ProsocialLearn: a Prosocial Games Marketplace

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Abstract— **ProsocialLearn is a digital pro-social games platform. ProsocialLearn consortium aims at delivering a series of disruptive innovations for the production and distribution of pro-social digital games that engage children (7-10 years old), as well as stimulate technology transfer from the games industry to the educational sector. ProsocialLearn will foster the creation of a new market for digital games aimed at increasing social inclusion and academic performance, as well as a distribution channel to deliver these games to children and teachers in European schools. In addition to provide a proven pro-social methodology to design digital games the ProsocialLearn platform makes available a series of application programming interface (APIs), which game developers can use to integrate many of the ProsocialLearn functions into their games, including emotion and engagement monitoring, in-game achievements, games adaptation based on Prosocial Learning Objectives (PLOs), micro-transactions, etc.**

Keywords— pro-social games, digital gaming platform, monitoring pro-social skills.

I. INTRODUCTION

Social inclusion is a key concept in Europe social policy, and both the Europe 2020 strategy and the Digital Agenda for Europe aim to ensure greater social cohesion and employment.

Support for disengaged and disadvantaged learners, enhancing their employability and integration into society is a key. This includes helping people with learning disabilities, and young people to be more employable. Children in danger of social exclusion, showing little to no signs of empathy and high levels of aggressive or anti-social behaviours should benefit from digital games tailored to teach prosocial skills, which can help them achieve academically, appreciate team work and recognize the value of understanding other people's needs. However, current digital games targeting the education sector are low quality and fail to capture the imagination of players, significantly reducing their effectiveness. Contrast this to games in the entertainment industry where innovative technologies and delivery models are revolutionising society and culture. It's clear that traditional game designers know how to produce engaging stories and game content but they are lacking scientifically proven game mechanics that can be used to create serious games for non-leisure contexts in a way that delivers beneficial outcomes for players.

The ProsocialLearn project (http://prosociallearn.eu/) is investigating how to create and deliver digital games for children (7-10 years old) within educational systems that support learning of prosocial skills. The approach combines prosocial pedagogies with advanced ICT technologies and cloud delivery models to create attractive and exciting learning opportunities for children based on digital games.

On the other hand, ProsocialLearn aims at establishing a new market for digital games targeting at increasing social inclusion and academic performance. A ground-breaking digital gaming genre is being created that focuses on helping children to acquire prosocial skills necessary for positive relationships, team working, trustworthiness and emotional intelligence.

A. ProsocialLearn project challenges

In-depth the main challenges of the ProsocialLearn project are therefore:

a) The creation of a new ecosystem for student learning and skill acquisition based on Prosocial Gaming that channels creativity, innovation and technologies from the traditional gaming industry to the education sector. The traditional game industry is thriving with ideas and technical solutions that can directly compliment and benefit serious games, however, the financial risk to small game companies must be significantly reduced to incentivise new game productions by offering domain specific expertise, marketing and distribution channels for digital games. The perception that games are for entertainment must be overcome to increase acceptance of their use by teaching professionals in school curricula.

b) The provisioning of a dedicated prosocial game development and distribution platform to distribute prosocial digital games from SME game companies to the education sector. The ProsocialLearn platform aims at supporting developers by providing scientifically proven prosocial game elements that can be used to develop games targeting children for Prosocial Learning through an API that allows them to integrate functions (visual sensing, identification of prosocial signals from in-game actions, personalised adaptation of game elements, player profiles, game mechanics and expressive virtual characters) into digital games, whilst supporting mechanisms for data collection with protection of personal information.

c) A prosocial gamification methodology for learning and skills acquisition using serious games will be offered based on a rigorous multidisciplinary approach that involves serious design and implementation grounded in scientific evidence in order to consistently deliver efficient content able to serve the required pedagogic goals.

B. ProsocialLearn project results

The ProsocialLearn main project results are the establishment of a new ecosystem for student learning and skill acquisition based on prosocial gaming that channels creativity, innovation and technologies from the traditional games industry to the educational sector. The financial risk to small game companies must be significantly reduced to create an incentive for new prosocial game productions, by offering domain-specific expertise, marketing and distribution channels for these games, and the perception of games must also be changed to increase acceptance of their use by teaching professionals in school curricula. Production and distribution of prosocial games A dedicated prosocial game development and distribution platform must be provided to distribute prosocial digital games from SME game companies to the educational sector.

