factors comprise:

- Social-engagement: comprises behaviours such as sense of collaboration with other, face to face interaction and social relatedness, improving or expanding social network or decision-making process (exchange of opinions).
- Self-engagement: comprises positive affect and enthusiasm, as well as high self-regulated learning, working with individual responsibility.
- Action-engagement: manages the affects for gaming the assets/resources and game coding in Create@School; this links with the number/intensity of interactions, total time using the system.

2.2.2 Bottom-up approach: Aggregation of coding parameters towards behaviours

The events tracked in Create@School were listed and grouped according to their functional perspective, in which we have call "sub-categories". The following table shows an example of how this process was done, presenting the 170 most common events in Create@School. Overall, more than 400 events were listed and grouped. The characterization between advanced and simple bricks was done by the UK partners (NTU).

Table 2: Create@School events grouped in functional sub-categories

Absolute time spent		
init	end (Sessionduration)	
Advanced bricks: New/modified/used conditional statements **Event:** AddBrick		
Brick names send within this event: • AddItemToUserListBrick • BroadcastWaitBrick • CameraBrick • ChangeBrightnessByNBrick • ChangeTransparencyByNBrick • ChangeVolumeByBrick • ChangeXByNBrick	• IfLogicBeginBrick • IfThenLogicBeginBrick • InsertItemIntoUserListBrick • NoteBrick • PenDownBrick • PenUpBrick • PlaySoundAndWaitBrick • PointInDirectionBrick • PointToBrick • RepeatBrick	• SetGravityBrick • SetMassBrick • SetPenColorBrick • SetPenSizeBrick • SetPhysicsObjectTypeBrick • SetTransparencyBrick • SetVelocityBrick • SetVolumeToBrick • SpeakAndWaitBrick

• ChangeYByNBrick • ChooseCameraBrick • ClearBackgroundBrick • ClearGraphicEffectBrick • CollisionReceiverBrick • ComeToFrontBrick • DeleteItemOfUserListBrick • DropBrick • FlashBrick • GoNStepsBackBrick	• ReplaceItemInUserListBrick • SceneStartBrick • SceneTransitionBrick • SetBackgroundAndWaitBrick • SetBounceBrick • SetBrightnessBrick • SetFrictionBrick	• StampBrick • StopScriptBrick • TurnLeftSpeedBrick • TurnRightSpeedBrick • VibrationBrick • WaitUntilBrick • WhenBackgroundChangesBrick • WhenConditionBrick
App Support		
hintsOption ("allowHints":"false" or "true")	OpenBrickHelpOption	
Customisation of characters/images/backgrounds in templates: Edit, Create		
CreateLook CreateObject	CreateSound EditLook	UseTemplate
Customizes/Changes GPII		
ApplyAccessabilitySetting		
Event Creation		
• AddBrick • CopyBrick • CopyLook • CopyObject	• CopyProgram • CopySound • CreateLook • CreateObject	• CreateProgram • CreateSound • DropBrick • OpenProgram
Event Deletion		
• DeleteBrick • DeleteList • DeleteLook	• DeleteObject • DeleteProgram • DeleteScene	• DeleteSound • DeleteVariable
Look&Feel: Create your own ressources (Pocket Paint, Camera, Recorder)		
• CreateLook ("source":"Camera") • CreateLook ("source":"PocketPaint")	• CreateObject ("source":"Camera") • CreateObject (source":"PocketPaint")	• CreateSound ("source:":"record")
Look&Feel: Use ressources from other sources (Media Library, Device)		
• CreateLook ("source":"Device") • CreateLook ("source":"MediaLibrary")	• CreateObject ("source":"Device") • CreateObject ("source":"MediaLibrary")	• CreateSound ("source:":"device") • CreateSound ("source:":"MediaLibrary")
Merge programs		
MergePrograms		
Modify scoring: formula change of the variable brick		
OpenFormula	SaveFormula	
Simple bricks: Coordination and Synchronization: wait block, x&y coordinates, broadcasting **Event: AddBrick**		
Brick names send within this event: • AskBrick • BroadcastBrick • BroadcastReceiverBrick • ChangeColorByNBrick • ChangeSizeByNBrick • ChangeVariableBrick	• IfOnEdgeBounceBrick • MoveNStepsBrick • NextLookBrick • PlaceAtBrick • PlaySoundBrick • PreviousLookBrick • SayBubbleBrick	• SetYBrick • ShowBrick • ShowVariableBrick • SpeakBrick • StopAllSoundsBrick • ThinkBubbleBrick • ThinkForBubbleBrick

• CloneBrick • DeleteThisCloneBrick • DropBrick • ForeverBrick • GlideToBrick • GoToBrick • HideBrick • HideVariableBrick	• SayForBubbleBrick • SetBackgroundBrick • SetColorBrick • SetLookBrick • SetSizeToBrick • SetVariableBrick • SetXBrick	• TurnLeftBrick • TurnRightBrick • WaitBrick • WhenCloneBrick • WhenScreenTouched • WhenStartedBrick • WhenTouchDownBrick
Time in Web View		
StartExploreSession / StopExploreSession (durationOfWebSessionInMillis)		
Time spent in Pocket Paint		
StartPocketPaintSessionCreateLook / StopPocketPaintSessionCreateLook (durationOfPocketPaintSessionInMillis) StartPocketPaintSessionCreateObject / StopPocketPaintSessionCreateObject (durationOfPocketPaintSessionInMillis) StartPocketPaintSessionEditLook / StopPocketPaintSessionEditLook (stopPocketPaintSessionEditLook)		
Time spent in programing (remaining time)		
remaining time		
Time spent in research/tutorials		
StartWebTutorialSession / StopWebTutorialSession (durationOfWebSessionInMillis)		
Time spent w/playing-testing the game		
StartProgramExecutionSession / StopProgramExecutioSession (durationOfProgramSessionInMillis)		
Tracked events/actions per minutes		
Events per minute		
Usage of templates		
UseTemplate		
Usage of variables and lists, broadcast messages		
createBroadcastMessage	CreateList	CreateVariable
Use of advanced functionalities: backpack/object groups		
• BackpackScene / UnpackScene • BackpackScript / UnpackScript • BackpackSound / UnpackSound	• AddGroup • AddScene • BackpackLook / UnpackLook	• BackpackObject / UnpackObject • MergeScenes

Likewise, the subcategories were grouped in categories which reflect capacities of students, for example capacities regarding aspects of design (look & feel) or coding level (use of simple or advanced coding bricks). The following table presents the created-subcategories linked to its respective capacity oriented category.

Table 3: Create@School I sub-categories grouped in categories

Absolute time spent
Absolute time spent in Create@School
App support
brick help option, hints option
Coding Skills

• Advanced bricks: New/modified/Used conditional statements • Merge programs • Modify scoring: formula change of the variable brick • Simple bricks: Coordination and Synchronization: wait block, x&y coordinates, broadcasting	• Usage of templates • Usage of variables and lists, broadcast messages • Use of advanced functionalities: backpack/object groups/
Collaboration	
Collaboration	
Complete/Sequence/flow/ narrative/story structure	
Complete/Sequence/flow/ narrative/story structure	
Event Creation	
Event Creation (creation events, e.g., create program/object)	
Event Deletion	
Event Deletion (e.g., delete program/object)	
Game originality	
Game originality (observational variable/parameter)	
Look & Feel/Customisation / Aesthetics	
• Customisation of characters/images/backgrounds in templates: Edit, Create • Customizes/Changes GPII	• Look&Feel: Create your own resources (Pocket Paint, Camera, Recorder) • Look&Feel: Use resources from other sources (Media Library, Device)
Match of academic & gaming objectives	
Match of academic & gaming objectives (observational variable/parameter)	
Teacher intervention (positive intervention / mentoring)	
Teacher intervention (positive intervention / mentoring, observational variable/parameter)	
Time in Web View	
Time in Web View (Start: Button Explore, End: going back to the Create@School app)	
Time spent in Pocket Paint	
Time spent in Pocket Paint (Start: Open Pocket Paint, End: Close Pocket Paint)	
Time spent in programming (remaining time)	
Time spent in programming (remaining time)	
Time spent in research/tutorials	
Time spent in research/tutorials (Start: Button Help, End: going back to the Create@School app)	
Time spent w/playing-testing the game	
Time spent w/playing-testing the game (Start: Play game, End: End Game with back button)	
Tracked events/actions per minutes	
Tracked events/actions per minutes	
Work defence	
Work defence (observational variable/parameter)	

In this part we understand that the events has been grouped in categories (parameters) in order to identify the functional tasks.

2.2.3 Linking the bottom-up and top-down approaches

To link the top-down approach and bottom-up approach, we linked the concept of the behavioural constructs defined in top-down approach (coming from work performed in the first cycle of the NOLB project) with the behavioural construct categories and functional sub-categories created from the Create@School events (the bottom-up approach). To make this links we developed a behavioural oriented matrix with the bottom-up constructs in the columns and the top-down constructs in the rows.

A first exercise was done inside the consortium where the different event oriented constructs definitions coming from Create@School were related to behavioural areas (construct from the top-down), beyond academic readiness and cognitive ability, which influence success in the learning process, relating them to factors that connect learner and the learning activity or the school environment/class. Through focus groups and meetings with teachers and the pedagogical team from piloting schools, who also refined and validated the pre-established relationships.

The following table presents the behavioural oriented matrix example. In section "2.2.1 Behavioural constructs from the top-down approach" the link between the behavioural constructs and related behavioural factors has been already explained. Each parameter (Didactical/Cognitive, Social Behavioural, Self-Regulatory and Engagement) is the result of the underlying behavioural factors. Plus (+) indicates if the student is over the average of the class and the minus (-) if she/he is below the average of the class. The X indicates that the parameters has been used at least once.

Table 4: Create@School behavioural matrix

Behavioural constructs (bottom-up)	Match of academic & gaming objectives	Game originality	Complete/Sequence/flo w/ narrative/story structure	Work defence	Collaboration	Event Creation	Event Deletion	Coding Skills	Look & Feel/Customisation / Aesthetics	Customizes/Changes GPU	Absolute time spent	Tracked events/actions per minutes	Time spent w/playing-testing the game	Time spent in Pocket Paint	Time in Web View	Time spent in research/tutorials	Time spent in program-ming (remaining time)	uses brick help option	Teacher intervention (positive intervention / mentoring)
Gathering data process																			
Observational: via PMD	**Teachers` observation**																		**Support (observation)**
Automatic: via SDK						**App related**					**Time Management (app related)**							**Support (App)**	
Behavioural constructs (top-down)																			
Didactical/Cognitive																			
Academic Readiness	x		x	x															
Usage of Create@School Coding						x	x	x											
Social Behavioural																			
Confidence	x			x		x		x (*)											
Self-efficacy	x							x (*)			-	+							
Performance	x		x					x (*)									x		
Positive Affect	x	x							x	+				x					x
Interest	x					x			x					x	x	x	x	x	x
Creativity		x	x						x										
Self-Regulatory																			
High Thinking	x		x					x (*)											
Persistence							x								x	x	x	x	x
Effort/dedicated time												x	x	x	x	x	x		
Concentration																	x (**)		
Engagement																			
Self-engagement									x	x			x	x					x
Action-Engagement						+		x	x										
Social Engagement					+														

(*) only advanced functionalities of coding skills / (**) Time programming/Time logged in

Codes: + over the average, - below the average, x at least used, param=parameters, % is percentage of the measurements for that parameter

2.2.4 Measuring the behavioural constructs

For measuring the behavioural constructs, the following steps were followed:

Definition of the grading (scoring measurement) scale: a 1-4 scale was used to reflect the performance of each student in each sub-category and category. This scale was defined as follows:

- 1 - entry level: 1 means that he/she did note meet the expected level of the skill or capacity; or seems he/she does not understand what was requested (failed or had low performance).
- 2- developing: 2 means that he/she approaches the skill or capacity; or so he/she seems to understand what is requested with a lot of guidance (passed or had basic performance).
- 3- secure: 3 means that he/she is meets the expected level of the skill or capacity; so, he/she seems to understand what is required with some hesitation but clearly (very good, or had high performance).
- 4- mastery: 4 means that he/she meets the expected level of the skill or capacity at excellent level, so he/she understand what is required appropriately and outstandingly (outstanding, or had excellent performance).

