
PLAYING TRACE EFFECTS WITH BRAZILIAN HIGH SCHOOL STUDENTS: COMPLEXITY AND GAMES

Valeska Virgínia Soares Souza
Isadora Aparecida Ribeiro dos Reis
Sabrina Aryane de Souza Oliveira
Instituto Federal do Triângulo Mineiro – IFTM

Abstract: One of the major problems Brazilian high school teachers face is that they have very few hours to teach the English language in formal schooling. Though we defend public policy regarding foreign language teaching should be reviewed in order to shift this scenario, it is important to think of immediate solutions to enhance the opportunities of access to English learning for these students. This leads to our interest of analyzing digital technologies and their integration in the school curriculum, specifically the use of digital games. Following the Complexity Paradigm as theoretical background, we have conducted an investigation of the game Trace Effects and how it can be used with high school students. The results of the analysis show the complexity of the process of becoming engaged in language learning.

Keywords: English language learning – Games – Complexity Paradigm – High School.

Resumo: Um dos maiores problemas enfrentados por professores brasileiros de Ensino Médio é o tempo curto que têm a disposição para ensinar inglês no ensino regular. Embora defendamos que as políticas públicas relacionadas ao ensino de línguas estrangeiras devam ser revistas para reverter esse cenário, é importante pensar em soluções imediatas para aumentar as oportunidades de acesso à aprendizagem de inglês por esses estudantes. Isso nos leva a analisar as tecnologias digitais disponíveis e seu processo de integração no currículo escolar, especificamente o uso de jogos digitais. Seguindo as premissas do Paradigma da Complexidade, nós conduzimos uma investigação sobre o jogo *Trace Effects* e como ele pode ser utilizado com alunos de Ensino Médio. Os resultados de nossas análises mostram a complexidade do processo de engajamento em práticas de aprendizagem de línguas.

Palavras-chave: Aprendizagem de língua inglesa – Jogos – Paradigma da Complexidade – Ensino Médio.

Introduction

Reading the words of the dean of São Paulo's University's (USP), Professor Marco Antonio Zago, in an interview to *Veja* magazine (SOUZA; BARROS, 2014) indicating that the lack of knowledge of the English language was the main reason why USP lost the first rank as the best university of Latin America to Pontifícia Universidade Católica (PUC) in

Chile, it is clear we should get worried again about the Brazilian situation when it comes to English learning. Fortunately, governmental actions such as the “English without borders program”¹, which seeks to improve students’ academic English, have benefitted Brazilian undergraduates. However, what has been done for High school students, since the differential is that Chilean students can already communicate in English when they enter college or university?

One of the major problems for Brazilian High School is that we have very few hours to teach the English language in formal schooling: some schools have two 50-minute classes a week, while most have just one 50-minute class. This differs a lot from what happens in other countries throughout the world. Though we believe public policy regarding foreign language teaching should be reviewed in order to shift this scenario, it is important we think of immediate solutions to enhance the opportunities of access to English learning for these students, and this leads us to think of digital technologies and their integration in the school curriculum.

Recent governmental documents directed to High School have already claimed that digital technologies bring new opportunities for language learning, because the use of information networks, such as the internet, favor this process (BRASIL, 2008; MINAS GERAIS, 2007). The edict² for the National Program for Textbooks (PNLD), which has enabled the distribution of textbooks to all Brazilian public High School students for the years 2015-2018, added the possibility of the component digital book. Even though isolated actions have been happening, we are still far from the real integration of digital technologies in the school context.

In this scenario, this research aimed to reflect upon the integration of the game Trace Effects³, designed for English learning, into a teaching proposal of beginning learners at the light of the Complexity Paradigm. Firstly, we have conducted an evaluation of the educational quality of the game using the RETAIN Model (GUNTER; KENNY; VICK, 2008) as a

¹Further information at: <<http://isf.mec.gov.br/programa.html>>.

²More information on document at: <file:///C:/Users/Usuario/Downloads/edital_pnld_ensino_medio_2015.pdf>.

³Game can be found at: <http://americanenglish.state.gov/trace-effects>.

framework for the analysis process. At the same time, we investigated the students and their openness for learning English with games. We noticed they already understood the importance of learning English for their future careers, but they felt left behind since they had classmates who had been studying in language centers for a while and knew much more English than they did. Also, some of them were opened to gaming as a way of learning. Having offered some of the students an optional 6-hour course, we used a combination of observation, interviews, teacher's notes, worksheets, students' journals and narratives to register the process. After finishing the course, the data collected were analyzed in order to answer three questions. How do A1-level students react to an experience of learning English using Trace Effects in terms of engagement? What benefits and hinders the process of becoming engaged in playing a game for English learning purposes in this context? What are the differences among students with previous gaming experiences and the ones without in this context?