ProsocialLearn's innovative API will allow developers to integrate a range of functions into prosocial digital games, though supporting mechanisms for data collection and protection of personal information. A prosocial gamification methodology for learning and skills acquisition using serious games must also be provided in order to consistently deliver effective content that serves the required pedagogic goals.

C. Validation of the ProsocialLearn platform

Student outcomes must be linked to prosocial learning objectives to communicate expectations and to provide the basis for evaluating teacher, student and game effectiveness.

Prosocial skills must be measured efficiently and cost-effectively using a series of informational cues related to gameplay behaviour and signals hidden in game mechanics will be linked to prosociality. Using a pedagogically sound prosocial model that stores student data over time, teachers will be able to efficiently monitor progress and assess mid- to long-term learning outcomes across multiple games and game sessions. Games will also be aligned to curricula, helping teaching professionals to understand how to incorporate games into teaching programmes. A series of studies have been conducted in real schools throughout Europe using games produced by the five Gaming Providers that are part of the consortium. Those studies aimed at evaluating mid and long term social and academic effectiveness of prosocial gaming as input to feedback to policy makers. All experiments are supervised by an ethical oversight procedure and ethics advisory board, active over the whole duration of the project.

II. PLATFORM OVERVIEW

Acquiring skills for social and emotional well-being is important for inclusive societies and academic achievement. Studies have demonstrated the beneficial link between prosocial behaviours and improved results in curriculum topics

0. The primary purpose of the platform is to enable a prosocial learning process for creation and delivery of digital games for children (7-10 years old) within educational systems that support learning of prosocial skills.

The approach combines prosocial pedagogies with advanced Information and Communication Technologies and cloud delivery models to create attractive and exciting learning opportunities for children; produce novel digital game-based pedagogies and simplify deployment within educational organisations. Prosociality is a concept that refers to an individuals propensity towards positive social behaviours. Individuals with prosocial skills are, for example, able to join in conversations, talk nicely, identifying feelings and emotions in themselves and others, identify someone needs help and ask for help. ProsocialLearn classifies these skills in terms of Friendship, Feelings and Cooperation. By using interactive digital games supported by additional instructive and reflective activities, ProsocialLearn project allows children to learn social skills that can be generalised to real life situations in the classroom, playground and at home.

ProsocialLearn project adopts a skills based-approach to learning social skills. We have identified an initial set of 40 skills within three classes: skills for friendship, skills for feelings, and skills for collaboration [1]. The skills were selected considering their applicability to and benefit from digital game-based learning, for example, the skill can be measured through sensor observation and monitoring tools. The skills are also of different difficulties and can be incrementally learnt to progress students through levels of prosociality.

For example, identifying feelings is necessary to be able to showing concern for other′s feelings or dealing with angry feelings. Each game can be used to learn one or more skills depending on the nature of the game situations, decisions and mechanics. The adoption of digital games by the formal education sector requires significant innovation in practices of formal schooling, and in the procurement and certification systems for education products. Issues such as the lack of community of practice and time to prepare lessons based on games, the perception that the game takes over from the teacher and incompatibility with teaching practices and general fit to the curriculum are some of the challenges faced by games companies targeting the sector.

Our approach to resolving these problems is to provide a platform supporting the multidisciplinary, co-creation of social games in a way that bridges the gap between communities of teachers and game developers, whilst accumulating evidence for the benefits of social games within schools. Fig. 1 shows the ecosystem for the proposed platform. Teachers access games and work with game designers to create and share usage scenarios, lesson designs and success stories within educator networks, promoting adoption and best practice for the wide variety of educational settings expected in schools. The platform operators business models are based on revenues derived from interactions between users (schools and games companies). The platform itself has little or no value for the initial users and we adopt an appropriate a seeding strategy for engaging users in what is an unknown business proposition

