GamES MOOC
Conceptual Ideas and First Steps Towards Implementation of a MOOC for Children

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Abstract: This paper presents conceptual ideas and a first prototype towards establishing a GamES (**Gam**ified **E**lementary **S**chool) MOOC for children who do not have access to schools. The project is being developed across several Bachelor student projects in collaboration between Cooperative State University, Karlsruhe and the German University of Cairo. A hybrid architecture is designed to support children on mobile devices with intermittent Internet access. Upon access, current learning status and new content are updated. The content consists of leveled games addressing skills defined by the US common core standards for K-5 in subjects Mathematics and English (that can be adapted to other languages). The children's MOOC combines ideas of adaptive user interface, off-line personalized learning, common core standards, and game-based learning. The child's user interface is gamified and after initial registration designed to be manageable for K-5 graders. A second interface addresses the community of game developers who are interested in donating games for certain core skills. In a next step, assessment and government certification of achievements will be tackled. The MOOC software is intended as open source to allow for community development.

1 INTRODUCTION

Education matters. It is the primary factor in economic growth. It improves the overall health of a population. It also helps in creating and sustaining democratic governments and provides the necessary skills for running an effective government (Birdall, 2006).

Unfortunately, according to the 2011 'Education for All' Monitoring report of the UN, one of the first casualties in war is education. Not only are children in war-torn developing countries almost twice as likely to not be enrolled in a school, even when compared to countries with an equally low GDP, but they are also 20% more likely to drop out of school, 30% less likely to enroll in secondary education and 20% less likely to be literate when they reach adulthood (Watkins, 2011, p. 132). Even more unfortunate is the fact, that the number of people living in conflict-ridden areas is increasing daily. Ever since the year 2008 global peace has decreased in almost every part of the world (Institute for Economics and Peace, 2014), which means that an increasing number of children grow up not being able to go to school or even get a basic education in some other way.

One alternative is M-learning. Even though Internet user growth in the developing world has slowed down, the growth was still significant at more than 10% between 2009 and 2013 (Jorge, 2015). Since cell phones in the developing world are "nearly ubiquitous" (Wike and Oates, 2014) it is not hard to imagine a world where Internet access is almost constantly provided. Meanwhile, education is difficult to obtain, economically or safely. Many see MOOCs (Massive Open Online Courses), as a solution to this problem. Even though they are a move in the right direction MOOCs are criticised that most of their content relies on constant Internet access, and even if the MOOC platforms provide offline applications, they require huge amounts of data, like videos, to be transferred to the childrens devices via the Internet (Roberston, 2015). MOOCs also rarely provide content that is age appropriate for K-12 or K-5 children, mostly focusing on College education. In fact, 83% of MOOCs students have finished their secondary education (Chris-

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tensen et al., 2013). There are also issues with retention (Khalil and Ebner, 2015). Khan Academy presents one of the MOOCs that are addressing children, however not open source in content or platform, nor game based. Khan academy is often used together with schools (Murphy et al., 2014).

The goal of this project is to develop a prototypical platform, that mediates what are considered weaknesses for our target audience by presenting adaptive course material in a manner that is available offline with minimal need for Internet updates. Age appropriate education is approached through game-based learning. Key is to motivate children through games in the absence of teachers. In order to achieve this, learning game skills are tied with US Common Core Standards for English and Mathematics with a view toward adaptation to other languages. The next step is to crowd source the content, mediated through social networks. In this way the architecture, content and maintenance is fundamentally different to existing platforms like Coursera and edX, as examples. While these platforms host the content, the platform described here represents a highly structured backbone for content (ie. games) that is hosted elsewhere. The principles of MOOCs still apply as defined in (Yousef et al.,), in particular, the term "Massive" refers to the capacity of the course to expand to large numbers of learners. The platform is called GameES (**Gam**ified **E**lementary **S**chool) MOOC.

The rest of this paper proceeds as follows. After a description of the functional and non-functional requirements of the proposed application in Chapter 2, Chapter 3 discusses the Common Core Standards and how these will be used for the gamified user interface. Chapters 4 and 5 describe the learning interface design and the underlying architecture and first screenshots of the prototype under development before finishing with a conclusion on future work. The material presented here is work in progress and therefore does not yet have a chapter on evaluation.

