Challenges of serious games

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Abstract

Although educational games have revealed to be a very effective focus in diverse situations, their use in education is still very limited. In this paper we analyse the main challenges concerning educational games that, from our perspective, have to be approached so that the use of this kind of games can be widespread. These challenges are classified in three main dimensions: socio-cultural, educational and technological. Once the challenges are identified, some possible measures are suggested to address or reduce these problems so that the use of educational games may be widespread.

1. Introduction

The use of games in education is far from being a new idea. The game is an activity closely related to the learning process (all mammalian offspring develop their skills through play), and educators have identified gaming in general, and more recently digital games, as a natural and very effective approach when it's time to capture and hold students' attention [6], [18].

Games can lead the user to get so involved in the play, keeping his/her attention so deeply, that even his/her perception of time can be distorted. This state, identified as *flow*, was proposed and described by Mihaly Csikszentmihalyi [4]. This author characterised the set of circumstances that are needed for the *flow* to occur either in games or in other daily life situations. This state is usually achieved when some motivating task is being accomplished, and it requires a proper combination of factors such as having a clear goal, which is interesting and involving a challenge, but simultaneously providing a sense of control and feedback, or progression. These are characteristics present in most of the best games. On the other hand, games provide a highly interactive and safe environment in which the player has to take the initiative to explore, make

mistakes and learn from them, to finally acquire a wider experience that will enable him/her to achieve his/her goal. All these characteristics present in videogames are highly desirable in a learning process.

While educational centres work hard to awake the pupil's interest in the learning process, the videogames industry has flourished, having experienced exponential growth for the past two decades. This has lead to a great increase in investments (and risk) to learn how to develop products that capture the attention of players of all ages and backgrounds. And they have succeeded: the videogame industry has learned to capture and hold the players' attention like no other medium. Its highly interactive nature, with very short feedback cycles, deeply engage the player, easily generating these immersive and deep absorption states (*flow*), even blurring the line between attraction and addiction. These successes have led several researchers to argue (and demonstrate in some domains) that this medium is ideal for improving the knowledge and skills needed by the next generations.

However, despite this impetus and the high level of acceptance within the educational technologies research field, the actual use of educational videogames in real environments remains limited, and its adoption is still very slow. For example, in the 2013 and 2014 NMC Horizon

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Reports, games are described as one of the most promising educational technologies, in both cases citing an adoption window of two to three years [10], [11]. Nevertheless, this seems an optimistic projection: its widespread use is still far due to a series of social, technological and cultural barriers, making it difficult to embrace this medium in educational institutions (in fact, this is also referred in the 2012 NMC Horizon Report both regarding high schools and higher education institutions [12]).

In this work some of these barriers are revised, which in many cases are common to the use of educational technologies (ICT), and possible solutions or ways to mitigate the identified problems are proposed. Thus, we present a possible roadmap for a widespread acceptance of using educational games in the classroom.

2. Dimensions

The challenges and problems found when taking games into the educational system and into the classroom are very diverse. Some stem from a quite degraded social image both of videogames and of their users. Those users who dedicate a significant part of their leisure time to game play are often referred as *gamers*. Other challenges are more related with educational aspects such as the teacher's role when games are used, or his/her knowledge and attitude towards using new technologies in the classroom. Finally, there are also some more technological-related problems associated with the development and distribution of games, as this requires complex teams that not always are available, or for implying high development costs.

This wide variety of challenges requires a multidisciplinary focus to analyse and face the inherent problems. In this work we particularly identify three actual dimensions, each one presenting unique challenges.

- *Socio-cultural dimension.* Videogames have a negative image for a significant part of the society mainly because of being frequently associated with problems of violence and sexism, and due to the large media coverage of some extreme addiction cases. Culturally, there is resilience as well, as school is understood as a place for "serious" activities and not as a place for playing, making it difficult to include these activities in the curriculum.
- *Educational dimension.* This aspect is related to doubts concerning games educational value, their effectiveness for teaching, their efficiency as regards effort and results, the possible difficulties when assessing or the lack of tested pedagogical models for the use of games in the classroom. Here it is also to be highlighted the teacher's role issue. The teacher is necessarily required to perform a new role in the classroom, for which he/she needs a certain training. Besides, he/she has to be open to adopt technologies and working habits he/she might not be familiar with, and for which he/she has not been specifically trained.