This grading scale is also used by teachers to evaluate the observations. Its definition allows that all teachers evaluate in the same way, with the same grading system, to all the students. In the case of Germany and Spain, and the following equivalence was used (decimals included):

- 1: holds grades from 0 to 4.9, which means that the student has failed (suspense in Spanish)
- 2: holds grades from 5 to 6.9, which means that the student has passed (approved in Spanish).
- 3: holds grades from 7 to 8,9, which means that the student did good (notable in Spanish)
- 4: holds grades from 9 to 9.9; which means that the student did excellent or outstanding (excellent in Spanish).

Evaluation of observational construct in the PMD: each of the cognitive oriented categories was evaluated in the PMD by the teachers for each class project of each student. Automatic evaluation based on the SDK automatic gathering of events: The automatic evaluation process comprises several nested steps:

Adding the Create@School (automatic gathering data) events and standardization of data to provide a grade (1-2 score) by used sub-category and category of events: All events used in each project class (during the all the sessions held for each project class) were added according the definition of the sub-categories and categories, per each student. So, each sub-category and category of events adds the total of events comprised in it per student. Also, all events are added by class where the student belongs, keeping not only the average of each event but also the highest number (maximum) of events used by a student in each class.

The standardization of data process (gauss bell) with cumulative percentiles was used to automatically provide a score to students to each category of events used. This method was used to provide a comparative evaluation system applying a Gaussian curve for the distribution of grades (Roell, K.), taking in account four fundamental reasons:

- the method allows to establish a common standard that ensures uniformity and easy comparison between different the different activities performed for the different subjects (students) in each class.
- Avoids possible inflation of bills.

- Eliminate bias and thus evaluate relative (versus absolute) performance among classmates in each section.
- It allows to evaluate in a relatively simple way in cases in which a parameter is key for the final qualification. For example: who used more functions or events?
- Or Which program generates the fastest response? Or Who completes the task in less time? ...

The gaussian method has a normal distribution that follows a bell-shaped frequency distribution curve; where most of the data values tend to cluster around the mean. The further a data point is from the mean, the less likely it is to occur. There are many things, that naturally follow a normal distribution, such as grade in a classroom, intelligence (Burt, C.). Standard deviation was used to calculate four percentiles (as the scoring selected was 1 to 4). The following image shows the cumulative percentiles in a gaussian or normal curve, which follows the empirical rule that 34.13% of the data lies between -1 SD and 0 SD, approximately 68% of the data lies within 1 SD of the mean, approximately 95% of the data lies within 2 SD of the mean and approximately 99.7% of the data lies within 3 SD of the mean; so, the mean at the 50% mark and it indicates that 50% of the data lies below the mean. The "cumulative percentage" line refers to the percentage of data that lies to the left of the value. The following image represents the gaussian curve for evaluating with a 1-4 grading scale; and 2,99 becomes the passing threshold.

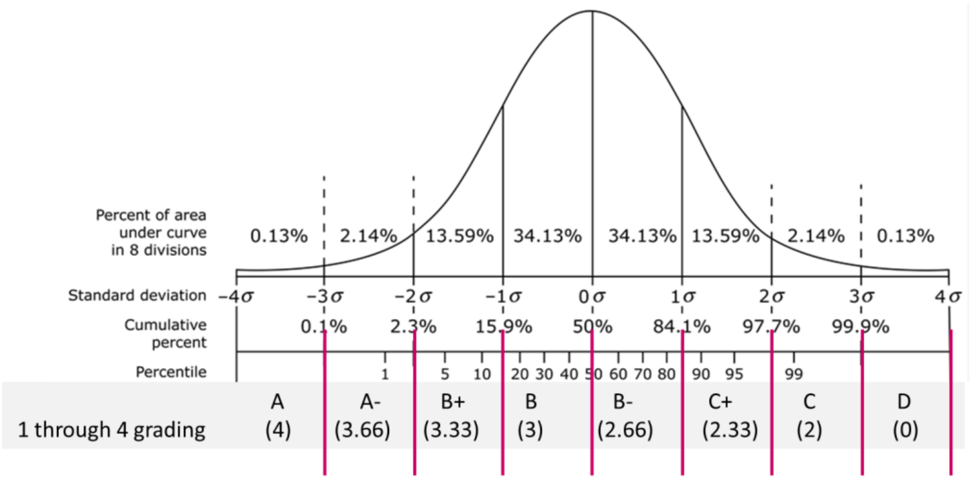
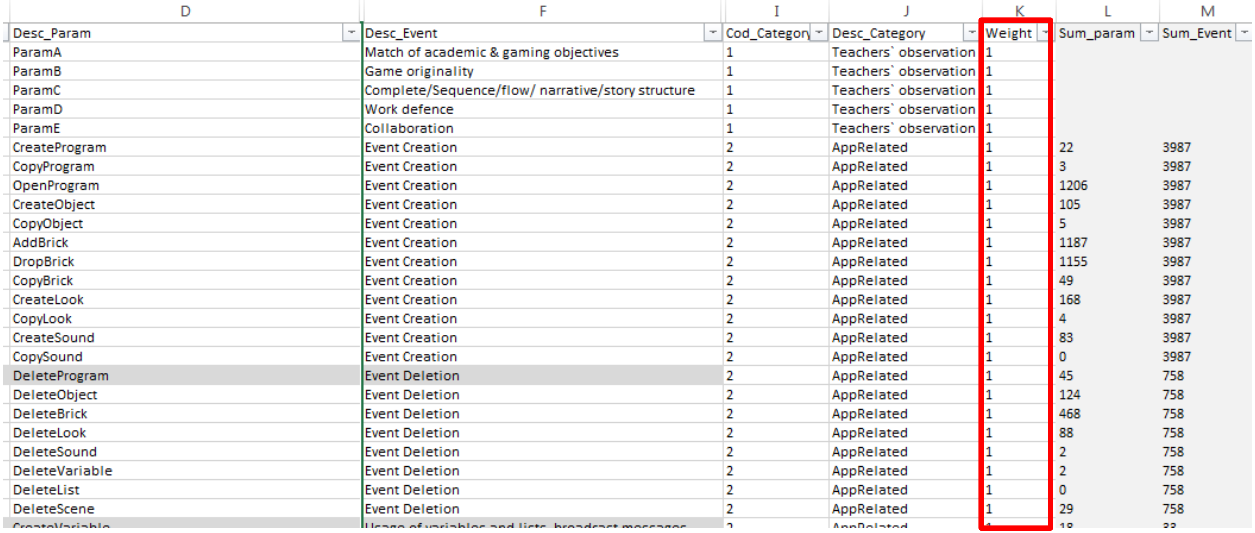


Figure 1: Gaussian / normal distribution methodology

Transferring categories` scoring to top-down behavioural sub-categories and categories: for this purpose, weighted average was used to transfer scoring to the top-down behavioural sub-categories and to the categories, using the behavioural matrix as the tool to link the two behavioural approaches. Currently and according to the teachers all variables that compose a top-down sub-category or category have the same weight (so an average on the grades could be done), but each teacher can change the weight within the excel sheet to see a different distribution. Thus, a table such as the following defines the relationship of both behavioural approaches and weights.



D	F	I	J	K	L	M
Desc_Param	Desc_Event	Cod_Categon	Desc_Category	Weight	Sum_param	Sum_Event
ParamA	Match of academic & gaming objectives	1	Teachers` observation	1		
ParamB	Game originality	1	Teachers` observation	1		
ParamC	Complete/Sequence/flow/ narrative/story structure	1	Teachers` observation	1		
ParamD	Work defence	1	Teachers` observation	1		
ParamE	Collaboration	1	Teachers` observation	1		
CreateProgram	Event Creation	2	AppRelated	1	22	3987
CopyProgram	Event Creation	2	AppRelated	1	3	3987
OpenProgram	Event Creation	2	AppRelated	1	1206	3987
CreateObject	Event Creation	2	AppRelated	1	105	3987
CopyObject	Event Creation	2	AppRelated	1	5	3987
AddBrick	Event Creation	2	AppRelated	1	1187	3987
DropBrick	Event Creation	2	AppRelated	1	1155	3987
CopyBrick	Event Creation	2	AppRelated	1	49	3987
CreateLook	Event Creation	2	AppRelated	1	168	3987
CopyLook	Event Creation	2	AppRelated	1	4	3987
CreateSound	Event Creation	2	AppRelated	1	83	3987
CopySound	Event Creation	2	AppRelated	1	0	3987
DeleteProgram	Event Deletion	2	AppRelated	1	45	758
DeleteObject	Event Deletion	2	AppRelated	1	124	758
DeleteBrick	Event Deletion	2	AppRelated	1	468	758
DeleteLook	Event Deletion	2	AppRelated	1	88	758
DeleteSound	Event Deletion	2	AppRelated	1	2	758
DeleteVariable	Event Deletion	2	AppRelated	1	2	758
DeleteList	Event Deletion	2	AppRelated	1	0	758
DeleteScene	Event Deletion	2	AppRelated	1	29	758
CreateVariable	Usage of variables and lists, broadcast messages	2	AppRelated	1	18	33

Figure 2: example of table that links the different behavioural approaches

The row “Desc Param” are the behavioural constructs. See bellow the match between ParamA to F and the observation variables:

- ParamA = Match of academic & gaming objectives
- ParamB = Game originality
- ParamC = Complete/ Secuence/ Flow/ Narrative/ Story structure
- ParamD = Work defense
- ParamE = Collaboration
- ParamF = Teacher intervention (positive intervention/mentoring)

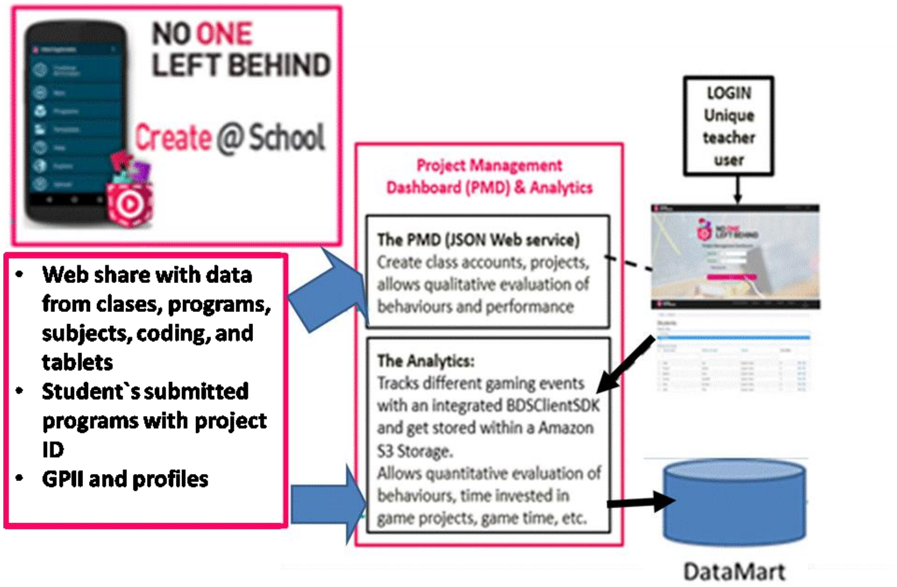
With the help of this excel sheet we were able to summarize the events coming from the SDK and the PMD and make a distinction between teachers` observation and app related parameters. Currently the weight has the value 1 (highlighted in red) and is the same for every parameter.

3 INFRASTRUCTURE FOR ANALYTICS AND DASHBOARD

As shown in the following figure the PMD and analytical big data web services have been created to support the measurement of the teaching-learning process in classes, and thus generate feedback for improving teaching skills, capacities, planning and learning processes.