2 REQUIREMENTS

There are a number of requirements specific to the described children's MOOC that relate to the functional (children and contributors) and non-functional requirements.

1. Usability for K-5
2. Adaptivity
3. Motivational
4. Self-guiding
5. Extensibility for community support
6. Accessibility combining off-line with on-line access
7. Compatibility with minimal mobile technology

2.1 Child Interface

Usability for K-5 is not trivial. Furthermore, adaptability is important according to child, learner type, age, learning-status. For example, in Kindergarten one cannot assume reading skills. Users can get overwhelmed when they are presented with too much information or can get lost when no navigation help is provided (Brusilovsky, 1998). Basically, the interface should fit all users and adapt to a specific user accordingly. Since GamES MOOC is designed to deal with young children this is especially important. In order to achieve this, we draw on motivational theories in connection with games, allowing adaptation to gamer type (Metawaa and Berkling, 2016). Self-guidance is solved through a gamified interface that includes levels according to standard learning sequences and successive unlocking as skills are acquired.

2.2 Offline Availability

Constant Internet access, especially broadband, is extremely rare in the developing world. In Africa, for example, only 1% of the population has broadband access and only 12% have any Internet access on a regular basis (ITU, 2015). Due to irregular Internet access efficient data usage is of primary concern (Hiscott, 2015). Offline availability can be achieved with many different technologies, however, it is important to realize that mobile platforms vary by region. While Android is very common, rivals like Windows Phone and FirefoxOS are on the rise. So, to reach the broadest number of children, GamES MOOC should ideally be able to work offline on almost every platform.

2.3 Easy Extensibility

The platform is intended to live through community donations by game developers. Therefore, it must be easy to plug games into the platform and hook them into predefined sets of skills. While there is a variety of learning software on the market, ranging from MOOC platforms to educational games, none of these are easy to extend. Only one of the eleven most used platforms support an external API for easy integration (Ortega et al., 2014). In order to make use of the already existing technologies regarding education software communication and interaction, GamES MOOC needs to be easily extensible. Therefore, it should offer an easy to use API with minimal requirements for

Table 1: Common Core Terminology.

Course	English Language Arts	Mathematics
Grade	K-12	K-12
1st Level	Strands (L = Language)	Domains (OA = Operation/Algrabraic Thinking)
2nd Level	Anchor Standards (1 = Conv. of Stand. Engl.)	Clusters (C=Add and subtract within 20)
3rd Level	Standard / Skill	Standard / Skill
Skill example	CCSS.ELA-Literacy.L.K.1.a	CCSS.Math.Content.1.OA.C.6
GamES example	Many apps exist already that teach drawing upper- and lowercase letters on screen	Many apps exist already with playful add/subtract games in the range 1-20

plugins and additional software, including a specific interface for game developers who donate games (corresponding to lessons in the proposed construct).

3 CONTENT

In order to provide content, games have to address skills. To level the games for learners, the skills need to be leveled and specific. Such predefined standard skills are then used to connect with the game when they are plugged into the platform. The following steps are necessary to enable the MOOC with this feature:

- In a first step, the US common core standards were analyzed to contain specific and leveled standards of skills for both English and Mathematics for Kindergarten through Grade 5. (CCSS, 2010).
- An intuitive interface is needed to enable game designers to sort their games into skills.
- The standard levels are used to create an individual yet sequenced learning experience for the children's interface.

3.1 The Common Core Standards

The Common Core Standards is an initiative to increase the value of learning in schools. They focus on standardising specific fine-grained content and sequencing of skills that are measurable and intended to prepare students for college and career. Our focus is on English and Mathematics standards for K-5 as the foundation needed by students. The standards are criticized for being used more for testing rather than preparing students for their future careers. However, for our purpose they provide standard sequencing and a way of potentially testing into the correct level without the need for a school or teachers.

3.1.1 Terminology

The platform uses the terminology of the US common core standards as defined below for the GamES MOOC. **Grade** is the year of study to which a learning standard is assigned. We are looking at K-5 in a first round. A grade could be determined according to a test or assigned by a mentor/teacher/parent. **Courses** are "Subjects" (f.ex. English, Mathematics) defined by Common Core State Standards. Their availability depends on the child's grade. **Strands** are the key areas for English Standards: Reading (Literature and Informational), Writing, Speaking and Listening and Language. **Domains** are analogous to Strands for Mathematics and may vary by grade. **Anchor Standards** repeat for each grade and contain grade specific skills for English. **Clusters** fulfill the same function for Mathematics but may vary by grade. Clusters and Anchor Standards contain Standards or Skills by grade. Skills are specific abilities that can be taught, learned and tested for. A game is associated with one or more skills. The proposed platform GamES MOOC provides the backbone for leveling and making these games available according to the standards. Figure 1 intends to clarify the terminology with an example.