- *Technological dimension.* This is the closest to the research on the use of information technologies, covering issues such as the excessive cost of game development, the lack of support tools to facilitate the subsequent monitoring of results, or the challenges to face when schools provide suitable devices for the use of educational games.

This classification aims mainly at structuring the analysis of educational games challenges. We are aware that, as whenever dealing with any complex problem, there are no clear or perfectly defined borders. Certain critical aspects, such as those concerning teachers, affect every dimension.

3. The social dimension

To analyse the social dimension it is interesting to compare the videogame sector with the cinema or video worlds. The latter are also greatly important as educational content, which has recently been reinforced with the arrival of massive open online courses (MOOCs), mainly supported on videos. However, it is much more common to find news about the release of a new film or the opening of a film festival than about the launching of a game or the awards for the best game of the year. Yet, the videogames industry is today much more important than the film industry both from the business turnover's perspective and the amount of jobs it has created: throughout the rapid growth of videogames in recent years, their impact as industry in the media is relatively insignificant when compared to its economic impact.

Nevertheless, both industries experience a quite distinct social perception. Although the cinema comprises several subjects where very thorny issues are handled, and despite the high amount of more extreme sequences than those represented in video games, the way the media handles them is very different. On the one hand as for the film industry, there is a worldwide understood system about content classification for adults only; on the other hand, usually it is not established any direct link between the type of movies someone regularly watches, and a certain typified behaviour. On the contrary, games are frequently the focus of thorough media attention whenever bearing contents with very high levels of violence or sexist behaviour. The habit of playing videogames is even held as responsible for violent acts, despite recent studies stating that playing games does not influence neither violent nor bullying behaviours [5].

The perception the media provide is quite negative. There are videogame titles from the past presently being recovered for mobile devices, such as "Carmageddon,"[1] that were greatly focused by the media due to their extreme violent content. Other titles, for instance "Grand Theft Auto," have also had quite an impact in the society due to the misconducts that can be carried out in the gameplay, which have even led the producers to be charged at Court as

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[1] http://www.europapress.es/portaltic/videojuegos/noticia-carmageddon-arranca-motores-android-20130516135829.html

instigators of criminal acts after this game was played.[2] Finally, titles such as "Medal of Honor", "Call of Duty", and "Counter Strike" have raised suspiciousness even at governmental level[3] due to the way some characters are handled in the game, for example, the possibility of playing the role of a terrorist in the game.

It is important to refer that all the games typically starring these controversies are clearly signalled as being for over 18 year-old individuals; however the lack of habit of paying attention to these restrictions (in contrast to movies) makes it too common for these games to end up in the hands of much younger individuals than defined by law. In the EU, the Interactive Software Federation of Europe has put in motion the PEGI[4] initiative used in more than 31 countries, following the trail of the United States ESA, and the ESRB rating. Even though both these ratings are undoubtedly the most widely used, lots of countries have their own systems and agencies.

On the one hand, there are many other non-violent games with big budgets and sales figures that receive much less attention by the media. This generates a widespread perception that games in general are violent and sexist, and promotes the image that games are solitary activities for young unsociable men, although data and research disprove this perception.[5] On the other hand, the benefits that videogames may have when well-used are generally ignored [8]. Recent studies confirm previous results in which the benefits of videogames have been tested in distinct aspects, such as cognitive (e.g. can improve attention or decision-making), motivational (e.g. help dealing with failure), emotional (e.g. can be used to improve mood-control), or social (e.g. contribute to promote a better social behaviour) [7].

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[2] Being one of the most controversial sequels, it is very common to find this type of references in the press: http://www.elmundo.es/navegante/2006/09/26/juegos/1159261119.html, http://elpais.com/diario/2005/12/15/sociedad/1134601207_850215.html, http://www.elperiodico.com/es/cartas/entre-todos/grand-theft-auto-violencia-extrema/85566.shtml
[3] http://www.elmundo.es/elmundo/2010/08/23/navegante/1282575939.html
[4] http://www.pegi.info/
[5] In 2013, the Entertainment Software Association (ESA) indicates in its annual report that the players' average age is 31 years old, and that 48% are women; percentages are very similar in some popular games such as League of Legends (70 million online players).