initially without critical mass. The strategy focuses on establishing a set of exemplar games created by teachers and games companies that used to build evidence and are promoted through regional ambassadors. The goal is then to rapidly grow the network on a global scale and remove all barriers to interaction. How the interaction translates to revenue is dependent on the adopted business model. If teachers cannot or will not pay directly (e.g. pay-per-use, subscription, etc.) then other sources of funding are needed e.g. advertising, sponsored games, loss leaders, etc.
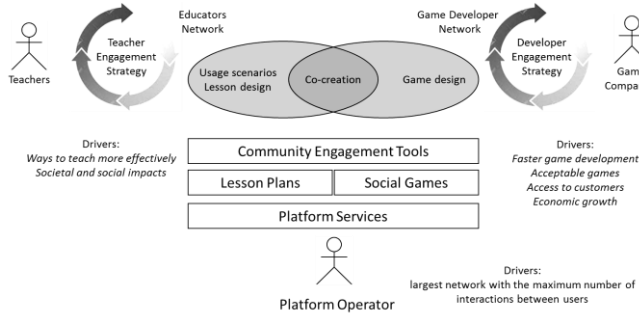

Fig. 1 High level concept of the ProsocialLearn platform

Platform Functional Overview

ProsocialLearn platform is implemented through a technology platform offering systematic pedagogical support for prosocial games developed by an ecosystem of teachers and games companies. Capabilities include multi-modal sensors to observe emotional affect, game interaction and decision-making. Information is acquired through standard protocols (e.g. xAPI [2]) and evaluated by learning analytics algorithms to provide real-time feedback on player behaviours that are be used for in-game feedback and adaptation, and by teachers to shape follow-up activities. The platform infrastructure is deployed at European schools to gather evidence for effectiveness, to promote to policy makers and to increase adoption of game-based learning in schools. The platform considers how to support interactions between different users of the platform (teachers and games companies). Games companies produce value by offering a range of social games to teachers for evaluation and incorporation into lessons.

Games are developed using the platform API that aims at accelerating game development by supporting a learning process through generic capabilities for student observation and fusion, game interaction monitoring, social learning analytics, feedback and adaptation and access to the educational game marketplace. Through these capabilities, games using the platform support a learning analytics pipeline that transforms student monitoring and observations into actionable insights for teachers as part of reflection and feedback activities, or for dynamic intelligent adaptation of the game itself. Three analytics channels are combined to provide knowledge of a player's prosocial behaviour (Fig. 2). At runtime skill measurements are acquired through game interaction monitoring whilst temporal emotional state is observed through multi-modal sensors analysing voice and facial expression. The data is stored across multiple games as part of a learning record and combined with off-line questionnaires capturing additional

information such as demographics and cultural context. The platform aims to offer capabilities supporting the prosocial learning process through an API offered to games developers and decision support tools for teachers.
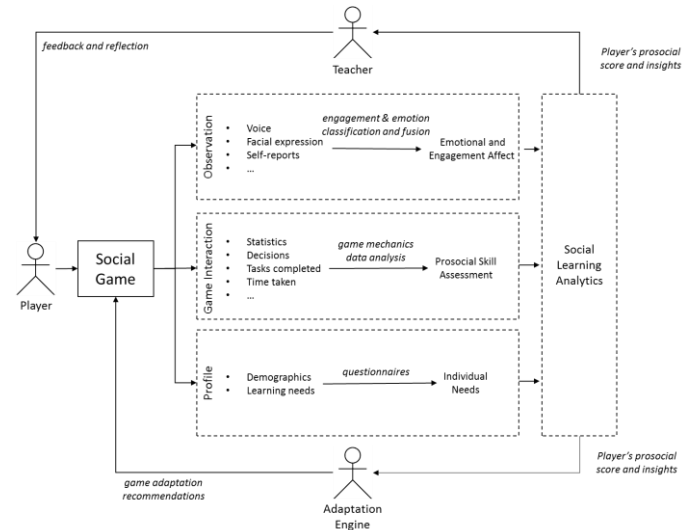

Fig. 2 Prosocial learning analytics pipeline

III. PROSOCIALLEARN INFORMATION SYSTEMS ARCHITECTURE

The high level information systems architecture is shown in Fig. 3. The architecture is composed of loosely coupled services each providing a coherent set of functionality contributing towards management and delivery of prosocial learning experiences. Each subsystem offers APIs that contribute to the full Prosocial API with respective data management and user interface components. A description of each subsystem is shown in Table I.
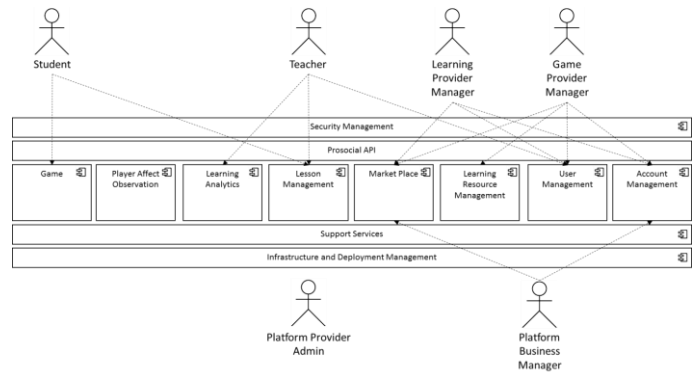