3.1.2 English

The Common Core for English Language Arts has 4 Strands (Language, Reading, Writing and Speaking and Listening). The Anchor Standards are the same across grades K-5. The reading standards emphasize the complexity of reading content introduced to the students. The sophistication increases grade by grade. The student must be encouraged to connect missing pieces and ideas and develop an observation of weak reasoning in text. Writing standards aim to develop the ability to use writing styles: arguments, informative, explanatory texts and narratives. They also emphasize helping students observe the writing-reading connections and write about it. They also aim

to develop the students research skills. The speaking and listening standards works on the oral and interpersonal skills of students. They aim to develop team work, listening and communication skills among students. They also aim to develop the student's flexibility in adapting what he/she says according to context. Finally, the language standards provides the essential guidelines of using the English language within the activities of all the standards.They work on vocabulary, phrases, their relationships and grammar in general. The acquired vocabulary and other skills should be useful for the student across different domains and different subjects.

In order to link a game to specific skills, these have to be detailed and concrete. This may not be possible for all Anchor Standards. As an example for English Grade 1, Strand for "Language", Anchor Standard for "Conventions of Standard English" (Page 26) the Standard 1 "Demonstrate command of the conventions of standard English grammar and usage when writing or speaking" is defined as follows (CCSS, 2010):

(a) Print all upper- and lowercase letters.

(b) Use common, proper, and possessive nouns.

(c) Use singular and plural nouns with matching verbs in basic sentences (e.g., He hops; We hop).

(d) Use personal, possessive, and indefinite pronouns (e.g., I, me, my; they, them, their; anyone, everything).

(e) Use verbs to convey a sense of past, present, and future (e.g., Yesterday I walked home; Today I walk home; Tomorrow I will walk home).

(f) Use frequently occurring adjectives.

(g) Use frequently occurring conjunctions (e.g., and, but, or, so, because).

(h) Use determiners (e.g., articles, demonstratives).

(i) Use frequently occurring prepositions (e.g.,during, beyond, toward).

(j) Produce and expand complete simple and compound declarative, interrogative, imperative, and exclamatory sentences in response to prompts.

3.1.3 Mathematics

In Mathematics a course consists of domains (Geometry, Algebraic Thinking, Measurement & Data...etc). Each domain in turn consists of clusters and each cluster consists of standards as shown in Figure 1. An example of skills for the domain "Measurement and Data" is shown in Figure 2.

The categories in Math are not fixed across the early grades but they revolve around some topics: Operations and Algebraic Thinking, Number and Operations in Base 10 and Fractions, Measurement Data and Geometry. The domains and clusters may change according to the focus of the grade. The standards for grades Kindergarten to Grade 5 provide students with a strong base in whole numbers, addition, subtraction, multiplication, division, fractions and decimals in order to provide a sound foundation.

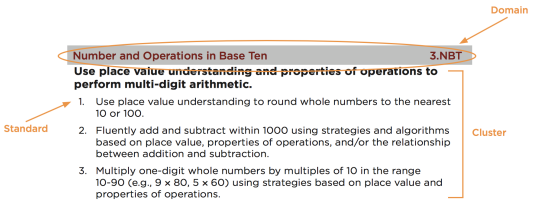

Figure 1: Domains and Clusters in the Common Core Standards for Mathematics.

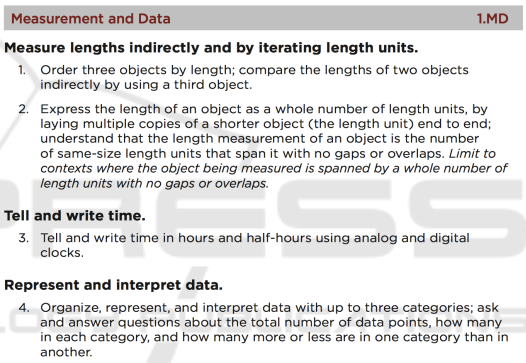

Figure 2: Grade 1, measurements according to US Common Core Standards.