In the dynamic moment in which we live, conducting the proposed research on digital games at the light of theoretical assumptions that seek to privilege not only elements and agents, but also the interconnection between them, appears pertinent and relevant. We believe that the agenda of topics of interest to Applied Linguistics will be contemplated and that English students of Brazilian high schools will benefit from the socialization of the results of this study.

This paper is organized into six sections, after this introduction. First of all, we bring available premises on digital games in the area of language learning. Then, we discuss the Complexity Paradigm viewed from the perspective of Applied Linguistics. The third section brings the methodological procedures in detail. In sequence, we bring the analysis we have conducted in two separate sections, which are followed by some final considerations.

Games in language learning

Many authors have insisted that the current school system, with its linear and textual approach, is not appropriate for today's students, since they were born in a digital context

(PRENSKY, 2001; 2006) and are better adapted to non-linearity and multimodality. In Demo's words (2007, p. 24), "what bothers the most is that, while the world around changes frenetically, school continues paralyzed and, even so, thinks of itself as a place of change". Gee (2013, p. 27) also questions formal schooling, which demands that students "use their memories the way computers do, rather than the way humans do". Computers store data in a stable way; we process information through dynamic association and from our experiences. Thus, school's role is to provide rich and meaningful experiences for the learning process.

Despite the fact that there has been pertinent criticism that digital games exacerbate negative psychosocial and addictive tendencies, as observed by Mitchell and Savill-Smith (2004), their use is an everyday practice that joins the assumptions of learning to learn (DEWEY, 1938) and contemporary digital technologies, viewing the user as a central participant. According to Shaffer; Squire; Halverson and Gee (2005), games are powerful because they enable the development of situated understanding and the action of playing means developing a series of effective social practices.

Conforming to the Horizon Report about the prospects for the Brazilian middle and high school teaching,

this issue has gained considerable weight during the last decade as games have proven their efficiency as a learning tool and they have benefitted cognitive development and favoring of skills among students; such as collaboration, communication, problem solving and critical thinking (NMC & FIRJAN, 2012).

We understand a game is an activity in which the player seeks to solve a problem and uses a playful approach to do so. Gaming differs from playing due to the fact the first action follows constitutive rules and the second term refers to a more spontaneous and less rigid action. Games - cards, dice, board games, etc.. - have existed for millennia, but the digital technology component enabled the social practice of playing become commonplace in different devices such as TVs (attached to video games), computers, cell phones and other mobile devices.

The current trend of using elements commonly found in games in contexts that are not exactly games to motivate someone and increase their activity and retention of information is

called "gamification". As stated in Deterding et. al. (2011), "gamifying" involves realizing what games can teach us, learn from their design and appreciate the opportunity to have fun.

In line with Barab, Gresalfi and Ingram-Goble (2010), some advantages of using games is the discursive richness, the depth of collective research, the exploration of situated identities and the cycles of perception and action that are offered to players. For the school system, I see a unique opportunity to offer situated learning in the most profound way, through the appropriation of dynamics present in games in order to reframe the traditional way of teaching the curriculum subjects.

The content of the Horizon Report (NMC & FIRJAN, 2012) predicts one of the integrations of digital technologies that should occur in the short term, probably a year or less, is gaming in educational experiences. Game-based learning is relevant because it provides the approach of school subjects in an engaging manner, offers opportunity for discovery-driven goals in order to develop skills in teamwork, and also comes from a practical activity many students are familiar with.

In the realm of digital games, Gee (2003) presents learning principles which recur in good games that, despite the contextual informality in which they are used and their non-pedagogical purpose, are more conducive to effective learning than most educational games, and even than the school environment led by the teacher. Briefly, these principles indicate that learning happens in a semiotic field in which there is an interrelationship between multiple semiotic systems (images, words, symbols, actions, among others) and that this learning provides the redefinition of the players' identities, the self and the trajectories towards achievement. From a situated meaning, knowledge is not only transferred but practiced following a cultural model, as a social activity, allowing feelings of affinity and belonging.