Fig. 3. Prosocial information systems architecture

TABLE I. DESCRIPTION OF PROSOCIALLEARN SUBSYSTEMS

Subsystem	Functional description
Account Management	Provides function to establish business relationships between platform users and the platform provider
User Management	Provides function to manage platform user roles and associated groups
Learning Resource Management	Provides function to manage the lifecycle of learning resource artefacts including deployment, testing, and certification.
Marketplace	Provides function to publish, search and buy learning

	units
Lesson management	Provides function to manage lessons based on learning units
Learning Analytics	Provides function to assess students learning performance during lessons and retrospectively
Player Affect Observation	Provides function to observe and measure prosocial indicators such as emotion and engagement
Game	Provides function to play digital games that are designed to teach prosocial skills
Security Management	Provides function to authenticate and authorise users and their agents (e.g. services, client applications)
Support Services	Provides function for core distributed system capabilities such as load balancing, service registry, time synchronisation and content management
Infrastructure and Deployment Management	Provides function to manage infrastructure required to host platform and game services
Prosocial API	The Prosocial API provides a document developer guide for programming the ProsocialLearn platform building on the APIs of the platform subsystems

Game Architectural Approach

The platform offers a suite of easy-to-integrate APIs for students' behaviour monitoring, game players' management and game matches adaptation. Games, to be managed by the ProsocialLearn platform have to follow a well-defined architectural style. Here, a short list of the main characteristics a ProsocialLearn game should have:

The games implement a standard architecture pattern providing a series of interfaces as presented in Fig. 1. ProsocialLearn approach allows game developers freedom to use their favourite technology (Unify 3D, Unreal Engine, etc.) to implement games. ProsocialLearn games are managed by the platform. The platform governs (create, start, stop/pause and destroy) game matches which are instances of games between one or more players. The interaction between the platform and the game is supported through Restful APIs.

Games matches are managed through a well-defined lifecycle defining the multiple game states as presented in Fig. 2. ProsocialLearn games are typically multiplayer. The interaction among players during the game play should be transparent to the platform. However, the platform is notified about any relevant actions taken by the game necessary for measuring player performance and progress towards objectives.

Game Service Interfaces

Game servers must expose a series of interfaces to be managed by the platform: getLessonPlanTemplate(); getGameState(); getFrontEndURL(); playGame().

getLessonPlanTemplate(): Interface invoked by the platform to retrieve the Game Lesson Plan Template once the Game has been published in the marketplace.

setGameState(gameState: [start|pause|stop], gameId): Interface invoked by the platform to set a specific game state.

playGame(matchID): Interface invoked by the game front-end to retrieve the specific context of the match.

Interaction between the Platform and the Game

ProsocialLearn Games are governed by the platform. Lessons build up the "connection" between games and players. A Teacher describes the Lesson requirements through a Teacher's dashboard by selecting a Learning Unit and tailoring a Lesson Plan Template (provided by the Game Provider) for a Learning Group. This process includes tailoring group and individual level prosocial learning objectives, selecting an allocation plan for distributing students in the group to game instances, and setting any game specific configuration if needed. The lesson is given a start time and duration which is initially taken from the Lesson Plan metadata.

Game Matches Status

Matches pass through well-defined states:

Game match state "initializing": the game server creates the game match when the first players joins the match. The match is not stated yet. Automatically the match passes to the next state "waitingForPlayers".

Game match state "waitingForPlayers": players are able to join the game match. The match is not stated yet. As soon as the match is complete (all the players joined the match) match pass to the next state "ReadyToStart".

Game match state "ReadyToStart": the game is ready to start. Once the Teacher click on Start Game match pass to the next state "Running".