3.2 Using the Standards and Structure

Standards are available via XML format for developers at their hostsite (corestandards.org). In a first version, the standards used in the software are the standards in the category of Language for grades: Kindergarten, Grade 1 and Grade 2. That is because these skills are is category provides standards with more focus on small foundational skills. In Math, the used standards in the software are the standards in all categories for grades: Kindergarten, Grade 1 and Grade 2. Generally, each category in each grade might have one or more domains and each domain has one or more clusters. The learning experience is designed as an individual path through these skills as explained in more detail in Section 4.3.

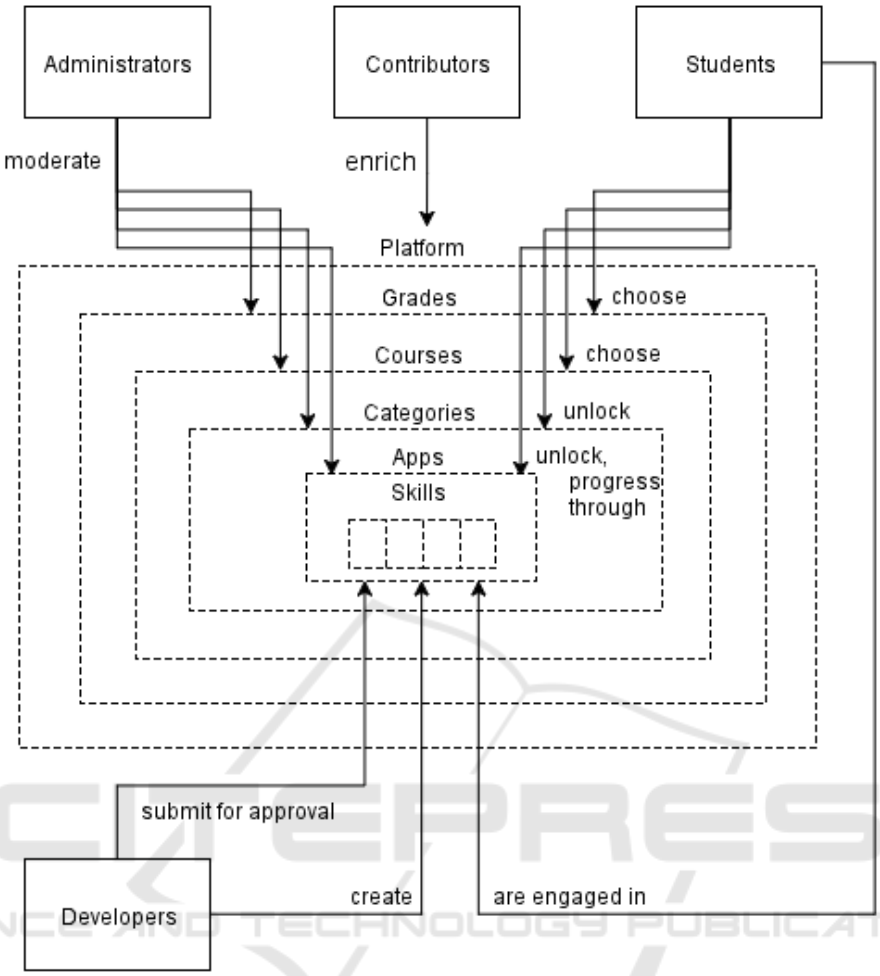

Figure 3: Use cases overview.

4 LEARNING INTERFACE DESIGN

This chapter deals with the functional requirements for both the learner and the game designer perspective.

4.1 Use Cases

Use cases describe how a user of a specific role will interact with the software and the goals this actor can achieve. The overall Use Case diagram is shown in Figure 3 (This depiction was chosen over UML standard due to readability).

4.2 Actors

The Application has three key actors. The teacher that is usually present in education environments is absent in this diagram. The premise behind the tool is that teachers are not available. In future a contributor role is envisioned that is described below.

4.2.1 Administrators

The administrator has the ability to restructure the standards and update the content. This actor can furthermore moderate third-party content.

4.2.2 Student

Children or students use the system to update their games and status when online and play games to gain skills offline. Games are updated by using a sort of MOOC app store that presents available games based on current skill level.