The Project Management Dashboard provides the measures gathered by the observation process. Those are the ones provided directly by the teachers (qualitative ones provided by the teachers and that respond mainly to the cognitive process). The analytic services are provided by a set of big data oriented web services that have been built to track the behaviour of students while coding. For this purpose, a set of parameters that have been linked to the coding process (events sent by the students` tablets while coding), and allow real-time monitoring of the coding during the different sessions used to code games or programs in Create@School.

Thus, results of the qualitative data, real-time coding parameters and data coming from Create@School (IDs programs, tablets' information, etc) is merged and kept in the data mart, to be analysed and reported to teachers.


NO ONE
LEFT BEHIND
Create@School
Project Management Dashboard (PMD) & Analytics
LOGIN Unique teacher user
DataMart

- Web share with data from clases, programs, subjects, coding, and tablets
- Student`s submitted programs with project ID
- GPII and profiles

The PMD (JSON Web service)
Create class accounts, projects, allows qualitative evaluation of behaviours and performance

The Analytics:
Tracks different gaming events with an integrated BDSClientSDK and get stored within a Amazon S3 Storage.
Allows quantitative evaluation of behaviours, time invested in game projects, game time, etc.

Figure 3: High level view of how Create@School connects with the analytics

3.1 The Project Management Dashboard (PMD)

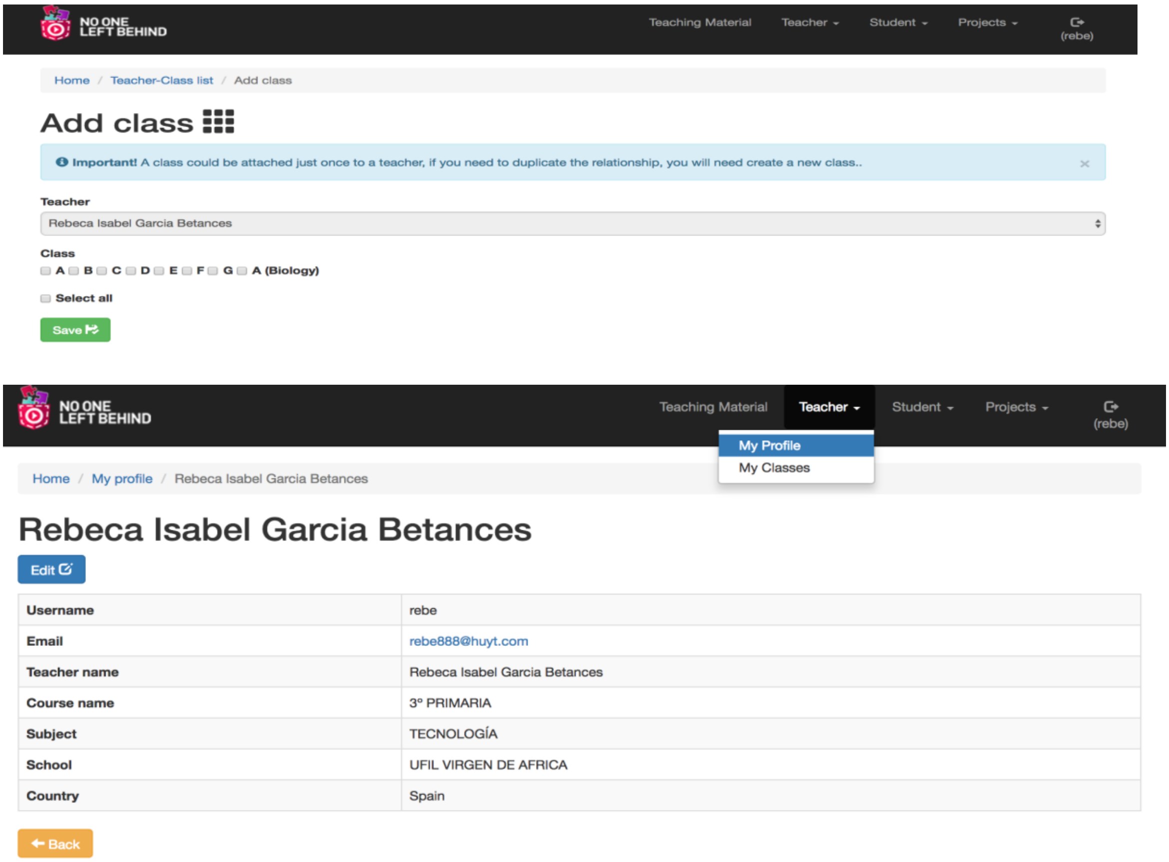
The PMD is a web interface that allows orchestration of the class environment and enables integration of information from all students in class, including the list of students per class, the projects assigned and the evaluation of the projects about the academic or curricular objectives. Thus, through the PMD the teachers not only can plan, assign and manage the delivery of game projects to support new game based teaching approaches; but also, the evaluation of students regarding the completion of projects and achievements of academic objectives.

3.1.1 Components PMD

The PMD is a JSON based web solution that comprises a web interface and a data base.

The web interface comprises several "tabs" (sections) that allow to manage data from students, classes and class projects assigned to students.

Through the “Teacher” tab the teacher can create, configure and manage the classes (e.g. the technology class for 3rd year of primary).



Add class

Important! A class could be attached just once to a teacher, if you need to duplicate the relationship, you will need create a new class..

Teacher

Rebeca Isabel Garcia Betances

Class

□ A □ B □ C □ D □ E □ F □ G □ A (Biology)

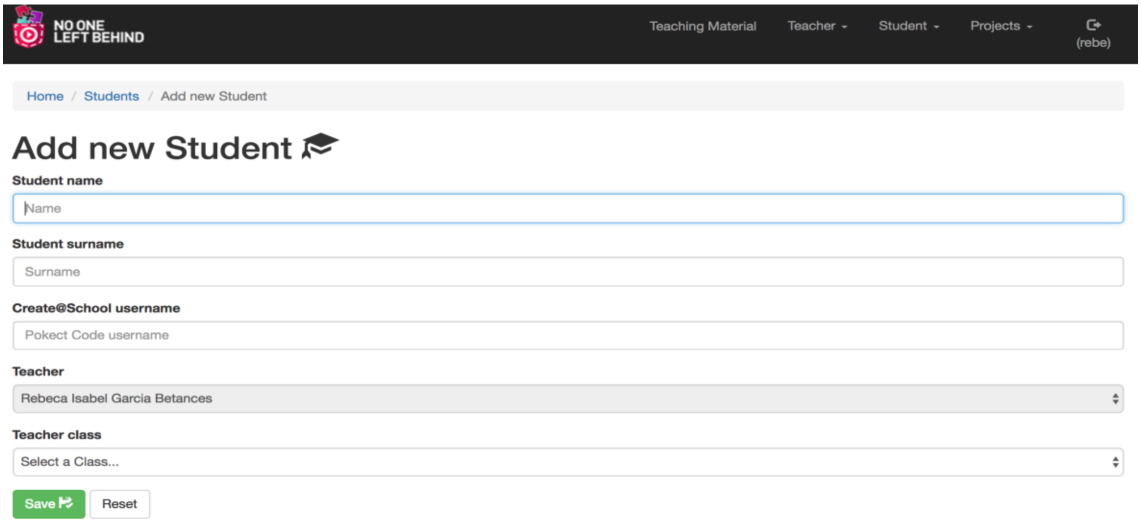
□ Select all

Rebeca Isabel Garcia Betances

Username	rebe
Email	rebe888@huyt.com
Teacher name	Rebeca Isabel Garcia Betances
Course name	3º PRIMARIA
Subject	TECNOLOGÍA
School	UFIL VIRGEN DE AFRICA
Country	Spain

Figure 4:Teachers Tab

Through the “Student” tab, the teacher can create and associate a set of students to the classes, such as add new students or to edit them if already exist and to associate the students to their classes.



Add new Student

Student name

Name

Student surname

Surname

Create@School username

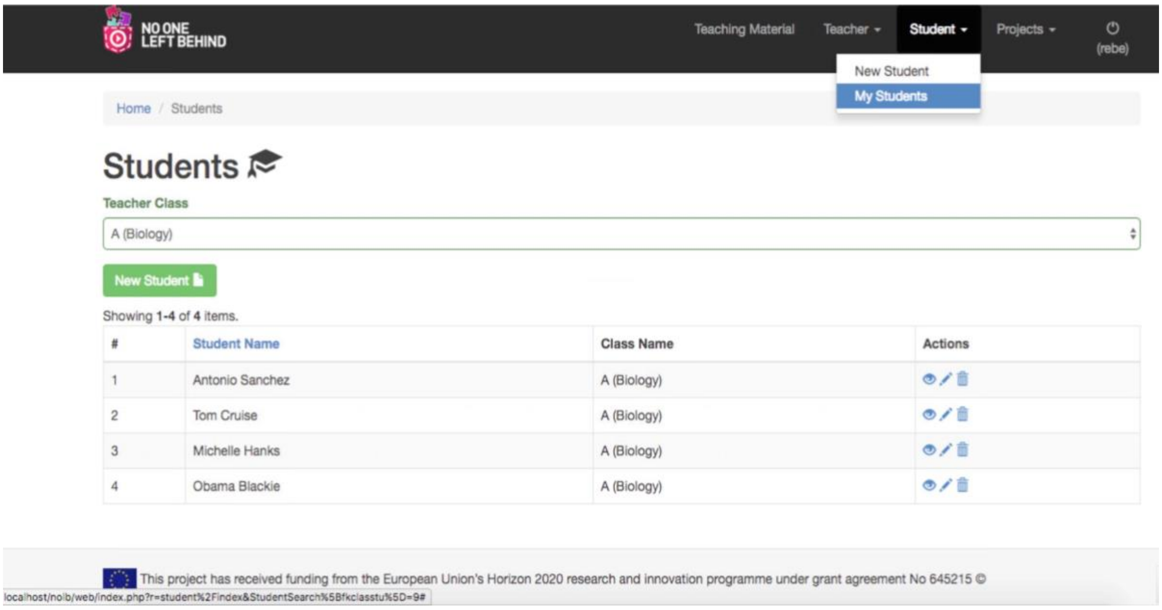
Pokect Code username

Teacher

Rebeca Isabel Garcia Betances

Teacher class

Select a Class...



Students

Teacher Class: A (Biology)

New Student

Showing 1-4 of 4 items.