Game match state "Running": the match is running. The match can change state to "Stopped" or "Paused" if the teacher asks for Stopping or Pausing the match. The match can change state to error if an internal error rises.

Game match state "Stopped": when the round is out or the teacher stopped the game for any reason.

Game match state "Paused": the match is in pause.

Game match state "Error": when match is in error.

Interaction with sensors

The Player Affect Observation (PAO) subsystem automatically acquires, classifies and fuses player emotion and emotion in relation to game play events. A series of multi-modal observation channels are established from input sensors connected to player devices including microphones, cameras and keyboard, in addition to more advanced gaming sensors such as Microsoft Kinect and Leap Motion. Using sensing and classification techniques emotion from voice, facial expression and body language is acquired and then fusion processes applied to provide the emotional state of the user [5][6].

The individual classifiers are supervised and pre-trained on an input set of labelled features. The classifiers' outputs are then fused to make a final decision based upon the input features. In general, fusion can happen at two specific levels: feature level fusion (early fusion) and decision level fusion (late fusion). Early and late fusion approaches mainly differ in the way they combine the results from feature extraction on the various modalities. The latter fuses mono-modal decisions into a multimodal semantic representation rather than a multimodal feature representation.

As a result, the fusion of decisions becomes easier, while reflecting the individual strength of modalities. Moreover, the late fusion approaches are able to draw a conclusion even when some modalities are not presented in the fusion process, which is hard to achieve in the early fusion approach. In addition, late fusion schemes offer flexibility, in a way that different computational models could be used to different modalities. Recent studies have shown that deep learning networks can be applied at feature level as well as at decision level, being trained directly on raw data or decisions accordingly. In our case, we employ a late fusion scheme, where each intermediate classifier is trained to provide a local decision. In terms of affect, local classifiers return a confidence as a probability in the range of [0, 1] in a set of predefined classes. The local decisions are then combined into a single semantic representation, which is further analysed to provide the final decision i.e., the affective state of the user [6]. Player affect observations are modelled in accordance with the OGC Observation and Measurement model according to the JSON implementation profile [3]. Valance-arousal dimensional space is used for all modes of measurement unit for classification of emotional state [4].

TABLE II. EMOTION OBSERVATION MODEL

OBS	Features of INterest	MEASURE	MEASURE unit
Voice	Carious sound features (energy in frequency band, pitch, duration)	Audio stream capture, feature extraction classification	Valance-Arousal
Facial Expression	Low-level distance and angle measures associated with eyes, eyebrows and mouth	Video stream capture, feature extraction and classification	Valance-Arousal, 5 basic emotions emotions (Anger, Fear, Happiness, Sadness, Surprise)
Body Motion	3D body movement features extracted from joint-oriented skeleton tracking (e.g., kinetic related features, spatial extent related features, smoothness related features,) symmetry related features, leaning related features)	Skeletal data capture, feature extraction classification	Valance-Arousal, 5 basic emotions emotions (Anger, Fear, Happiness, Sadness, Surprise)

The sensor observation channels are incorporated into a data fusion pipeline using decision-level techniques to bring together multi-modal sources and analyse emotional affect. Decision-level fusion is used to determine events along a timeline at which learned decisions are extracted from all unimodal features and integrated into higher semantic concepts (e.g. valance arousal). The platform enables multichannel acquisition of observations. Each channel has its data processing pipeline related to the nature of the observation but are integrated into the platform using a consistent architectural model to allow for manageability. Each classifier implements a stream-based processing function that processes sensor data input and asserts player affect observation output for downstream processing and analytics (e.g. Adaptation and Learning Record Store).

Game adaptation

The aforementioned elements are measured through an observations acquisition framework that aims to transform raw signal data into player affect and engagement information. Since engagement is a multifaceted phenomenon with different dimensions, i.e., behavioural, cognitive and affective, we model student engagement using real-time data from both the user and the game. More specifically, we use data from sensors to identify the affective state of players, while we extract features related to their cognitive and behavioural engagement based on the analysis of their interaction with the game. The information on user engagement for a particular game is used to identify the game's elements that rank highest for a particular student's persistent *engagement profile* for that game. A separate *prosociality profile* is also maintained for each player to rank players according to their achievements with respect to a number of Prosocial Learning Objectives (PLOs), indicating player's ability to properly use and display specific prosocial behaviours or skills. A dedicated Prosocial Adaptation Manager (PAM) component is therefore employed to provide personalization capabilities to the game and enhance the prosocial behaviour of the players.