Although we could argue the reason for this negative bias, that discussion is beyond the scope of this paper, because it does not focus on the fundamental problem: successful or not, this perception exists and is widespread among parents, teachers and even students. Hence, even though the educational games we try to take to educational institutions do not give room for violence, sexism or addiction problems, it is common that, led by the existing perception, the diverse involved parts initially reject this approach. This reality has to be taken into account, and it needs to be corrected at the very first time the use of educational videogames is considered.

4. The educational dimension

One of the major barriers games have to face as educational tools is precisely videogames educational dimension. Games educational value is clear and this is completely accepted throughout the earliest stages of child education [3]. Nonetheless, this perception does not apply in later stages of education, not only because of the socio-cultural problems mentioned before, but also due to teachers' lack of knowledge and suspiciousness regarding several aspects. Some of the frequently asked questions are: What is the real educational value of games?, Do students really learn contents when playing?, How are educational contents/ knowledge/ objectives approached in a game?, Does the game fit the curriculum?, or How should games be used to actually be effective in the classroom?

The truth is that even though games and simulations have largely demonstrated their effectiveness in diverse fields such as aeronautics, the military environment, or the medical field, there still remain many doubts about transferring these successes to other more general areas or domains. It is right that there are games being successfully used in the classroom. However, these still don't have much impact and they aren't used widely enough so that they can be considered another tool. The available examples are still limited and in many cases have been applied only in some countries or for very specific concepts [1]. It is not yet clear if these successful cases are expandable or generalizable to different environments, or if they simply occur in those environments where the users are more heterogeneous.
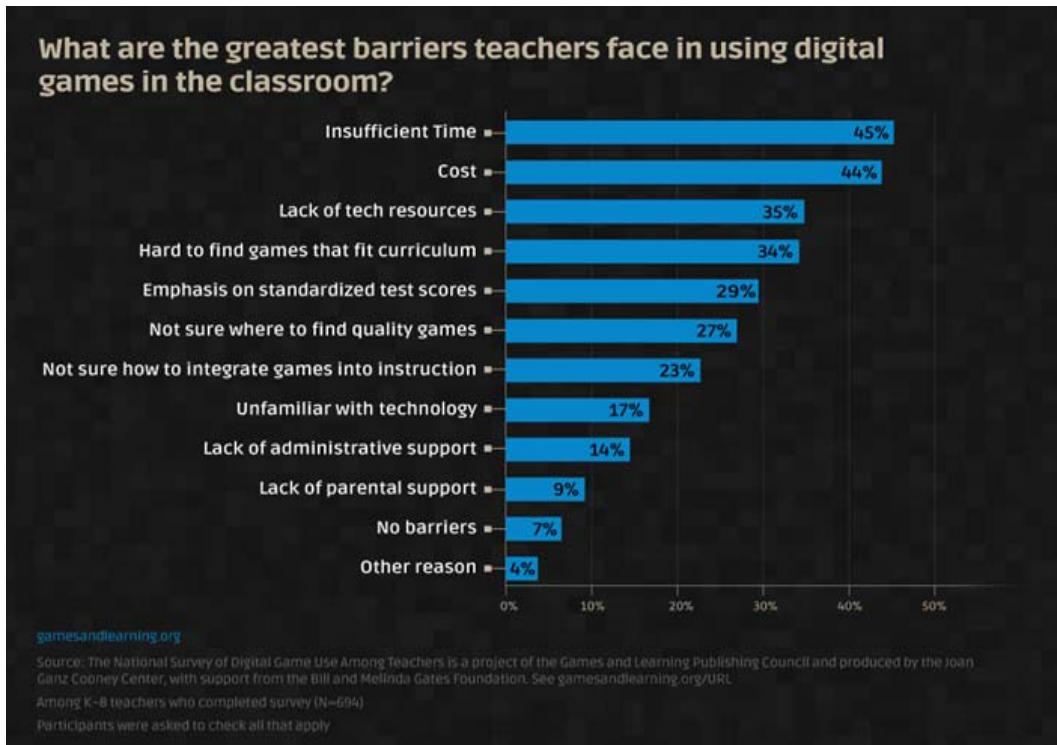
What are the greatest barriers teachers face in using digital games in the classroom?