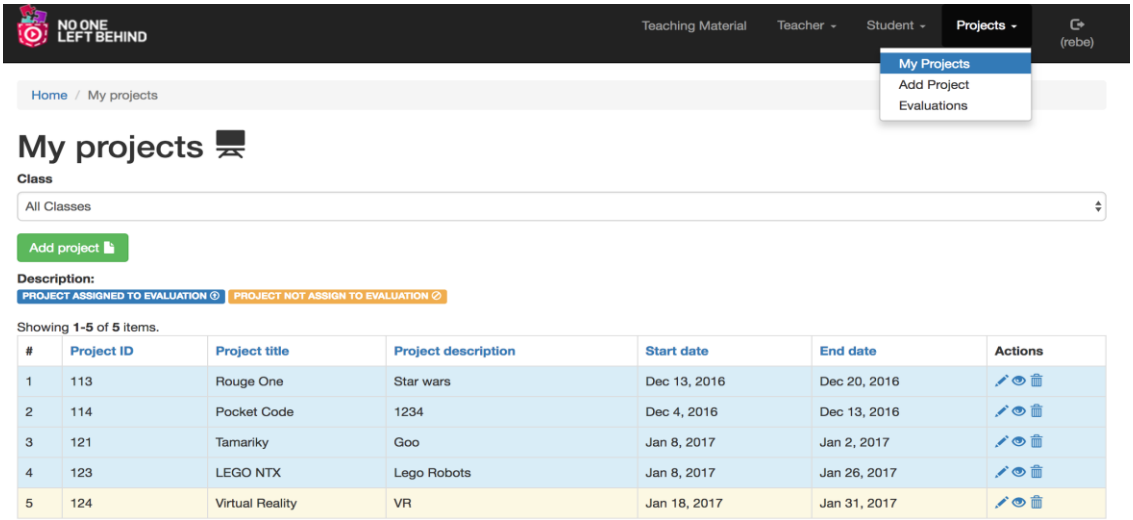
#	Student Name	Class Name	Actions
1	Antonio Sanchez	A (Biology)	
2	Tom Cruise	A (Biology)	
3	Michelle Hanks	A (Biology)	
4	Obama Blackie	A (Biology)	

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 645215 ©

localhost/nolb/web/index.php?r=student%2Findex&StudentSearch%5Bfkclasstu%5D=9#

Figure 5: Student tab

The “Projects tab” allows the teachers to add projects for the students of their classes. It generates a Project ID which is included in the Create@School programs by the students when they create the project in their tablets. The teachers provide a deadline and information from Create@School updates the PMD with all submitted programs from the students` tablets. So, the teacher can evaluate the students in the evaluation tab. The “evaluation tab” allows to score the classwork, based on a set of parameters that he or she considers relevant for the evaluation of the student. The parameters include



My projects

Class: All Classes

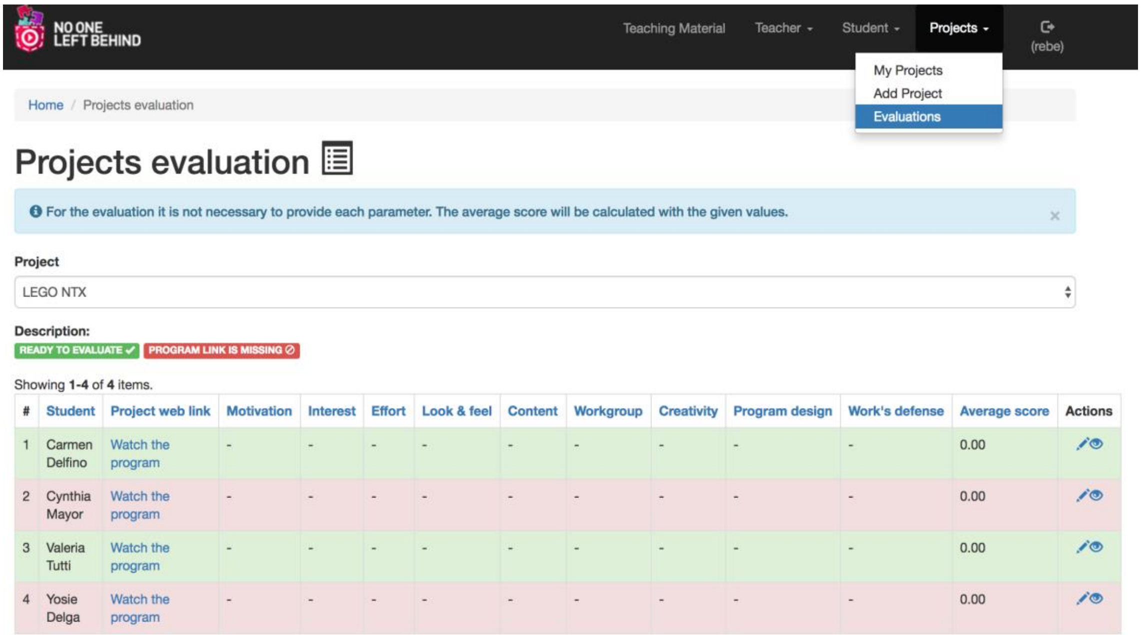
Add project

Description:

PROJECT ASSIGNED TO EVALUATION ✓ PROJECT NOT ASSIGN TO EVALUATION ⊘

Showing 1-5 of 5 items.

#	Project ID	Project title	Project description	Start date	End date	Actions
1	113	Rouge One	Star wars	Dec 13, 2016	Dec 20, 2016	
2	114	Pocket Code	1234	Dec 4, 2016	Dec 13, 2016	
3	121	Tamariky	Goo	Jan 8, 2017	Jan 2, 2017	
4	123	LEGO NTX	Lego Robots	Jan 8, 2017	Jan 26, 2017	
5	124	Virtual Reality	VR	Jan 18, 2017	Jan 31, 2017	



Projects evaluation

For the evaluation it is not necessary to provide each parameter. The average score will be calculated with the given values.

Project

LEGO NTX

Description:

READY TO EVALUATE ✓ PROGRAM LINK IS MISSING ⊘

Showing **1-4** of **4** items.

#	Student	Project web link	Motivation	Interest	Effort	Look & feel	Content	Workgroup	Creativity	Program design	Work's defense	Average score	Actions
1	Carmen Delfino	Watch the program	-	-	-	-	-	-	-	-	-	0.00	✎ 👁
2	Cynthia Mayor	Watch the program	-	-	-	-	-	-	-	-	-	0.00	✎ 👁
3	Valeria Tutti	Watch the program	-	-	-	-	-	-	-	-	-	0.00	✎ 👁
4	Yosie Delga	Watch the program	-	-	-	-	-	-	-	-	-	0.00	✎ 👁

Figure 6: Programs and evaluation tabs

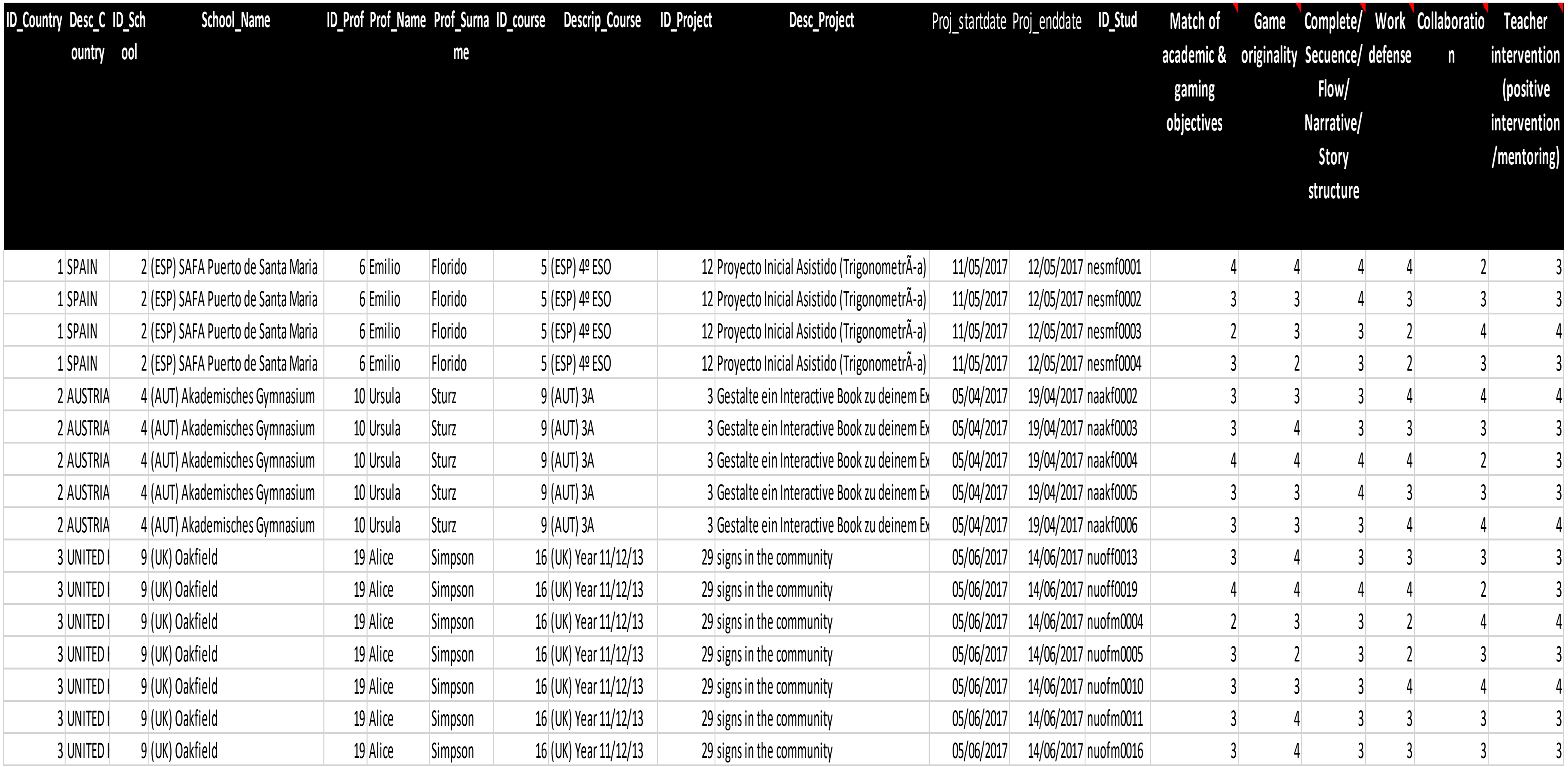
3.1.2 Data provided by the PMD

Data provided by the PMD is stored in a database and exported to the data mart. The database comprises the following information:

ID_Country, name of the country (Spain, Austria, UK), ID_School, name of teh school (School_Name), ID_Prof, Professor name and surname (Prof_Name and Prof_Surname), ID_course, name of the course(Descrip_Course), ID_Project, name of the project (Desc_Project), Date when the project is assigned to sutdents (Proj_startdate) and due date when the project needs to be submitted by students to the theacher (Proj_enddate), Identification of the student (ID_Stud) and the scoring for the following parameters:

- Match of academic & gaming objectives: scoring given to the evaluation of the game looking the achievement of the goal of the academic theme or content that needs to be learned by the student.
- Game originality: scoring given to the student according to the originality of the game, or how the academic concept "is gamified").
- Complete/ Sequence/ Flow/ Narrative/ Story structure: scoring given by the teacher taking in account how the academic concept and its different areas/parts are represented in the game – "gamified"-.
- Work defence: scoring given to the student taking in account how the student presents the project (game) to the teacher, "defends" the performed work and answers the teacher`s questions.
- Collaboration: scoring given to the student taking in account the observations of the teachers regarding the collaboration, support and interaction in classes with other students while coding the assigned project.
- Teacher intervention (positive intervention/mentoring): scoring given by the teacher to the student, taking in account the interest shown in class as well as the questions and interaction of the student with the teacher.

An example of the data provided by the PMD, and exported to the data mart is given in the following figure.