Shaffer et. al. (2005) criticize educational games for not being based on a coherent learning theory in an emerging arena that invites the use of learning environments pervaded by properties which are naturally present in educational games, such as Gee (2003) argues. But if game environments are so common in students' everyday lives and already present learning principles naturally, what is the need for the teacher to engage in this process? We borrow the words from Shaffer et. al. (2005, p 108): "Learners are novices. Leaving them to

float in rich experiences with no guidance only triggers the very real human penchant for finding creative but spurious patterns and generalizations".

This reflection leads us to understand the guiding role of teachers that may lead to a systematic and meaningful learning process, not only for matters of personal interest, but also academic and professional ones. Aware of the need for the integration of coherent educational games in the classroom environment, Escheverría et. al. (2011) propose a pedagogical model to assist this integration encompassing educational and fun dimensions, focusing on the pedagogical goals present in the curriculum proposals. It will be from potential student needs to learn English that we shall examine ways of integrating games. Also, we view the importance of analyzing the integration process at the light of the Complexity Paradigm, to which we turn in the next section.

Complexity Paradigm and language learning

The Newtonian paradigm has defended world phenomena of linear, cause and effect interactions between isolated objects, leading to mechanical and reduced views of these phenomena. The Complexity Paradigm, on the other hand, proposes regarding them as a set of interconnected elements, which give rise to the patterns we observe around us. This helps us see learning contexts as open systems, guided by self-organization, adaptation and evolution (SOUZA, 2011).

In the realm of language learning, Larsen-Freeman (1997) wrote a seminal article in which she calls attention to the similarities between complex systems and language acquisition. "The term 'complex systems' as used here refers to systems that are heterogeneous, dynamic, non-linear, adaptive and open" (LARSEN-FREEMAN; CAMERON, 2008, p. 36). In an interview to Craig Sower (1997), Diane Larsen-Freeman explains that a specific book motivated her to understand the similarities between the mentioned phenomena: *Chaos: making a new science*, by James Gleick (1991). Since then, many applied linguists have used this theoretical framework to conduct research in the area of foreign language education.

“Language learning involves determining structure from usage and this, like learning about all other aspects of the world, involves the full scope of cognition”; also; “there is an all-important social dimension to the process” (ELLIS; LARSEN-FREEMAN, 2009, p. 91). This means learning a language is both an individual and an interactional activity. At an individual level, a learner needs to remember episodes, to categorize experiences, to determine patterns and to generalize schema. At the same time, it is in social encounters that a coadaptation process begins, and experiences that are accessible and relevant foster learning.

Ke and Holland (2006) indicate the origin of language from an emergentist perspective and discuss the study of language acquisition in order to investigate such origin, more specifically when computational modeling is adopted as a research methodology. The model they use underscores two main characteristics of emergent phenomena: heterogeneity and non-linearity, both extremely important for Applied Linguistics.

According to Larsen-Freeman and Cameron (2008), change and heterogeneity are central to complex systems we find when conducting research in Applied Linguistics. A heterogeneous system is composed of parts of different kinds. In an English classroom, each learner can be seen as a system with an individual personality, interacting with a teacher and classmates within another system that is the learning institution, comprised of a diversity of agents and elements. Exemplifying heterogeneity and diversity, Paiva (2008) reported the English learners’ narratives she analyzed were not identical because the elements or agents in each system were different, and so were the dynamics of individual experiences.

Finch (2002) calls for a systems view of the language classroom since it will enable teachers and researchers to see the learning environment as a heterogeneous whole, with characteristics that are independent of its constituents and which can be maintained as the components change. Accepting the classroom as a space of heterogeneity with a positive perspective, and not trying a reductionist approach of homogenizing it, will provide for flexibility in teaching and autonomy in learning. All stakeholders can benefit from the view that the language classroom is a process, in which seemingly insignificant events can build up critical effects, in a non-linear way.

Non-linearity refers to an effect which is disproportionate to the cause. In complex systems, small quantitative differences in certain parameters lead to phase transition, which means qualitative differences. This property known as ‘butterfly effect’ was first observed by Lorenz (1963, p. 139), who claimed “two states differing by imperceptible amounts may eventually evolve into two considerably different states”. In a classroom, individual differences in students, for instance, may conduct a teacher’s lesson plan to a different implementation of this plan, compared to what had been designed. Returning to Paiva’s research (2008, p. 15), she pointed out the narratives were “all unique, and yet all of them revealed a turbulent, nonlinear dynamic process of transformation of order into disorder yielding the emergence of a new order, a new language”. This new order is possible because complex systems have a highly adaptive behavior.