In a first step, the user interface focuses on children in the age group from Kindergarten to Grade 2.

The software is personalized by focusing on creating a learner's experience that adapts to his/her performance and interests. The learner can play the games offline without the need for continuous Internet access. Students can sign up for the GamES MOOC by registering and then using their account. The student is then able to view the list of courses offered by the MOOC and can enroll in any of the courses. Each course has categories and each category has a set of unlocked and locked skills and each skill has registered games that have been assigned to skills. A student signs up and uses the account to view courses and their categories anytime. On each category page, the student can view the unlocked games in this category. Each game has a link to its android store page for downloading. Registered games to the MOOC have to enable the student to login and submit scores in the game using API requests. The student's experience provides more motivation, autonomy and freedom to the student and is accompanied with a mechanism for unlocking games using the standard's defined sequence. The mechanism is discussed below.

4.2.3 Developers

Developers build apps. They are usually game developers that adjust the skills to learning content according to the standards and can hook their games into the MOOC by adding plug-ins to the game to provide for single sign-on, gamer statistic maintenance and score uploading to the server upon Internet availability. The app is reviewed by the administration team.

The developer has support with access to the API documentation of a skill if registered for it. The API demands only 2 requests to be included in the game: Logging in and submitting a score. Submitting a score triggers a set of background actions that updates a students performance level and unlocks new games if necessary. The API and documentation helps speed up the process for the developer who donates his/her game.

4.2.4 Contributors

A future extension includes a more general role for diverse individuals, willing to contribute to the MOOC with ideas, experiences and time. The contributors can be teachers, designers, home-schooling parents, parents, educators, college professors and others, making up the community that supports the platform. Contributors and developers have a rich communication channel with up-votes, down-votes, comments, ideas' bank and the ability to send an e-mail to any of the contributors or developers. Both developers and contributors have to register to a skill as contributors to be able to view the skill's page and benefit from the features. The skill registration provides trackable experiences that would help make the communication more efficient in the future. It also draws the attention to ignored skills.

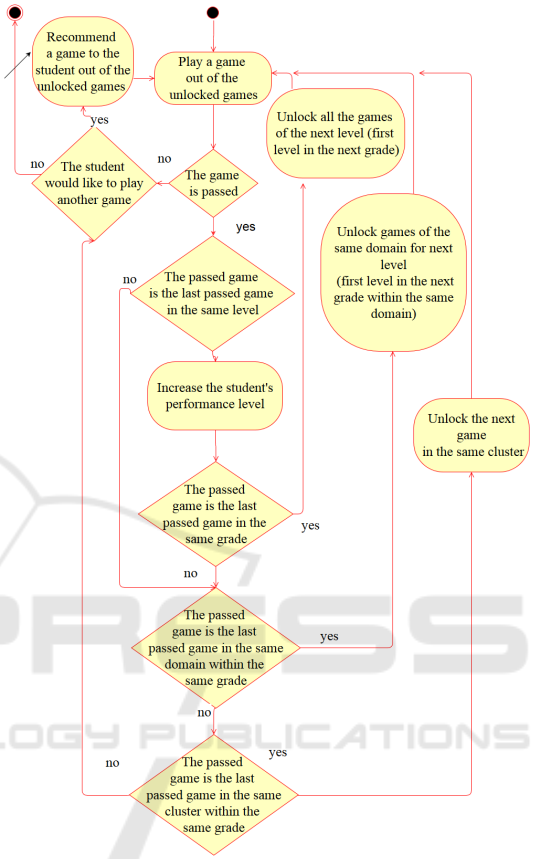

Figure 4: Learning experience flowchart.

4.3 Designing the Learning Experience

The interface for the student uses the core standards to sequence the student learning. However, the order of the courses or the speed a student chooses in order to work through the levels in each shapes the child's experience in a very individual manner. Each of the skills in a course has any number of games associated with it. For example, course "ELA", Strand "Language", Grade 1, Anchor Standard "Vocabulary Acquisition and Use" has three Standards (L.1.4-6) of associated games open. Once mastered (as defined by the game scores), this level is completed and the next level for this anchor standard opens, which is in Grade 2. (Alternatives to consider: 1) All anchor standards and clusters in a strand or domain must be completed before moving on to Grade 2. 2) All strands and domains must be completed before moving on to Grade

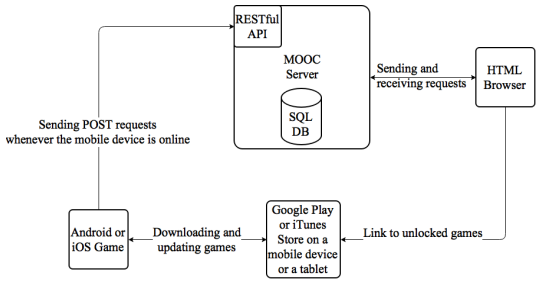

Figure 5: Software Architecture.