ID_Country	Desc_Country	ID_School	School_Name	ID_Prof	Prof_Name	Prof_Surname	ID_course	Descrip_Course	ID_Project	Desc_Project	Proj_startdate	Proj_enddate	ID_Stud	Match of academic & gaming objectives	Game originality	Complete/ Secuence/ Flow/ Narrative/ Story structure	Work defense	Collaboration	Teacher intervention (positive intervention /mentoring)
1	SPAIN	2	(ESP) SAFA Puerto de Santa Maria	6	Emilio	Florido	5	(ESP) 4º ESO	12	Proyecto Inicial Asistido (TrigonometrÃ-a)	11/05/2017	12/05/2017	nesmf0001	4	4	4	4	2	3
1	SPAIN	2	(ESP) SAFA Puerto de Santa Maria	6	Emilio	Florido	5	(ESP) 4º ESO	12	Proyecto Inicial Asistido (TrigonometrÃ-a)	11/05/2017	12/05/2017	nesmf0002	3	3	4	3	3	3
1	SPAIN	2	(ESP) SAFA Puerto de Santa Maria	6	Emilio	Florido	5	(ESP) 4º ESO	12	Proyecto Inicial Asistido (TrigonometrÃ-a)	11/05/2017	12/05/2017	nesmf0003	2	3	3	2	4	4
1	SPAIN	2	(ESP) SAFA Puerto de Santa Maria	6	Emilio	Florido	5	(ESP) 4º ESO	12	Proyecto Inicial Asistido (TrigonometrÃ-a)	11/05/2017	12/05/2017	nesmf0004	3	2	3	2	3	3
2	AUSTRIA	4	(AUT) Akademisches Gymnasium	10	Ursula	Sturz	9	(AUT) 3A	3	Gestalte ein Interactive Book zu deinem Ex	05/04/2017	19/04/2017	naakf0002	3	3	3	4	4	4
2	AUSTRIA	4	(AUT) Akademisches Gymnasium	10	Ursula	Sturz	9	(AUT) 3A	3	Gestalte ein Interactive Book zu deinem Ex	05/04/2017	19/04/2017	naakf0003	3	4	3	3	3	3
2	AUSTRIA	4	(AUT) Akademisches Gymnasium	10	Ursula	Sturz	9	(AUT) 3A	3	Gestalte ein Interactive Book zu deinem Ex	05/04/2017	19/04/2017	naakf0004	4	4	4	4	2	3
2	AUSTRIA	4	(AUT) Akademisches Gymnasium	10	Ursula	Sturz	9	(AUT) 3A	3	Gestalte ein Interactive Book zu deinem Ex	05/04/2017	19/04/2017	naakf0005	3	3	4	3	3	3
2	AUSTRIA	4	(AUT) Akademisches Gymnasium	10	Ursula	Sturz	9	(AUT) 3A	3	Gestalte ein Interactive Book zu deinem Ex	05/04/2017	19/04/2017	naakf0006	3	3	3	4	4	4
3	UNITED I	9	(UK) Oakfield	19	Alice	Simpson	16	(UK) Year 11/12/13	29	signs in the community	05/06/2017	14/06/2017	nuoff0013	3	4	3	3	3	3
3	UNITED I	9	(UK) Oakfield	19	Alice	Simpson	16	(UK) Year 11/12/13	29	signs in the community	05/06/2017	14/06/2017	nuoff0019	4	4	4	4	2	3
3	UNITED I	9	(UK) Oakfield	19	Alice	Simpson	16	(UK) Year 11/12/13	29	signs in the community	05/06/2017	14/06/2017	nuofm0004	2	3	3	2	4	4
3	UNITED I	9	(UK) Oakfield	19	Alice	Simpson	16	(UK) Year 11/12/13	29	signs in the community	05/06/2017	14/06/2017	nuofm0005	3	2	3	2	3	3
3	UNITED I	9	(UK) Oakfield	19	Alice	Simpson	16	(UK) Year 11/12/13	29	signs in the community	05/06/2017	14/06/2017	nuofm0010	3	3	3	4	4	4
3	UNITED I	9	(UK) Oakfield	19	Alice	Simpson	16	(UK) Year 11/12/13	29	signs in the community	05/06/2017	14/06/2017	nuofm0011	3	4	3	3	3	3
3	UNITED I	9	(UK) Oakfield	19	Alice	Simpson	16	(UK) Year 11/12/13	29	signs in the community	05/06/2017	14/06/2017	nuofm0016	3	4	3	3	3	3

Figure 7: example of data coming from the PMD

3.2 *Analytics Big Data Services infrastructure*

The Analytics Engine rests over the Big Data based architecture and is made up of the analytic engine and the data visualization component (dashboard). The following figure shows the integration of the overall architecture, which includes the integration of the Big Data services, the PMD data and web service and the Create@School app.

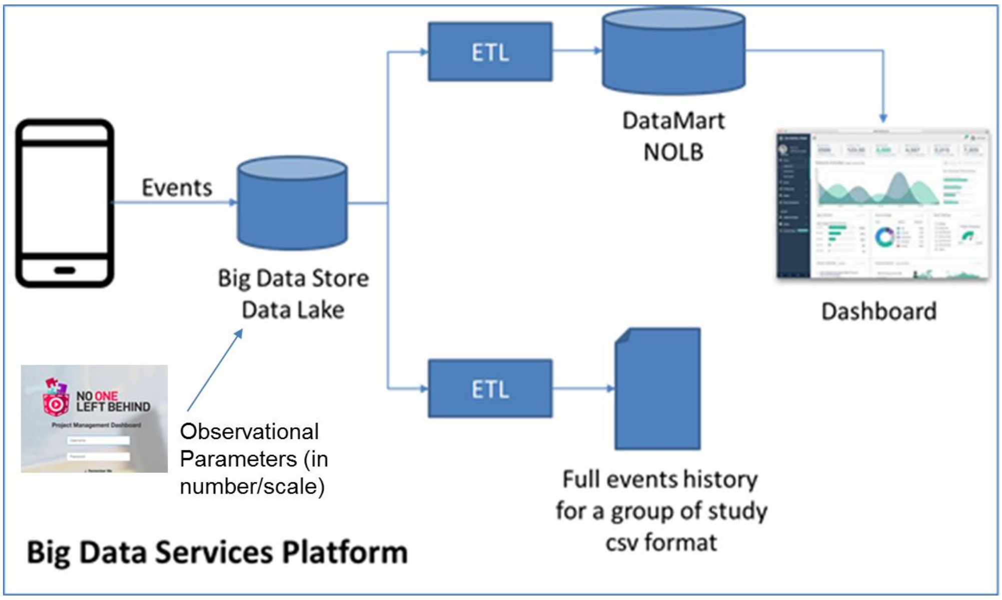

ETL
DataMart
NOLB
Events
Big Data Store
Data Lake
Dashboard
ETL
Observational Parameters (in number/scale)
Full events history for a group of study csv format
Big Data Services Platform

Figure 8: Analytics Big Data Services

How does it work?

The Create@School app invokes the Stream API data ingestion web services. This API is built over a Django framework in a redundant architecture, able to process thousands of events per second.

The Data Lake is a flat files structure that holds huge amounts of raw data in its native format. Underlying technology is based on Hadoop’s HDFS simple and scalable storage system. Only simple and direct calculations are performed in this data layer during the data acquisition, keeping source data as-is.

Since the data are stored in atomic form without aggregations, with sufficient historical perspective is possible to execute data mining processes capable of detecting temporal patterns in the behaviour of the data.

Business Intelligence is the architecture environment for information analysts to exploit business data stored in the data lake, through data analysis tools based on:

- Dashboards
- Reports
- Advanced visualizations

Data is moved and transformed from Data Lake into Business Intelligence layer through Apache Spark processes.

Educational analysts can also perform their own investigations beyond defined dashboards, through custom data extractions from the Data Lake.

The following picture represents the functional view of the analytics architecture, representing how it works.

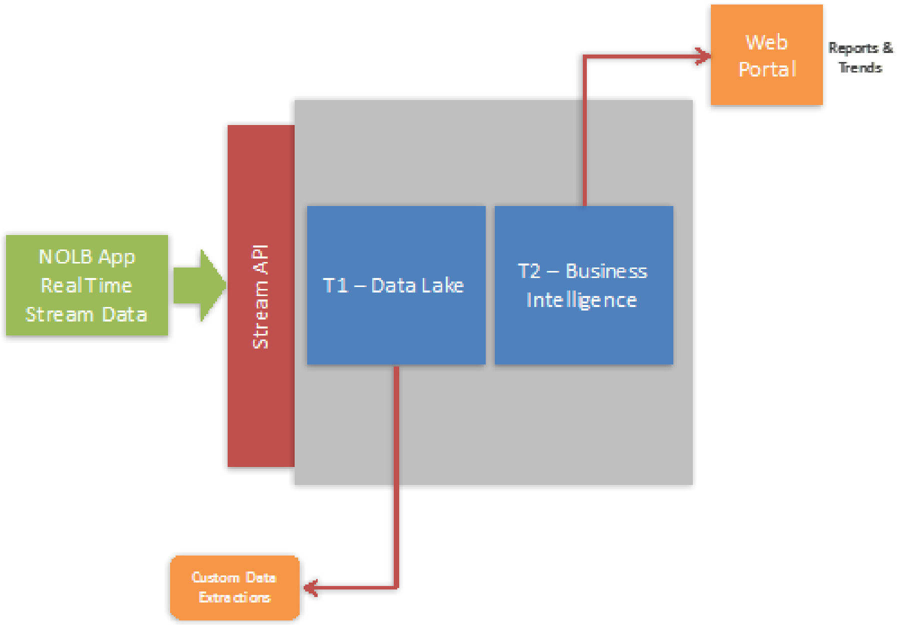


Figure 9: Functional View of the Analytics architecture

3.2.1 Components of the Analytics Platform

3.2.1.1 BDSClientSDK

The Create@School app makes use of an SDK, the **BDSClientSDK (Big Data Services Client SDK)**, which is a very simple and lightweight library with no external dependencies that allows developers to send different types of events related with their applications to the **Big Data Services (BDS)** platform. The **BDSClientSDK** library is a **.jar file** that gets included in the libs folder, when developing. The SDK includes information about the current device in each event.

Different types of events such as: Init session (init_session) or End session (end_session) can be generated, which come as parameters and allow us to know and track the coding processes of students.

As the BDSClientSDK can detect when the app is started or pushed to background and determine if an *initSession* or an *endSession* event should be sent, then we can perform session management. Using the SDK, the following parameters get tracked with every event:

Table 5. Event parameters

Parameter	Description
appId	NOLBPocketCode
userId	Username (linked to the session)
timestamp	The time associated to the event. If indicated value is 0, the final one will be autogenerated now of event creation; including sessionDuration: only for **endSession** events. Time in milliseconds
event type	Provides the type of event (creation, deletion, etc) e.g. createExampleProgram
header	JSONObject that contains data about the device. Typical metrics used by **BDS** are: e.g. device_id, os, app_version, os_version, device, model, product, country, sim_country_iso, locale, screen_width, screen_height
custom data	optional JSONObject that contains additional information about the event; e.g. name of the program, object etc.

3.2.1.2 customData usage

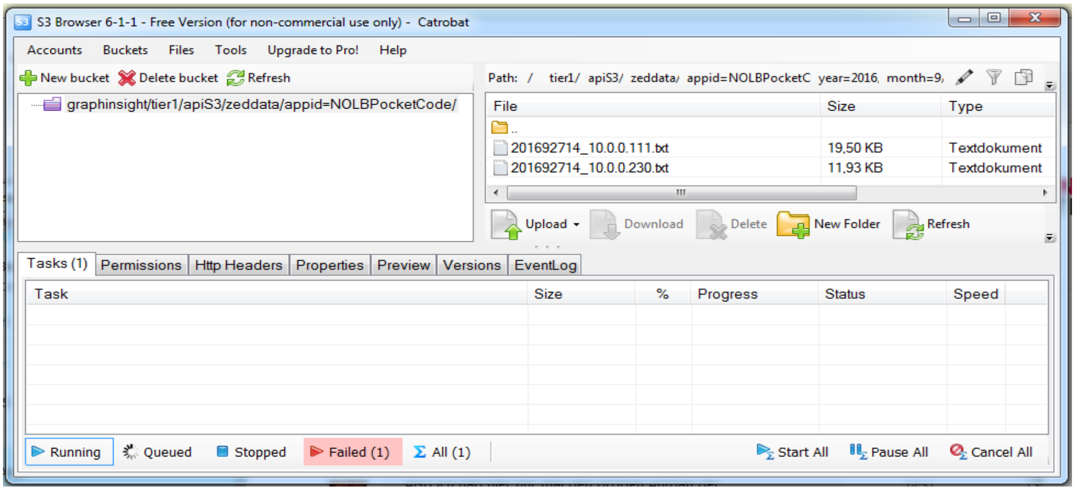
The `customData` parameter, in addition to the *event type* parameter, holds the main power for tracking activity when using the Create@School app. The following table provides an overview of the current possibilities of the tracked data. The user action shows the performed action by the user and which custom data gets stored within the event.