Barrier	Percentage
Insufficient Time	45%
Cost	44%
Lack of tech resources	35%
Hard to find games that fit curriculum	34%
Emphasis on standardized test scores	29%
Not sure where to find quality games	27%
Not sure how to integrate games into instruction	23%
Unfamiliar with technology	17%
Lack of administrative support	14%
Lack of parental support	9%
No barriers	7%
Other reason	4%

gamesandlearning.org

Source: The National Survey of Digital Game Use Among Teachers is a project of the Games and Learning Publishing Council and produced by the Joan Ganz Cooney Center, with support from the Bill and Melinda Gates Foundation. See gamesandlearning.org/URL
Among K–8 teachers who completed survey (N=694)
Participants were asked to check all that apply

Figure 1. Difficulties identified by the teachers in the United States when using games in the classroom (Source:[19]).

Another aspect is the difficulty in finding games appropriate to the curriculum, and their use normally requires more time than a usual class. In addition teachers are required a greater effort to prepare the classes (when comparing with the traditional material) because, for example, it is necessary to use technical means that sometimes they do not dominate enough, besides being difficult to find games that address the specific concepts and with the appropriate depth to the level of the students attending the course. Even for teachers who are very motivated by the possibilities that the use of games offers, it is not clear where they can turn to find reliable games that fit their pedagogical needs. In Spain, for instance, there is no knowledge of a specific and centralized place/site where a teacher may look for a game to use in his/her class. If you access the website of the Institute of Educational Technology and Teacher Training (INTEF) there is a neutral access for paid content, and a free resources portal called Procomun[12]. If for instance, you make a search in Procomun (November 2014), using the keyword "videojuego" (videogame), the results are scarce (only a dozen), and the few executable games are mixed with a much larger number of game scripts and other related content. Paradoxically, a large number of results can be even worse since, unless they are very well rated or described, revising hundreds of videogames to verify their suitability for a given need requires a huge investment of time.

While teachers know how to organise their classes with usual activities and contents, they have no model on how to integrate educational videogames in the classroom dynamics to ensure their effectiveness. By deploying games in the class, students focus on the game, and the teacher ceases being the centre of attention. This makes it more difficult to manage the learning process, including to monitor students' actions to assess if they are really learning or not. For the class to be effective, it will depend a lot on the teacher's experience and skills, as teachers usually do not receive any specific training in this kind of activities. Moreover, unless the game incorporates elements for assessing and controlling the learning, it is the teacher who has to assess what students have learned either by promoting a subsequent discussion, or by using traditional assessment methods.

On the other hand, the present teaching system is very assessment-guided and oriented. For example, students' results in the standard external evaluations such as the PISA evaluation are determinant for a school's prestige and quality. When the student is learning through play, he/she

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[12] http://procomun.educalab.es

learns differently, and it is unclear if the acquired knowledge enables him/her to handle such traditional assessment tests with the same level of success.

Generally, the teacher has to change his/her role in the classroom when using games, becoming more an activity facilitator than the main content producer and transmitter. Some teachers consider that to diminish their authority as students may even master the technology better than them. This conception together with the previously referred aspects, make teachers feel unsupported on all the new tasks implied in the use of games and, therefore, they must be open to take some risk off the traditional practice.

Finally, these educational aspects also come into conflict with other more social and organisational aspects of the institutions. Playing in the classroom may have a negative effect in the parents' efforts to make their children use videogames at home more appropriately and reasonably. From an organisational point of view, in many faculties/schools it is forbidden to play in the labs. The use of games playable in mobile devices, like mobile phones or digital tablets, may be in conflict with the institution's rules concerning the use of those devices. For example, in some schools the use of connected mobile devices is completely forbidden during lecturing time.

5. The technological dimension

In addition to the social and technological challenges, there are also enormous technological barriers hindering the widespread development and deployment of videogames in the classroom.