Adaptation is a process or a capability through which systems can change in response to some event that happens within the environment, which may be initial conditions or feedback from the trajectories the systems go through. What usually occurs is a combination of positive feedback, in which certain factors perpetuate themselves, in conjunction with negative feedback, in which some limitation is imposed. In a language classroom, we can observe ongoing adaptation to contextual change. When a teacher proposes or changes a task, students need to adapt to the new proposal. When a student acts in a specific way, the teacher and the other students need to adapt to that behavior. It is considering the heterogeneous, nonlinear and adaptive nature of complex systems, such as language learning, that we conduct this research.

Methodology

For the first phase of the research process, we used the framework developed by Gunter, Kenny and Vick (2008), entitled the RETAIN Model, to guide our analysis of the educational strengths of the game Trace Effects. RETAIN stands for Relevance, Embedding, Transfer, Adaptation, Immersion and Naturalization. In order to observe how the game relates its content to the players’ world knowledge, the rubric Relevance is used by the evaluator.

Embedding means the integration of the story presented by the game, its play and the learning it fosters. With Transfer, the authors provide a basis for the reflection of how knowledge gained in gameplay can be transferred to other contexts. Adaptation is used to analyze how the game fosters players to build upon existing cognitive structures and how design is structured in a participatory and critical way. As for Immersion, it tackles game and pedagogical elements and how they enable players for reciprocal action and a holistic engagement of the player. Naturalization indicates how players were encouraged to synthesize content and to replay so there can be retention of content.

It is important to mention each rubric is supposed to be analyzed among Levels 0, 1, 2 and 3, with the understanding that a lower level means the game does not depict that specific rubric in a way a higher level does. Rubrics should also receive a specific weight for the analysis process: Relevance - 1, Embedding - 3, Transfer - 5, Adaptation - 4, Immersion - 2 and Naturalization - 6.

So that the context can be thoroughly understood, besides an analysis of the games, it was relevant to understand the students from whom a group was formed to play the game. These students already had regular classes with the teacher conducting the research, once a week, for 1 hour and 40 minutes. These were classes made up of 30 students with different English levels – from A1 to B2 according to the Common European Framework. During classes, they used a textbook which was chosen by their previous teacher. In order to understand their views on learning English and their openness to gaming, the teacher required them to write a brief English learning narrative.

For the second phase of the research, a 6-hour course using Trace Effects for beginning students who wanted to learn English was implemented. These students volunteered to participate in these extra classes. As research instruments, we used a combination of observation, interview, teacher's notes, worksheets and students' journals. We also collected narratives of some students at the end of the research period.

During the classes, the teacher spent the first five minutes explaining what they would do and giving them the tips she found necessary to play the Chapter. Then, they played for 45 minutes. While they were playing, they could ask for the teacher's help – she observed what

they were doing and took notes. In the last ten minutes, she talked to them – asked them what they had learned and their difficulties. She also took notes on that.

Student worksheets (activities on paper) of Chapters 1 and 2, learning journals in their regular classes during 5 weeks, game journals of our main observed (a student who has shown to be extremely engaged from the beginning), class attendance, the teacher's notes taken during/after observation, interviews with 5 students who have quit the course and narratives of 5 students at the end of the course were the information we collected.

For the final narratives at the end of the course, students were guided by the questions:

- a. Describe your experience of learning English using Trace Effects.
- b. Do you believe you were engaged during the process? Explain.
- c. What were the benefits and problems in playing a game for English learning purposes?
- d. Did you play games before? Do you think this affected this experience (positively or negatively)? Explain.

As for the five students who have come to only 1 class and haven't returned, they answered:

- a. Describe the experience of playing Trace Effects.
- b. Why didn't you continue coming to our lunch meetings? What kind of problem did you face?
- c. Did you use to play games before? Do you think this affected this experience (positively or negatively)? Explain.

In order to provide a clearer view of the data collection process in the second phase, we present a chart below which summarizes what data has been collected, whose data they are, when they have been collected and the purpose of collecting this kind of data.

WHAT?	WHOSE?	WHEN?	WHAT FOR?
Attendance	All students.	During 6 weeks	To check who is (not) continuously engaged in the course.
Student worksheets	The ones who completed the Chapters.	During 6 weeks	To check how engaged they are in terms of learning a second language.