Table 6. User actions and associated custom data

No.	User Action	Custom data
1.	User creates a new empty or example program	programname, landscape, exampleProgram
2.	User creates a new object with Pocket Paint, Camera, device, Media Library	programname, scenename, objectname, source
3.	User creates a new look with Pocket Paint, Camera, device, Media Library	programname, scenename, objectname, lookname, source
4.	User adds a new sound with record, device, media library	programname, objectname, soundname, source, length
5.	User adds a new brick	programname, scenename, objectname, brickcategory, brickname, brick position
6.	User adds variables or lists	programname, scenename, objectname, variablename, scope
7.	User deletes a program	programname
8.	User deletes an object,	programname, scenename, objectname, scriptsamount, bricksamount, looksamount, soundsamout
9.	User deletes a sound, look, brick, variable or list	rogramname, scenename, objectname, name
10.	User copies program, object, look, brick, sound	programname, scenename, objectname, name
11.	User opens program	Programname
12.	User clicks on explore	Duration of session
13.	User clicks on help button	Duration of session
14.	User downloads a program	Programname
15.	User uploads a program	Programname, description
16.	User uses templates	Templatename, landscape
17.	User changes GPII settings	Profilename, settingName
18.	User clicks on Bricks-Help option	programname, scenename, objectname, brickname
19.	User adds, deletes or merges scenes	programname, scenename
20.	User creates group	programname, groupname
21.	User uses formula	programname, scenename, objectname, brickname, brickfield, formula
22.	User executes stage	programname, scenename, duration of session
21.	User uses Pocket Paint	Duration of session
22.	User uses backpack (unpack/backpack)	programname, scenename, objectname

3.2.1.3 Analytics Data Lake

The Analytics engine uses the concept of Data Lake for storing information. This concept is independent of the format of the data, which was a typical limitation when using a purely relational database format. Data "registered" from the Create@School app is making use of Amazon Web Services, specifically an Amazon S3 Storage instance, that can grow elastically as needs for data stored grow.



S3 Browser 6-1-1 - Free Version (for non-commercial use only) - Catrobat

graphinsight/tier1/apiS3/zeddata/appid=NOLBPocketCode/

Path: / tier1/ apiS3/ zeddata/ appid=NOLBPocketC year=2016, month=9,

File	Size	Type
..		
201692714_10.0.0.111.txt	19,50 KB	Textdokument
201692714_10.0.0.230.txt	11,93 KB	Textdokument

Figure 10: Amazon S3 Storage.

Example log:

```
[{"appId":"NOLBPocketCode","userId":"Nolb.Austria;1474987943656;createExampleProgram;device_id#ac73e972
2742481f|os_version#|session_duration#0;amount#|msisdn#;at;Android;1.0;en_GB;;;custom_data#{"programNam
e":"bird","landscape":"true","createExampleProgram":"true"};

standard_data#;header#{"device_id":"ac73e9722742481f","os":"Android","app_version":"1.0","os_version":"3.10.84-
perf-
g5c59022","version_release":"6.0.1","device":"clark","model":"XT1572","product":"clark_reteu","brand":"motorola","con
nection_type":"wifi","carrier":"","network_type":"lte","country":"at","sim_country_iso":"at","mcc_mnc":"23201","display"
:"MPHS24.107-58-1","hardware":"qcom","id":"MPHS24.107-58-
1","manufacturer":"motorola","locale":"en_GB","screen_width":1440,"screen_height":2392,"screen_dpi_density":560,"ro
oted":false,"allow_mock_location":"0","ip":"129.27.34.129","adb_enabled":"1","airplane_mode":"0","auto_time":"1","blu
etooth_on":"0","data_roaming":"0","development_settings_enabled":"1","non_market_apps":"1","usb_mass_storage_en
abled":"1","wifi_on":"1"};
```

3.2.1.4 Analytics stored data

A lot of information can be stored, the following being just a sample:

Table 7. Sample information store for user actions

User Action	Parameters	Create@School	Data (only customData)
user creates new empty program	eventType (CreateProgram) userId (username) timestam (systemtime customData (programname, landscape, exampleProgram)	Class: ProjectManager Method: initializeNewProject	"custom_data":{"programName":"trackMe","landscape":"false","createExampleProgram":"false"}
user creates new object with Pocket Paint	eventType (CreateObject) userId (username) timestamp (systemtime customData (programname, scenename, objectname, source)	Class: NewSpriteDialog Method: handleOkButton	"custom_data":{"programName":"trackMe","sceneName":"Scene 1","objectName":"firstObject","source":"PocketPaint"}
user deletes program	eventType (DeleteProgram) userId (username) timestamp (systemtime) customData (programname)	Class: ProjectListFragment Method: deleteCheckedProjects	"custom_data":{"programName":"trackMe3"}
user deletes object	eventType (DeleteObject) userId (username) timestamp (systemtime) customData (programname, scenename, objectname, scriptsamount, bricksamount, looksamount, soundsamount)	Class: SpritesListFragment Method: deleteCheckedSprites	"custom_data":{"programName":"trackMe","sceneName":"Scene 1","objectName":"Blue duster-1","amountOfBricks":"0","amountOfScripts":"0","am

User Action	Parameters	Create@School	Data (only customData)
			ountOfLooks":"1","amountOfSounds":"0"}
user copy program	eventType (CopyProgram) userId (username) timestamp (systemtime) customData (programname)	Class: CopyProjectTask Method: doInBackground	"custom_data":{"programName":"trackMe2"}
user copy object	eventType (CopyObject) userId (username) timestamp (systemtime) customData (programname, scenename, objectname)	Class: SpritesListFragment Method: copySprite	"custom_data":{"programName":"trackMe","sceneName":"Scene 1","objectName":"Blue duster-1_Copy","name":"Blue duster-1_Copy"}
user opens program	eventType (OpenProgram) userId (username) timestamp (systemtime) customData (programname)	Class: StorageHandler Method: loadProject	“custom_data”: {"programName":"adventureTemplate"}
user clicks on explore button (web-share opens)	eventType (StartExploreSession) userId (username) timestamp (systemtime) customData (null)	Class: MainMenuActivity Method: handleWebButton	“custom_data”:{}

3.2.2 Information managed and analysed by the analytics web services

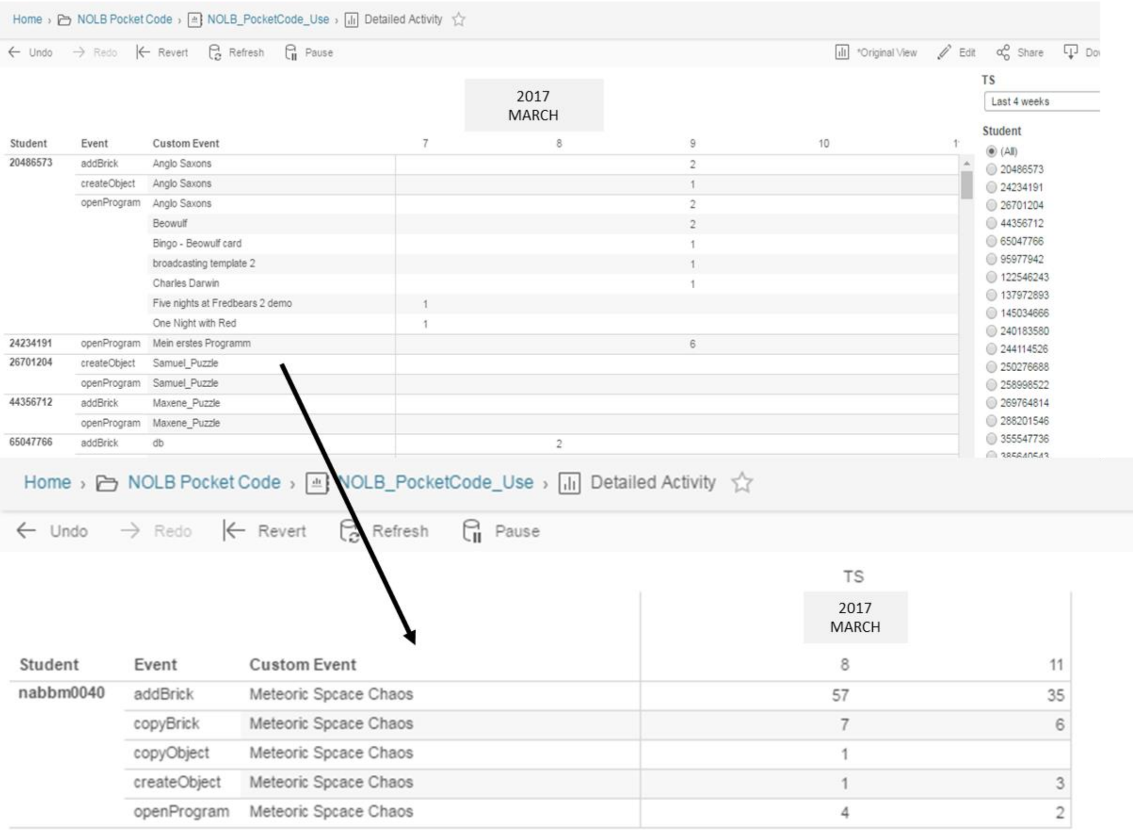
The following information is gathered by the SKD of the analytic architecture and stored in the Data Mart to perform the behavioural analysis.

3.2.2.1 Detailed Coding Activity

Detailed activity can be explored in a very rough way, like the contents of an Excel sheet. The detailed activity allows us to see all (or a single selected) events performed by all (or a single) students in a class, this means that we can see and monitor which coding blocks have been used by students in a class, and thus how they have coded the game or program for the assigned project.

By tracking the coding blocks, we can take each coding block as a parameter and gather information that links coding styles and level to different behaviours, such as confidence.

Through the detailed activity we can see the whole class (all students in a class) or individually each student. We can see in both cases several events (e.g. add brick + delete brick + other events) or a single event (e.g. add brick).



Home › NOLB Pocket Code › NOLB_PocketCode_Use › Detailed Activity
Undo
Redo
Revert
Refresh
Pause
*Original View
Edit
Share
Do

TS

Last 4 weeks

Student

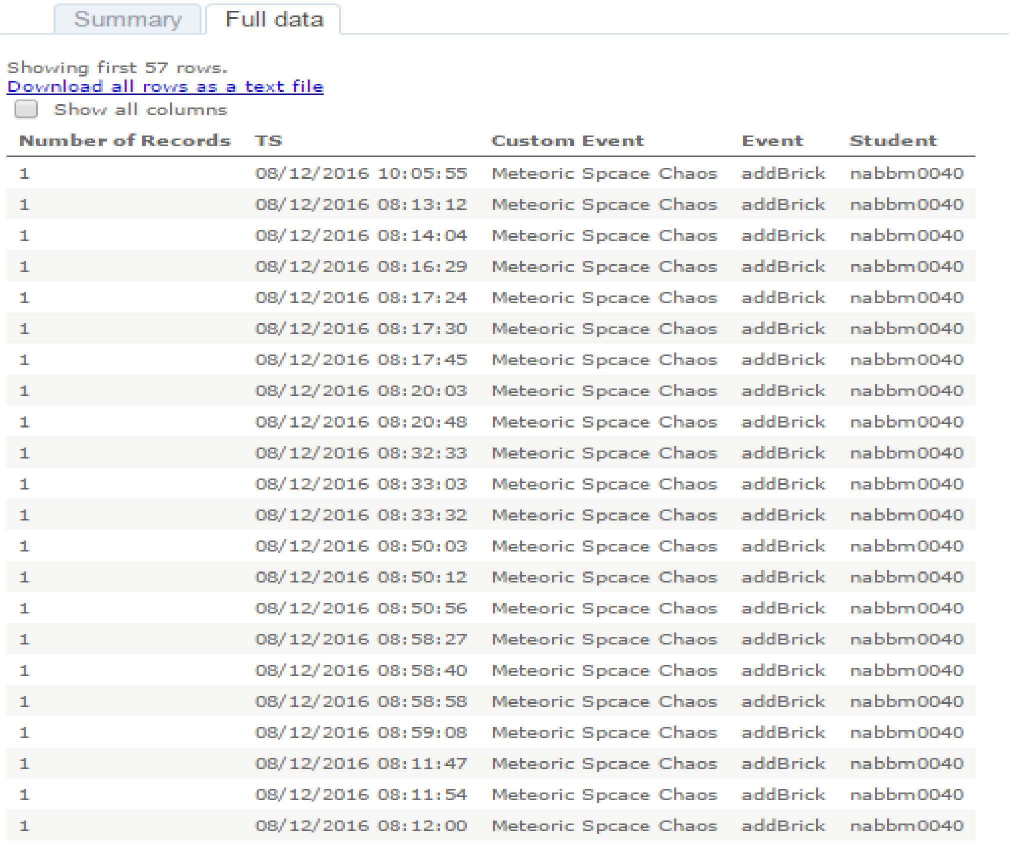
● (All)
○ 20486573
○ 24234191
○ 26701204
○ 44356712
○ 65047766
○ 95977942
○ 122546243
○ 137972893
○ 145034666
○ 240183580
○ 244114526
○ 250276688
○ 258998522
○ 269764814
○ 288201546
○ 355547736
○ 385640543