2.) Future work must study the effect of this freedom on related skills as the Common Core should be seen as an integrated approach across strands and domains.

Figure 4 shows this process as a flowchart explaining the games' unlocking mechanism and the student's performance levels. Initially, the courses first level games are all unlocked for the student to download and play. After each score submission, a series of milestone checks are triggered to update the student's unlocked games and levels if needed. The experience provides autonomy and motivation for the students. Autonomy exists through giving the students the choice of game they wants to play and the choice of domain they like to progress in, regardless of official grade or overall performance across all domains. Motivation exists through the design of levels. Levels encourage the student to compete with themselves or peers. The system encourages the student to play diverse games across all domains, in order to level up.

5 TECHNOLOGY AND ARCHITECTURE

Technology and Architecture is important when considering an offline/online construct. The general architecture is depicted in Figure 5.

5.1 Technology

The chosen technology is Ruby on Rails with a server side MVC framework. It is designed for the purpose of making the development of web applications easier by emphasizing the use of conventions that saves much of the code usually used for configurations.

Ruby on Rails provides open source free gems and plug-ins that provide extra customization and functionalities. The combination of qualities means that the code will be easier to maintain as open source code.

- It emphasizes the principle of not repeating code which improves maintenance and eliminates ambiguity.
- It can generate an admin panel automatically.
- Active records provide a trivial, easy to use interface to the database.
- The ruby command line supports all platforms and enables many administrator tasks.
- There is a strong community with rich documentation.
- It uses an MVC framework.

The software architecture consists of 4 main components: the HTML browser, the app store, and the MOOC server. The HTML browser interacts with the server using HTTP requests and responses and the interaction works only online. The browser provides links that lead to the MOOC "store" to download unlocked games on the device connected to the users account on the official app stores (Google play or iTunes store). The game sends post requests to the server to update student progress on particular skills. The server consists of a restful API to receive requests from games and a SQL relational database carrying all data about students, developers, contributors, games and other elements in the software. Figure 5 provides an overview of this architecture.

5.2 Architectural Considerations

The following concepts are important for the architecture.

- **Plugin** - Plug-ins to modify skill level: A game that works within the GamES MOOC must be able to connect to the main server to update and modify the skills achievement based on a player's achievement within the game.
- **Single Sign-on** - The game has to provide a common sign-in name with the GamES MOOC. Security between MOOC and games uses standards for secure authentication such as OAuth 2.0 Bearer (Jones and Hardt, 2012).
- **Skill** - A skill belongs to a game, a Standard and a player. Their accomplishment by a student is modified through the plug-in from within the game.
- **Course** - A course has a grade, a Strand or Domain, and an Anchor Standard or Cluster made up of skills. A student is enrolled in a number of courses according to grade.
- **Off-Line** - Skills scores must be kept on the device until an online connection is established. At

this time, the data has to synchronize with the server.

6 CONCLUSION

The work described here presents an ongoing process of establishing a community supported MOOC platform for children. The inspiration for this project is the lack of educational opportunities for so many children. In some parts of the world, schools lack motivation for learning while in other parts, motivation for learning is not sufficient because no (safe) access to (quality) education exists. The Common Core Standards were used to provide proven standardized content and sequencing. The platform was designed with a critical and flexible approach with an appropriate architecture taking into account the target audience's life style and limitations, such as no access to teachers, availability of mobile phones but rare Internet access.

The topic of social networks, community support, assessment and government certification are important next steps to tackle. These points are vital cornerstones for increasing motivation and traffic and providing rich content. The project provides an opportunity for the community of educational games to cooperate. Many existing educational games can be connected to the software without spending extra time on building new games. This is especially relevant as the number of educational games is rapidly growing. Little work is done in academia in this area and it poses immense challenges.

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