Student game journals	Main observed.	Weeks 2-6	To understand what benefits and hinders the process of becoming engaged in playing a game for English learning purposes in this context.
Learning journals	The ones who mention games.	Weeks 2-6	To check if they mention games outside the Trace Effects course context.
Teacher's notes	Teacher.	During 6 weeks	To compare and contrast my notes with the other data collected.
Interview with quitters	5 students who came only once.	Week 5	To understand what hinders the process of becoming engaged in playing a game for English learning purposes. To understand if there are differences among students with previous gaming experiences and the ones without.
Interview with the ones who continued	5 students who came 4, 5 or 6 times.	Week 6	To understand what benefits the process of becoming engaged in playing a game for English learning purposes. To understand if there are differences among students with previous gaming experiences and the ones without.

Understanding the context: the game and the potential players

Analyzing the game Trace Effects using the RETAIN framework (GUNTER; KENNY; VICK, 2009), we begin with Relevance. The story is content appropriate and the pedagogic elements are somewhat defined. Players are allowed to tackle the game from beginning to advanced level. It depends on the focus. This affords them to become engaged in appropriate or inappropriate content for their level. Specific didactic content is 'kind of' targeted and learning objectives are 'somewhat' defined. Games goals are more clearly stated than language and learning goals. It creates interest in what is to be learned and a natural stimulus and desire to learn more. It is relevant to players' lives, the world around them, using characters and themes familiar to them (people, cultural and intercultural aspects, etc.). It does not match learners to their appropriate level – not always does it have adequate cognitive challenges.

As for Embedding, it allows for extended experiences with contexts related to English language teaching curriculum. Intellectual challenges are presented to players of sufficient

level to keep them interested in completing the game. When watching the students, the teacher could observe the flow state, in which students were absorbed in the game. They were unhappy to stop playing before completing the chapter. It involves players mentally and emotionally and educational content is fully endogenous to the fantasy context.

In terms of Transfer, it offers levels of challenge that emphasize similar lines of thought and problem analysis to be applied in other implied context. For example, in the first Chapter, the word ‘quad’ is used in different moments. It contains cues and interactive animation that facilitate the transfer of knowledge during pedagogic events. Besides cues, students can use ‘hear again’ and see the text which was only heard the first time. Players may be able to progress through the levels easily. Active problem solving is required to move on to the next level. There is progress through instructional elements that are introduced in a hierarchical manner. One example is the ID CARD which has to be shown in the first chapter. It includes authentic real life experiences that reward meaningful ‘post-event’ knowledge acquisition. It also contains “after action reviews’ that offer players an opportunity to teach others what they have learned, such as a ‘can-do list’.

The fourth rubric analyzed was Adaptation. The game builds upon the players’ existing cognitive structure. New content is sequenced based on the principle of cognitive dissonance, an experience of discomfort when players question their own opinions. Instruction is designed to encourage players to go beyond given information – discover for themselves, for instance, in Chapter 6, the players visit a science fair. Players identify old schema and transfer into new ways of thinking, in an active, participatory process, constructing new ideas. The game enables learners to associate new information with previous learning.

Regarding Immersion, elements of play are not always involved with the didactic focus, but do not compete with pedagogic elements. The game presents little opportunity for reciprocal action in a defined context. There is cognitive, physical, psychological, emotional involvement in the game content. However, there is not fostering of shared responsibility for learning among the participants. It presents little opportunity for reciprocal action/active participation, but some environment and the opportunity for belief creation.

Finally, in terms of Naturalization, replay is encouraged to assist in retention and to remediate shortcomings. The game improves the speed of cognitive response, automaticity, visual processing. When students played the chapter a second time, they could do it much faster. It also encourages the synthesis of several elements and an understanding that once a skill is learned it leads to the easier acquisition of later elements, and requires the players to make judgments about ideas and materials, such as deciding the level of politeness in responses. The game causes players to be aware of the content in such a way that they become efficient users of that knowledge and to spontaneously utilize knowledge habitually and consistently.

The following chart summarizes the points attributed to the game, showing its quality level:

CRITERIA	LEVEL	WEIGHT	POINTS
Relevance	2	1	2 out of 3
Embedding	3	3	9 out of 9
Transfer	3	5	15 out of 15
Adaptation	3	4	12 out of 12
Immersion	1	2	2 out of 6
Naturalization	3	6	18 out of 18
TOTAL	-	-	58 out of 63

While analyzing the game, in order to understand the profile of the potential players, we asked the students about their English learning experience. All high school students of a federal institution (87) were asked to write a narrative of their English learning experience and what made this learning possible. As learning is a complex system, students' answers showed the heterogeneity of their experiences, indicating the teacher, digital technology, family influence, among other reasons they found important in influencing their foreign language learning. In the process of analysis, we observed some students had different views on the use of games to learn English, but as a repeating pattern, recognized it could be a positive trajectory to learn the language.