			2017 MARCH				
Student	Event	Custom Event	7	8	9	10	1
20486573	addBrick	Anglo Saxons			2		
	createObject	Anglo Saxons			1		
	openProgram	Anglo Saxons			2		
		Beowulf			2		
		Bingo - Beowulf card			1		
		broadcasting template 2			1		
		Charles Darwin			1		
		Five nights at Fredbears 2 demo	1				
		One Night with Red	1				
24234191	openProgram	Mein erstes Programm			6		
26701204	createObject	Samuel_Puzzle					
	openProgram	Samuel_Puzzle					
44356712	addBrick	Maxene_Puzzle					
	openProgram	Maxene_Puzzle					
65047766	addBrick	db		2			

Home › NOLB Pocket Code › NOLB_PocketCode_Use › Detailed Activity
Undo
Redo
Revert
Refresh
Pause

			TS	
			2017 MARCH	
Student	Event	Custom Event	8	11
nabbm0040	addBrick	Meteoric Spcace Chaos	57	35
	copyBrick	Meteoric Spcace Chaos	7	6
	copyObject	Meteoric Spcace Chaos	1	
	createObject	Meteoric Spcace Chaos	1	3
	openProgram	Meteoric Spcace Chaos	4	2

Figure 11. Detail Activity – all blocks for each/all students



Showing first 57 rows.

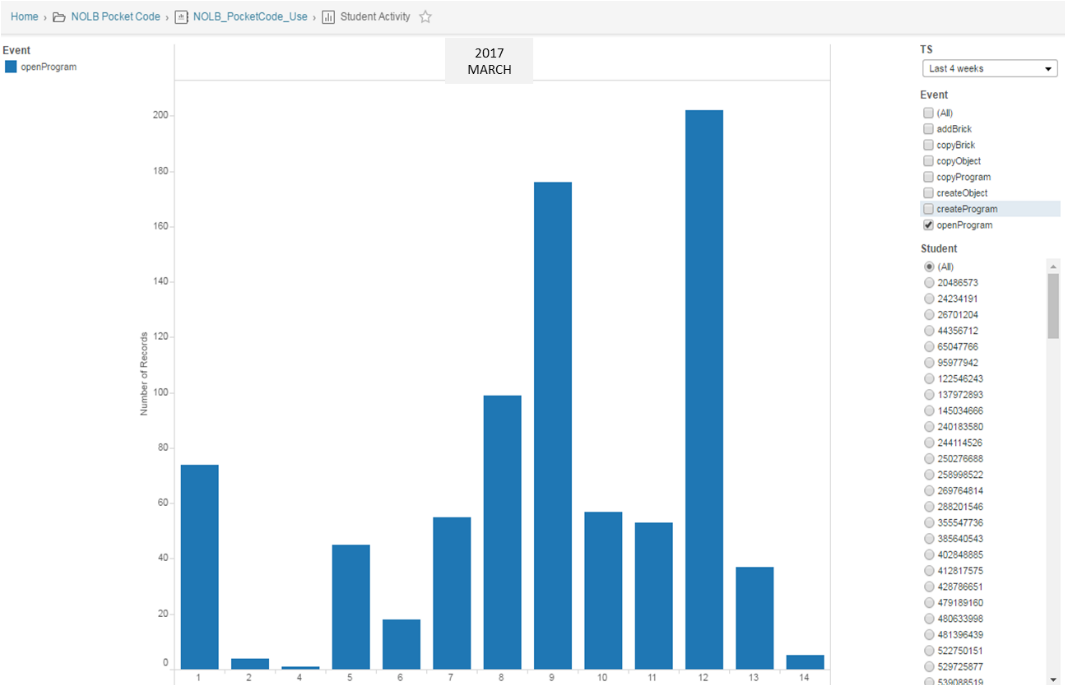
Download all rows as a text file

□ Show all columns

Number of Records	TS	Custom Event	Event	Student
1	08/12/2016 10:05:55	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:13:12	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:14:04	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:16:29	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:17:24	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:17:30	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:17:45	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:20:03	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:20:48	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:32:33	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:33:03	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:33:32	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:50:03	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:50:12	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:50:56	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:58:27	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:58:40	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:58:58	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:59:08	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:11:47	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:11:54	Meteoric Spcace Chaos	addBrick	nabbm0040
1	08/12/2016 08:12:00	Meteoric Spcace Chaos	addBrick	nabbm0040

Figure 12. Individual user – single event (e.g. addBrick)

Data monitoring, meaning detection of each parameter (“each type of event”) allows to count and compare the events used among the students, as thus to evaluate how one student performs in relation to the average of the class. Also, it allows to measure if a parameter (type of event) has been used by a student. Thus, to see the behaviour of each student as well as the whole class. A set examples with graphics representing how events could be monitored were presented in chapter 4 (visualization of dashboards) in D3.2 Analytics Dashboards.


Home › NOLB Pocket Code › NOLB_PocketCode_Use › Student Activity

Event
🟦 openProgram

TS
Last 4 weeks

Event
- □ (All)
- □ addBrick
- □ copyBrick
- □ copyObject
- □ copyProgram
- □ createObject
- □ createProgram
- ☑ openProgram

Student
- ● (All)
- ○ 20486573
- ○ 24234191
- ○ 26701204
- ○ 44356712
- ○ 65047766
- ○ 95977942
- ○ 122546243
- ○ 137972893
- ○ 145034666
- ○ 240183580
- ○ 244114526
- ○ 250276688
- ○ 258998522
- ○ 269764814
- ○ 288201546
- ○ 355547736
- ○ 385640543
- ○ 402848885
- ○ 412817575
- ○ 428786651
- ○ 479189160
- ○ 480633998
- ○ 481396439
- ○ 522750151
- ○ 529725877
- ○ 539088519

Figure 13. Student activity (all students) - Event type (single type): `openProgram`

3.2.2.2 *Users and sessions*

We can explore information about users and the sessions they have opened. Currently the information shows the activities grouped by: Users, Amount of Sessions opened and length of individual sessions.

This allows to register the “timing” of information, this means the time that a student has interacted with Create@School during a period of time (e.g. the period while the class project has been given to the students to be performed), a single session for coding or several sessions (e.g. total time of all sessions dedicated to the class project – develop the game-).

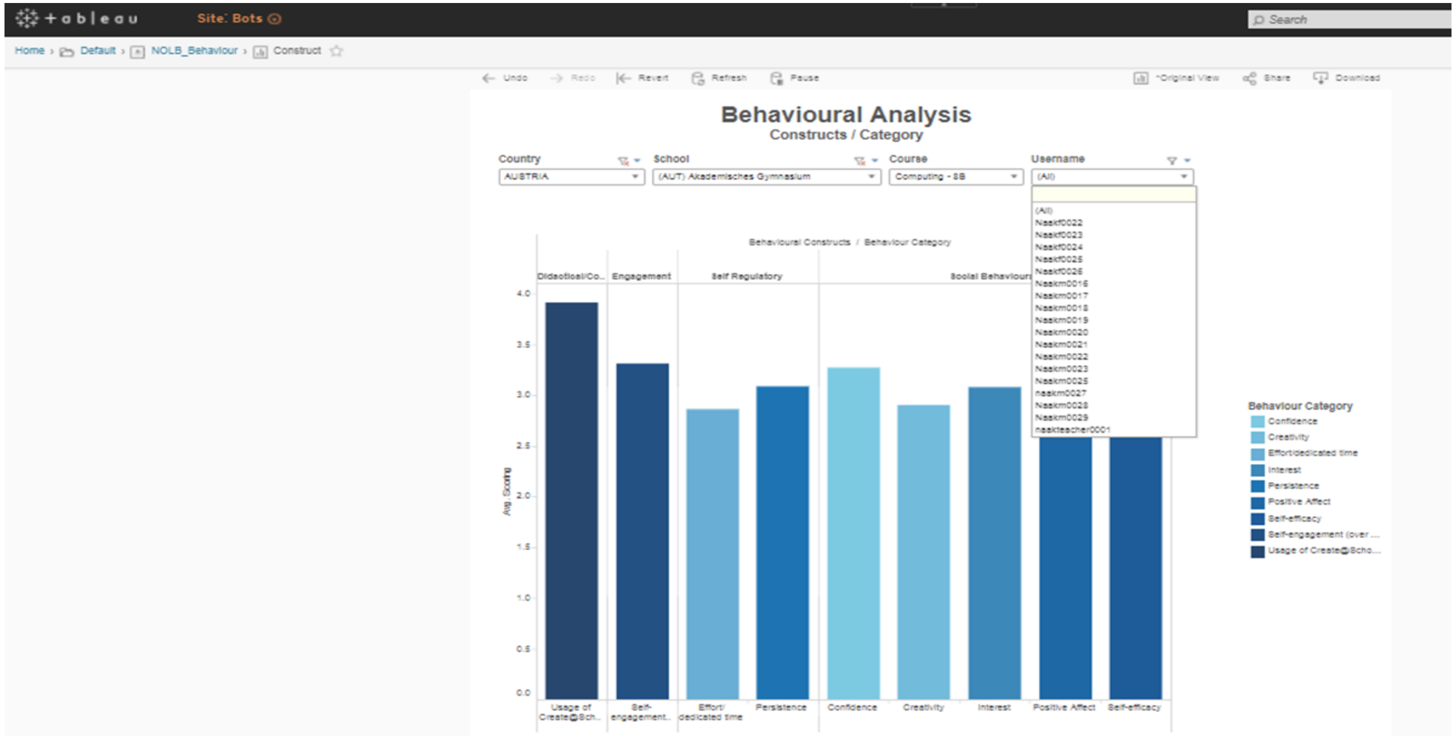
This information, linked to other parameters (e.g. type of coding blocks) allow us to provide information regarding engagement, persistence, motivation or parameters related with time dedicated to programming in Create@School. We can explore the activities in any period for all the class projects assigned to (all/each) student

4 VISUALIZATION DASHBOARD AND RESOURCES

To support the Create@School App several dashboards and resources have been created to show behavioural data and information. The dashboards are explained per pilot in more detail in Delivery 5.3 (Report and findings from experimental pilot in UK), Delivery 5.4(Report and findings from experimental pilot in Austria) and Delivery 5.5 (and findings from experimental pilot in Spain).

4.1 Behavioural metrics charts through online visualization

The big data platform uses tableau which provides automatic and online (provided in real time and through a link) to the different charts. Two types of charts have been defined: one for behavioural constructs and one for behavioural categories (top-down approach). The dynamic nature of the software allows to use the same chart while the data dynamically changes according to the selection of the person using the dashboard.