The first and major barrier is cost. Whether we consider the cost of using a commercial game or the development costs of a game expressly conceived to teach a particular subject. The arguments pointed out at the beginning of this work in favour of educational games describe the achievements of videogames industry in terms of generating *flow* states, difficulty progression, or presenting environments that capture the players' imagination. Still, it is important to consider that the budgets held by the industry are quite far from those available for producing contents in educational environments [13]. Therefore, many of the games are expensive. If you want to reuse a commercial game for educational purposes, it is mandatory to take into account the cost of the necessary licenses for using it in the class. An example of this situation is the game "Civilization" used to teach complex aspects such as the economic development or the labour division. This raises the problem of how licenses can be purchased and maintained over time. This issue depends a lot on the organisation of the education system, which normally doesn't consider any budget to handle such payments.

On the other hand creating a new videogame requires the use of very advanced programming techniques, the participation of artists (drawers, graphical designers, experts in 3D animation, musicians, etc.), and the use of complex tools. Developing modern videogames is, therefore, a complex job that requires a set of competences quite distinct from the usual skills a work team developing educational contents has, being much more centred on teaching and pedagogical issues.

A further aspect, straddling the educational and technical dimensions, is the game design goals: whereas a commercial game has a single main goal, "to entertain the player", an educational game also needs to link immersive and entertaining gaming dynamics with an educational role that should comply with the curricular objectives the best as possible. Mixing both intents is possible, but it significantly reduces the designers' degree of freedom [14].

This means that, before the widespread adoption of educational games, we need new and much cheaper tools and methodologies for the development of educational games, and which also allow education experts to actively participate in the process.

On the other hand, the technology behind modern videogames is much more complex than any other technology that can be used in a class. This also implies a significant challenge when deploying games in the classroom: whereas introducing elements such as video or interactive presentations requires quite reduced investment (screens, projectors or even digital boards), introducing modern videogames that are competitive with those introduced by the industry requires an investment in consoles or high-end computers, which also require specialised personnel for installing and maintaining them.

These technological shortcomings contrast with the students' increasing adoption of their own mobile devices (phones, tablets or even laptops), which are often more modern than the technological infrastructures available in the educational institutions. This has led distinct researchers to propose the so-called BYOD (*Bring Your Own Device*) models, which are far from being short of problems [9]. Although most participants have appropriate devices, those that don't have them may be excluded from these activities. Moreover, the wide variety of devices that students handle is an added difficulty to the development process as it would have to consider developing games that may be executed on multiple platforms (Android, iOS, Windows Phone), as well as on devices with extremely different computing capabilities. On the other hand, in case the connection between the students' devices is required, further difficulties come forward, regarding security and individual data privacy.

6. Lines of work

As described in the previous sections, the proposal, design, development and deployment of videogames in the classroom face enormous barriers. These are precisely the barriers we believe the academic community will focus a great part of their efforts on, when the time comes to raise a new generation of educational games ready to be deployed, and free of the limitations mentioned before.

The following sections describe the main lines of work related to each of the previous sections.

6.1. Reducing the social rejection

Social rejection is one of the problems that generates a higher level of initial resistance, albeit usually being relatively approachable if effort is made to develop games that avoid reinforcing that rejection, and if effort is made when sensitising and explaining why games are an adequate and beneficial resource.

The following challenges are particularly identified for the next developments:

- Improve the society's understanding of games as another form of art (what Squire calls "literacy on games" [17]).
- Avoid the design of educational games involving unnecessary violence, sexism or other types of discrimination when presenting conflicts or plots to the player.
- Educate the involved parties (parents, students, educators) about the social potential and benefits of videogames. Here it is important to transmit the results of recent researches on the various benefits videogames offer [7].

In our opinion, this problem is also being diminished due to the phenomenon of the occasional player on mobile devices, and due to the emergence of educational applications that use game techniques with educational purposes (this is what is called "gamification" or "edutainment"). For instance, free applications like Duolingo[13] for learning languages are greatly increasing the number of occasional players who previously didn't necessarily play or use applications to learn, and this helps to rapidly change their perception regarding games.