Some students affirmed they saw games as an opportunity to learn English and to remember content taught. They believed since they learned to play games and use the language, they could bring this knowledge to learn in the classroom. Thus, in students' points of view, games could help with their difficulties.

Excerpt # 1 – Student's narrative:

I play some games in English and this helps me a little.

Excerpt # 2 – Student's narrative:

I don't understand English a lot because I didn't learn Basic English in school. Some games help a lot have an idea of this foreign language, such as mobile games: 'duolingo' among others.

Some students separate their game and school learning. They view games as a good way to learn vocabulary and to associate images to words and expressions in the context of the game. They also claim they learn vocabulary in formal schooling, but the words they learn in one context are different from the other.

Excerpt # 3 – Student's narrative:

Most of the words I know I really learned at school, and the other I learned playing many games.

Some students described the interactive process that shows games foster learning. The possibility to learn while they are doing something they like to do appeals to them. For instance, students can play games in an area of interest. If each student likes different topics, they can play around the topic and learn while doing this.

Excerpt # 4 – Student's narrative:

I really dislike English classes. I only know a little bit of English because I play and search the internet. I always like to play some online game with my virtual friends on Skype and I always play English games without subtitles to become more fluent and able to play with Americans.

What some students seemed to have in common was that although they did not have an intermediate level of English, and could be considered A1-level students, they wanted to learn the language, especially because they felt left behind in comparison with some of their classmates who take private English classes. Envisioning the opportunity of learning the

foreign language through games, a group of students felt very enthusiastic, as can be read in the following excerpt:

Excerpt # 5 – Student's narrative:

I always had difficulty with languages, even Portuguese. My first contact with English was not very good, but then I had a teacher who made me like English by teaching through music. I always liked to learn with music. I began studying at the Federal Institute and I would really like to learn English with games.

Having found a game considerably interesting in terms of English language learning and feeling an openness to learn from games, we could go onto the second phase of the research.

Conducting an intervention with the game Trace Effects

As explained in the methodology section, a course was offered to students who were willing to learn while playing Trace Effects. The analysis was based on three questions.

QUESTION 1: How do the A1-level students react to an experience of learning English using Trace Effects in terms of engagement?

Only one student came the six weeks in a row, the one we named our main observed, and 4 students came 3 times. In the first week, there were 11 students, in the second, 18, in the third 16, in the fourth only 6 and in the fifth and sixth just 4. 11 students came twice.

Six (6) of the students, mentioned in attendance, completed the worksheets for Chapter 1 - they were let go their own pace. What we noticed is that only 2 of them checked the activity named Visited the Booths. Since they did not have to do that to complete the game milestones, it seems their engagement was only to complete the game, and they did not try to learn English in all possible opportunities the game offered, although they probably learned while being engaged in the game. One of the students wrote some words and their translations on the worksheet paper and another student took notes in his notebook – this shows some language learning engagement.

Considering weekly learning journals, asked from the 87 students, there were 4 mentions of how interesting learning from Trace Effects was in the first week. In the second week, we noticed something interesting: one of the students mentioned using another online course, which is gamified and has app and online versions (duolingo) and this happened because she mentioned using Trace Effects with another teacher (chemistry teacher) who suggested her to use Duolingo. It seems the effects of Trace went beyond what we could predict. Since complex systems are nonlinear, what emerged with the Trace Effects experience cannot be tracked exactly to the initial conditions. Also, two students mentioned they learned some verbs and they were the same verbs found in Chapter 1. We believe this also shows engagement since these were students who had come two weeks in a row.

QUESTION 2: What benefits and hinders the process of becoming engaged in playing a game for English learning purposes in this context?

For the last journal, our main observed answered “Doing things, I mean playing a chapter, several times is good because English starts to sound more natural, more like Portuguese”. This makes us understand familiarity with the language and knowing what to do are facilitators of the process and the contrary may hinder the process. Her engagement has shown us some students may really embrace an opportunity of learning and that beginning at any point may broaden a student’s horizons and conduct to a learning path. Our main observed played Chapters 1 and 2 at least three times. She had an experience with language practice, enjoyed it and was proud of herself for completing the activity correctly. She was also playing Duolingo and seemed happy with her English language development. Her experience illustrates the process of adaptation when another element becomes part of a complex system.