Behavioural Analysis

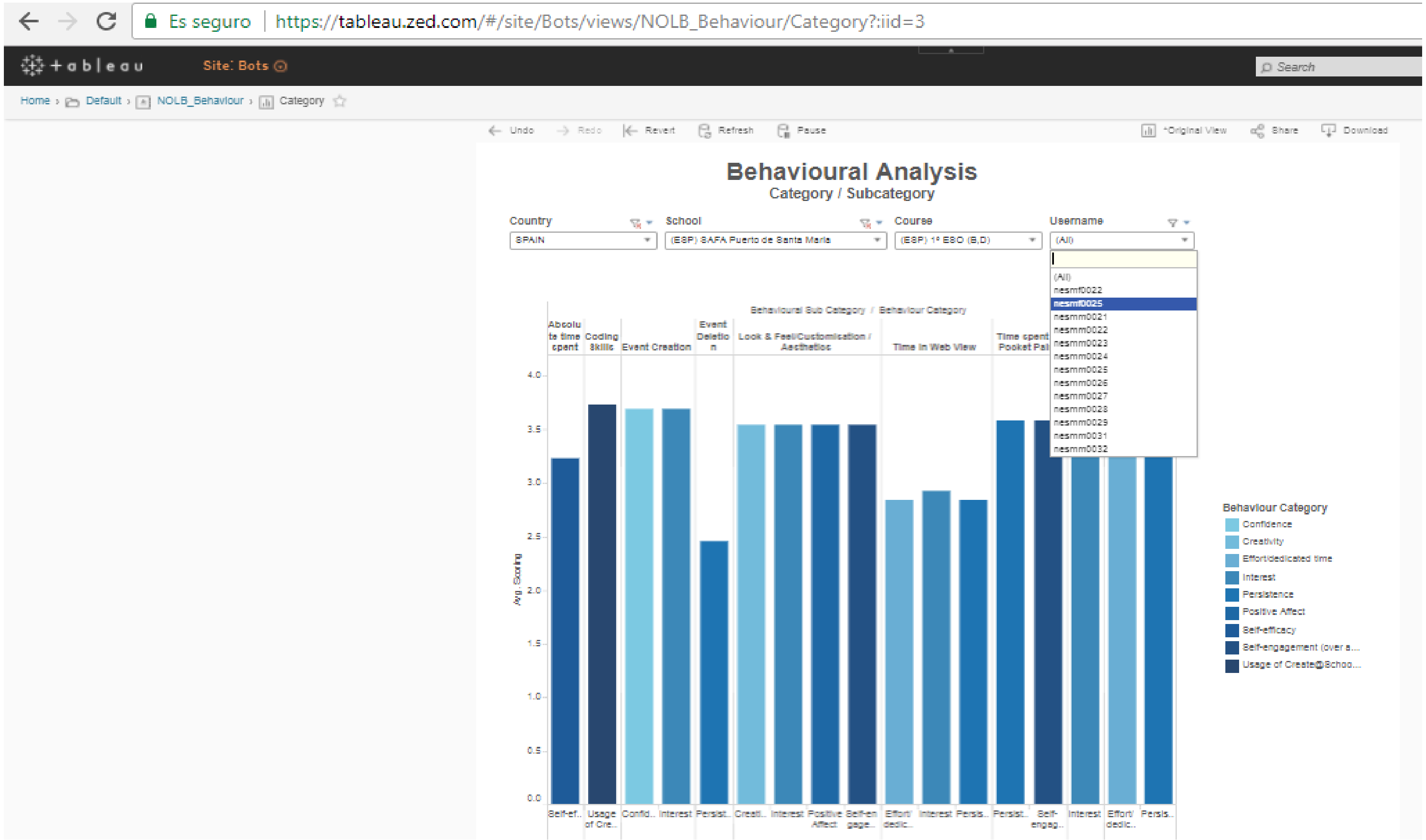
Constructs / Category

Country: AUSTRIA

School: (AUT) Akademisches Gymnasium

Course: Computing - 8B

Username: (All)



https://tableau.zed.com/#/site/Bots/views/NOLB_Behaviour/Category?:iid=3

Behavioural Analysis

Category / Subcategory

Country: SPAIN

School: (ESP) SAFA Puerto de Santa Maria

Course: (ESP) 1º ESO (B,D)

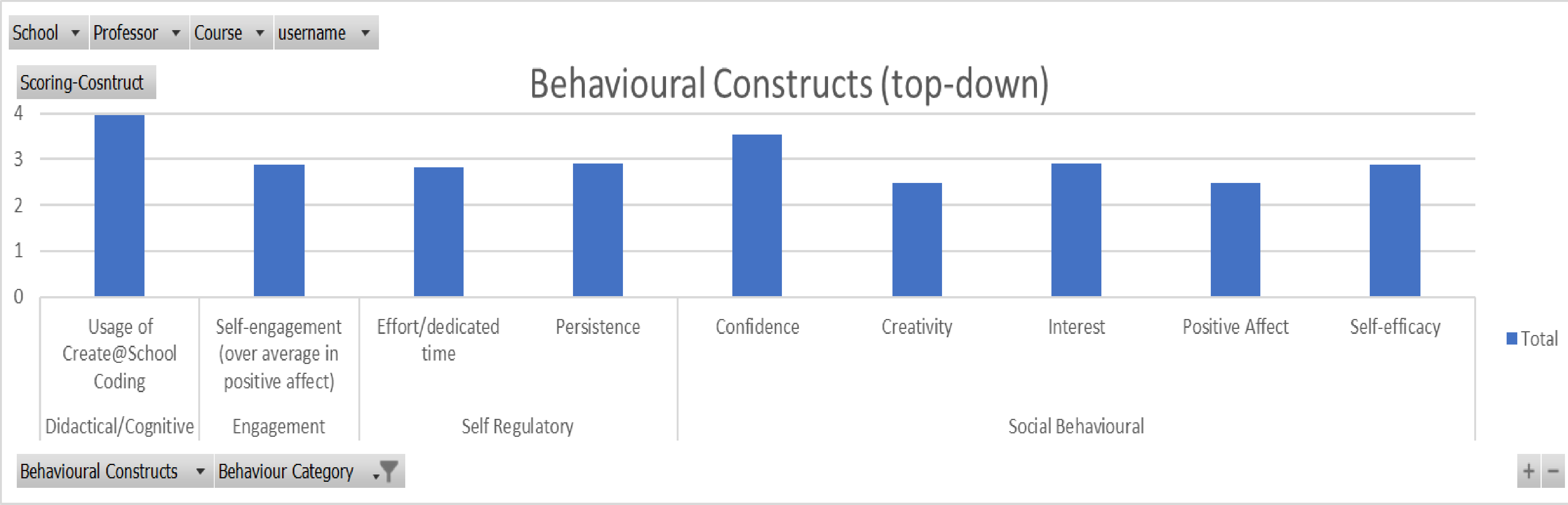
Username: (All)

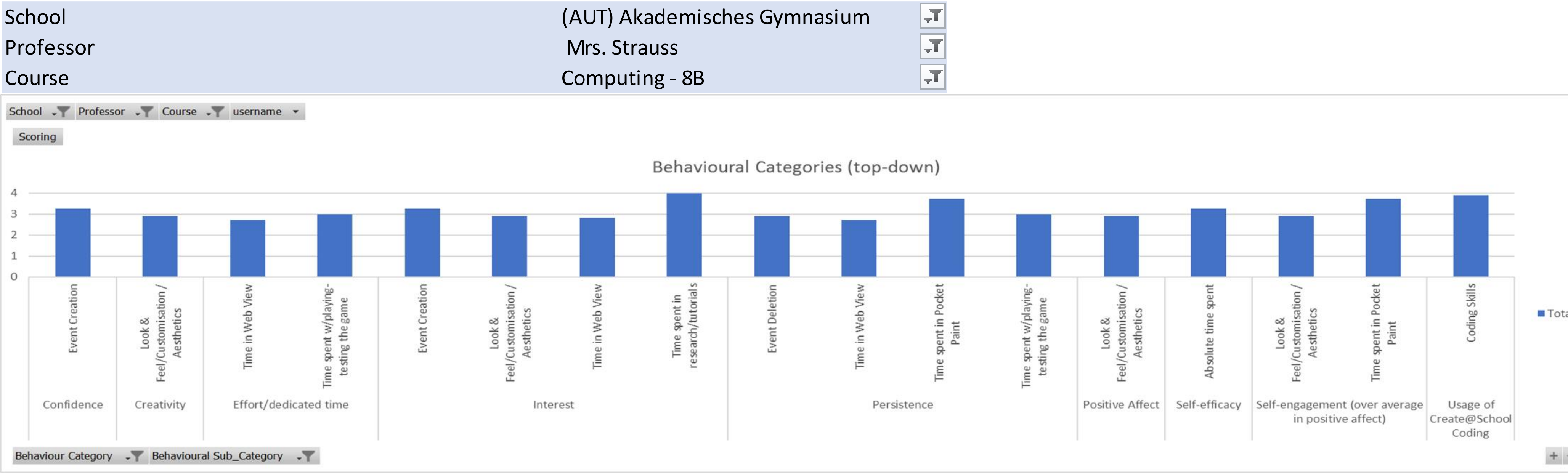
Figure 14. Dynamic dashboards presenting charts from the online tableau big data software

4.2 Behavioural metrics visualization resources

An excel sheet has been provided to the teachers, as an offline tool, which could be manipulated for exercising and dynamically select/analyse variables (classes, students). The following figure shows an example of the graph that represents the average score of the class for behavioural constructs and categories in each teacher in a school.

The dynamic nature of the charts in the excel sheet allows to use the same chart while the data dynamically changes according to the selection of the person using the dashboard.





School	(AUT) Akademisches Gymnasium
Professor	Mrs. Strauss
Course	Computing - 8B

School
Professor
Course
username
Scoring
Behavioural Categories (top-down)
4
3
2
1
0
Event Creation
Look & Feel/Customisation / Aesthetics
Time in Web View
Time spent w/playing-testing the game
Event Creation
Look & Feel/Customisation / Aesthetics
Time in Web View
Time spent in research/tutorials
Event Deletion
Time in Web View
Time spent in Pocket Paint
Time spent w/playing-testing the game
Look & Feel/Customisation / Aesthetics
Absolute time spent
Look & Feel/Customisation / Aesthetics
Time spent in Pocket Paint
Coding Skills
Confidence
Creativity
Effort/dedicated time
Interest
Persistence
Positive Affect
Self-efficacy
Self-engagement (over average in positive affect)
Usage of Create@School Coding
Tota
Behaviour Category
Behavioural Sub_Category
+

Figure 15. Dynamic dashboards presenting charts from the off line excel resources

5 CONCLUSIONS

This deliverable comprises the methodological and technical developments created to support and asses the usage of Create@School in the educational environment. Both the methodology (which provides an evaluation framework) as well as the technical developments are considered as part of the outputs generated by the NOLB project.

The methodological development that holds the behavioural evaluation process comprises a set of concepts, practices, pedagogical insights and paths that provide a coherent, standardized and evaluated (in pilots) assessment approach, which help teachers to improve their educational program design, implementation and Create@School usage. Thus, this output provides:

- A standardized and cross-country behavioural assessment system for the integration of game-based subject-relevant content and tools. It represents a common frame of understanding for assessing game mechanics, dynamics and Create@School into the academic curricula.
- It provides a shared vision that links to the assessment and feedback process of learning-teaching practices.

The methodology and definitions from the behavioural measurement framework have been transferred to the Create School's architecture, more specifically it has been imbedded to the big data analytic platform and PMD. By tracking the how students develop the games or the gaming events through analytic tool, we provide measured and analysed data (both academic and behavioural oriented data) as statistics to teachers, which not only supports the evaluation process, but generates feedback that allows new development and adaptation of the learning material; as well as helps teachers to improve the quality and efficacy of the academic curriculum.

The dashboards are accessible online through a link in the Project Management Dashboard (PMD) and through offline excel sheets; in both cases teachers can dynamically interact with data and check aggregated and specific results by classes, projects or students.

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