6.2. Increasing the educational value

Once the educators' rejection has been overcome, it is necessary to take other measures to promote the use of videogames in the classroom, among others:

- Improve the access to educational videogames in existing and future educational resources repositories to facilitate teachers' searching for as well as assessing the games before using them. In other words, when an educator has identified a videogame that can be applied as an educational tool, or when the Administration buys an educational videogame, it is essential to register that this resource is available together with its applicability (educational context, target students' age, goals, educational content matter, etc.), in the same way that other educational contents are presently registered.
- Create user and best practice guides for educational games. Even when making the tools available for teachers to use, it is necessary to provide guidance on how to use these new resources, for example, describing the possible educational activities that can be accomplished with the game, the activities organisation, etc., following a similar pattern to that used in the "teacher's book", or teaching guides. Related to this idea, the SEGAN LLP project has developed a massive open online course (MOOC) to introduce its participants not only to the concept of serious game, but also to its design and development requirements.
- Create communities of practice about educational games. The user and best practice guides may not reflect all the details and nuances about the use of the videogames. On the other hand, producing these guides may be costly, particularly time-consuming, and they imply further work for teachers. To mitigate this problem and encourage educators to participate, it would be advantageous to facilitate the creation of communities of practice [20], which allow communication and knowledge production and sharing to be less formal and strict and more agile. In this sense, within the framework of SEGAN project, a community of practice[14] was created for different user profiles: Educators, Developers and Researchers.

Another problem identified in the educational dimension is the videogames value as an educational tool that assesses the student's knowledge. In this sense, videogames may be used as assessment activities substituting the traditional tests for those skills and knowledge in which they are applicable [2]. These activities have the advantage of (if correctly designed) performing a non-intrusive assessment (*stealth assessment*, [16]), which allows assessing the actual required skill or knowledge, and not the student's capability of solving exams and answering questionnaires. This aspect should be simplified with the emergence of new analytical learning techniques (*learning analytics*) applied to games, allowing and simplifying their use in the classroom, because the teacher could have more information about what happens when students use videogames [15].

Including educational videogames in educational contexts involves changing the teachers' role in the classroom. The teacher becomes a facilitator or mentor, analysing the students' improvements within the game session, or even analysing the results obtained in different sessions. To facilitate this task, it is necessary to increase the integration of follow-up and diagnosis/assessment tools of game sessions to make it simpler for teachers, not necessarily experts in technology, to play the role of mentors and facilitators during those sessions [16].

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13 http://www.duolingo.com

14 http://www.seriousgamesnet.eu/

6.3. Using new development and deployment technologies

In this category we include the lines of work that aim at reducing the technological barriers that make the development of educational games and their deployment in educational institutions so difficult, due to technological infrastructure problems. Ideally, the game technology should be as "transparent" as possible. A teacher with minimum knowledge in technology should be able to use the games in the class, and higher knowledge level should be required only when developing, modifying or personalising the games. We have particularly identified the lines of work described below:

- Lower the development costs, providing new development tools and methodologies to reduce the costs and simplify the creation of games. Within this line, we have developed eAdventure, an environment for creating educational games that doesn't require programming skills.[15] However, it is necessary to go on improving and simplifying creation and community models for both teachers and students.[16]
- Look for participative models so that experts in pedagogy may actively participate in the development process together with programmers and artists [13].
- Reduce the technological requirements when deploying games in the classroom. It is important to look for games with moderate technical requirements, although it is also important to take into account that this may imply the games to be less attractive.
- Explore BYOD models, paying special attention to hybrid models in which the school allows using the student's device or one from the institution, never disregarding accessibility, security and privacy criteria.

An emergent option from the technological point of view is the use of mobile devices not only to play but also to create games. We believe that it can have much impact to develop new methods and tools that enable creating games and simulations directly in mobile devices (e.g. tablets), especially if the idea is to include students in the process of creating or co-creating, like the Mokap tool.[17]

7. Conclusions

Despite the strong interest in the use of educational games within the academia, experience reveals that making the transition from laboratory testing to real educational contexts is a huge challenge.

In this work we have analysed the principal barriers, many of them extremely complex to be overcome. From this analysis, we have proposed a set of lines of work that researchers need to address further before games are ready for widespread use in educational institutions.

It is to note that this work focused on the main challenges that are affecting the widespread use of videogames in education. However, while this innovation process is following its course, within the academic world researchers are already working in research projects that aim at defining new ways of using games and their technologies with educational purposes both at national and international levels. Nonetheless, all these improvements in research will be in vain if we don't reach the most important step of all: get students to really learn by playing.

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