When we asked one of the 5 students who quit the course why she stopped coming, she answered: “Because in the second and third meetings, I had appointments with my research advisor and couldn’t come. Then I thought I had missed too many meetings to continue”. The other four students who were interviewed also explained they had not continued the course due to time issues and they would return to the course if it was reoffered the following year. Reflecting upon this, we believe one of the issues that may inhibit the

process of engagement is the number of different activities they need to complete and are mandatory.

Something else which may deter the process is the fear of losing or not doing well (or as well as the other peers). Our main observed was reluctant to do language practice (a game activity). Then, we proposed she should do at least the first one. She did it and enjoyed it. We asked her why she hesitated and she said she was afraid she would not be able to do it. This fear of losing was also reported by one of the girls who quit the course. She explained she felt other students were completing Chapter 1 before she was able to. She was afraid she wouldn't be able to complete and decided not to come anymore. We notice new elements may impact the system positively or negatively; it depends on the process of adaptation.

QUESTION 3: What are the differences among students with previous gaming experiences and the ones without in this context?

One of the students who stopped coming to classes claimed that she had no previous gaming experience, but this did not interfere negatively in her engagement process because playing games naturally involves students her age. The ones who had gaming experience claim this has benefitted them since they see games as a new and fun way of learning.

We have noticed gamers tend to get engaged more easily, but they tend not to go very deeply in language terms. Non-gamers may get frustrated and not come back, as it happened with one student who got really annoyed, stood up and left the room in a very impolite way.

Our main observed seems to be an exception in terms of engaging in learning the language. She is a gamer and understands a lot about computers (which is her area of technical studies). It looks like she is comfortable with playing games and that makes it easier for her to focus on language issues. She kept relating to different characters in the game and every time we read her game journals, it seems she was part of the story; she was engaged in situated learning.

Among the five students who quit the course and we interviewed, the three boys were gamers and the two girls were not. There are two things mentioned in their answers that point to the differences between the two groups: how they view the game. One of the gamers explained the graphics of Trace Effects are not so well-designed, especially compared to the

non-educational games they usually play and this makes the game less interesting. Gamers seem to be more demanding in technological terms. One of the nongamers told us she was afraid of not being able to complete the Chapter. In the teacher's notes, it was often written how nongamers got lost in terms of commands and this took them longer to complete the Chapters. This seems to hinder not only the process of playing, but also the process of engagement.

Conclusion

With this research, we have learned that the majority of the students tend to become engaged when gaming, but they should be accompanied and constantly reminded of the need of seeing the game as an opportunity to learn in the process and not only to get points, badges or even be first in the leaderboard. We have also learned teachers need to be careful with timing issues. We proposed the course in a period in which students were flooded with tests and papers to give other teachers and this seems to be the major reason why most of them came only once.

As for Trace Effects, we recommend teachers use it as part of a broader program to guarantee students with different styles can benefit from the process. Besides, we believe a pilot project, such as the one developed with high school students, can be interesting not only for teachers to get acquainted with the game and its affordances, but also to have the opportunity to observe students' reactions to the game itself and other suggestions which may emerge during the process.

The teacher who led the research is planning to include Trace Effects as part of her syllabus in the following year and combine it with other resources: textbooks, videos and music from the Internet. What she plans to do is to propose a more multifaceted course so that she allows different students to go their own pace. This was definitely learned from the experience using Trace Effects: in the beginning the same sequence was planned for all the students to follow: the three first classes exploring Chapter 1 and the other 3 exploring Chapter 2. What happened was students completed their activities in different timings and this

situation had to be dealt with. There is no homogeneity when dealing with complex systems, with students and their individual and social features, which vary greatly. We believe this should be added to any class plan: activities that allow students to work in their own pace and benefit as much as they can from what they already know and what they are learning. Games are clearly an interesting and fruitful trajectory to follow; it is only a matter of designing a careful plan which fosters engagement in this complex path.

References

BARAB, S. A.; GRESALFI, M.; INGRAM-GOBLE, A. Transformational play: using games to position person, content, and context. **Educational Researcher**, v. 39, n. 7, 2010. p. 525-536.

BRASIL. **Orientações curriculares para o ensino médio**. Linguagens, códigos e suas tecnologias. SEB. Brasília: MEC/SEB, 2008.

DEMO, P. "Aprendizagem situada": discutindo ideias de Gee. **Educação Profissional: Ciência e Tecnologia**, v. 2, n. 1, Jul-Dez 2007. p. 11-26.