The PAM is divided into two parts, namely the offline and online adaptation mechanisms. The distinction concerns whether the processing takes place during gameplay or before, in the loading phase of the game. These two mechanisms aim to personalize the prosocial games towards maximizing the players' engagement during gameplay, or select appropriate settings (i.e., scenarios) for demonstrating prosocial skills acquisition. The reason for having two distinct mechanisms is to provide our game with better personalization capabilities. Each mechanism processes different information about the player and concerns different types of factors affecting engagement and prosocial behaviour.

Offline adaptation occurs prior to the game launch and aims to match the player's prosocial ability to a *game scenario*, i.e., pre-launch game conditions (such as difficulty setting, contextual data and story-driven interactions) that appropriately match the player's prosociality ranking. Game scenarios ranking is constantly updated as more and more players attempt, win or fail in achieving a particular scenario's prosocial objectives; offline adaptation therefore matches players to a game setting that is determined (by the total number of players) to be the most appropriate to their current prosociality ranking. Online adaptation on the other hand is responsible for making dynamic adjustments to the game in order to guide players towards game content they'll most likely enjoy, thus maintaining their engagement high. The adaptive features in this mode of adaptation, e.g., the *game elements* are best represented in the case of prosocial games as the game's means for administering positive reinforcement and corrective feedback to commend or correct player in-game actions with respect to the prosocial skill they need to demonstrate. Such elements may include among others the use of in-game GUI messages, graphics, audio messages or tutoring avatars.

The PAM uses the player's engagement profile for a particular game to determine the elements that are ranked highest in terms of in terms of engagement, and are likely to receive the most favorable response from the player, thus maintaining their engagement high and maximizing the potential of learning outcomes. To address adaptation in multiplayer games, a single-winner election method computes

each player's ranking score for each element based on its position in the player's preference list and then estimates the group's score for each scenario or element, thus choosing the most appropriate element based on the group, rather than the single player.

IV. MARKET PLACE

The ProsocialLearn marketplace provides function to publish, search and buy learning units incorporating prosocial games (https://prod-psl.atosresearch.eu/store/).

The marketplace is managed by the Platform Business Manager who is responsible for defining marketplace economics through definition of pricing models, revenue models, game provider publication agreements and learning provider access agreements.

Game Providers publish learning units to the marketplace according to a Game Providers Publication Agreement. The agreement outlines the outlining terms, conditions, obligations and liabilities for Game Providers such as revenue models and any specific market constraints that apply (e.g. geographies). When an agreement is signed it is associated with a Game Provider Account providing permissions for users associated with the account to perform actions on the platform such as developers testing Learning Units, publishing for certification and making marketplace offers. A published game is described according to the Learning Unit metadata specification allowing Learning Providers to discover new learning content, to understand potential learning outcomes and how the content can be integrated into the classroom and school IT infrastructure.

A Learning Provider (schools directors) can access Learning Units by agreeing to a Learning Provider Access Agreement. The agreement outlines terms, conditions, obligations and liabilities for Learning Providers such as pricing models and usage constraints (e.g. how many students, etc). When an agreement is signed it is associated with a Learning Provider Account providing permissions for users within the account to perform actions on the platform such as create lessons using a Learning Unit covered by the agreement.

In the context of the project, five game providers (European SMEs) have already developed pro-social games and published them in the ProsocialLearn marketplace. The marketplace has been adopted by several schools in Greece, Italy, Spain and UK.

V. CONCLUSIONS

This paper discussed the architecture of the ProsocialLearn platform: a digital distribution platform for pro-social digital games. The paper introduces the ProsocialLearn methodology to design and implement digital games aimed at increasing social inclusion and academic performance as well as software facilities and a community to support the creation and delivery of digital games for children (7-10 years old) within educational systems that support learning of prosocial skills. The platform provides an application programming interface (API) framework, which gaming developers can use to integrate many of ProsocialLearn functions into their games, including engagement monitoring, in-game achievements, micro-transactions, etc.

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ProsocialLearn deliverable D1.1 – Market And Competition Analysis – http://prosociallearn.eu/wp-content/uploads/2015/10/D1.1-Market%20And%20Competition%20Analysis-Final%20version.pdf