DETERDING, S. et. al. From game design elements to gamefulness: defining "gamification". **Mindtrek**, 2012.

DEWEY, J. **Experience and Education**. New York: Macmillan, 1938.

ELLIS; N. C.; LARSEN-FREEMAN, D. Constructing a second language: analyses and computational simulations of the emergence of linguistic constructions from usage. In: _____ (Ed.). **Language as a complex adaptive system**. United Kingdom: Blackwell Publishing, 2009.

ESCHEVERRÍA, A. et. al. A framework for the design and integration of collaborative classroom games. **Computers & Education**, v. 57, Santiago, Chile: Elsevier, 2011. p. 1127-1136.

FINCH, A. E. **A systems view of the EFL class: mapping complexity**. 2002. Disponível em: <<http://www.eslteachersboard.com/cgi-bin/articles/index.pl?page=3;read=909>>. Acesso em: 10 nov. 2008.

GEE, J. P. **What games online have to teach us about learning and literacy.** New York: Palgrave; Macmillan, 2003.

_____. **The anti-education era: creating smarter students through digital learning.** New York: Palgrave; Macmillan, 2013.

GLEICK, J. **Caos: a criação de uma nova ciência.** Tradução de Waltensir Dutra. 4. ed. Rio de Janeiro: Campus, 1991. 310 p.

GUNTER, Glenda A.; KENNY, Robert F.; VICK, Erik H. Taking educational games seriously: using the RETAIN model to design endogenous fantasy into standalone educational games. **Education Tech Research Dev.**, vol. 56, n. 5-6, p. 511-537, 2008.

KE, J.; HOLLAND, J. H. Language origin from an emergentist perspective. **Applied Linguistics**, Oxford: Oxford Journals, v. 27, n. 4, p. 691-716, 2006.

LARSEN-FREEMAN, D. Chaos/complexity science and second language acquisition. **Applied Linguistics**, v. 18, n. 2, p. 141-165, 1997.

LARSEN-FREEMAN, D.; CAMERON, L. **Complex systems and applied linguistics.** Oxford: Oxford University Press, 2008. 287 p.

LORENZ, E. N. Deterministic nonperiodic flow. **Journal of the Atmospheric Sciences**, v. 20, n. 2, p. 130-141, 1963.

MINAS GERAIS. DIAS, R. **CBC Língua estrangeira: ensino fundamental e médio – proposta curricular.** SEE-MG, 2007.

MITCHELL, A.; SAVILL-SMITH, C. **The use of computer and video games for learning: a review of the literature.** London Learning and Skill Development Agency, 2004.

NEW MEDIA CONSORTIUM (NMC); FIRJAN. **Perspectivas tecnológicas para o ensino fundamental e médio brasileiro de 2012 a 2017: uma análise regional por NMC Horizon Project.** Austin, Texas, The New Media Consortium, Estados Unidos, 2012.

PAIVA, V. L. M. O. **Chaos and the complexity of SLA.** 2009. (Submetido a publicação) Disponível em: <http://www.veramenezes.com/edgechaos.pdf>. Acesso em 22 fev. 2015.

PRENSKY, Marc. **Digital game-based learning.** New York: McGraw Hill, 2001.

_____. **Don't bother me mom - I'm learning.** St. Paul, Minnesota: Paragon House, 2006.

SHAFFER, D. W.; SQUIRE, K. R.; HALVERSON., R.; GEE, J. P. Games online and the future of learning. **Phi Delta Kappan**, v. 87, n. 2, 2005. p. 104-111. Available at: <<http://website.education.wisc.edu/kdsquire/tenure-files/23-pdk-VideoGamesAndFutureOfLearning.pdf>>. Retrieved on: 10 jul. 2014.

SOUZA, V. V. S. **Dinamicidade e adaptabilidade em comunidades virtuais de aprendizagem**: uma textografia à luz do Paradigma da Complexidade. 255 f. Tese (Doutorado em Linguística Aplicada) - UFMG, Belo Horizonte, 2011.

SOUZA, L.; BARROS, M. Entrevista Marco Antonio Zago. É preciso arriscar muito mais. **Veja**, v. 2370, n. 26. São Paulo: Editora Abril, 25 de junho de 2014. p. 13-15.

SOWER, C. An attitude of inquiry: an interview with Diane Larsen-Freeman. **The language teacher online**. Tokyo: JALT Publications, v. 21, n. 6, p. 27-28, 1997.