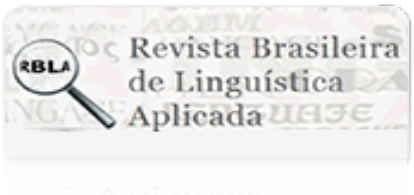

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Fractal Groups:[1] Emergent Dynamics in On-Line Learning Communities

Grupos fractalizados: dinâmicas emergentes em comunidades de aprendizagem on-line

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RESUMO: Com base na teoria da complexidade, este trabalho apresenta resultados de pesquisa de doutoramento na área de Linguística Aplicada e discute dinâmicas complexas e padrões que emergem em comunidades de aprendizagem *on-line*. A análise deste estudo será pautada nas interlocuções de cinquenta alunos que interagiram em pequenos grupos, sem a intervenção direta da professora, em um curso de graduação ofertado na Faculdade de Letras da Universidade Federal de Minas Gerais. Por meio da análise dos dados, demonstro que das relações entre os pares em comunidades autônomas de aprendizagem *on-line* emergem oportunidades de construção compartilhada de conhecimento, liderança distribuída, entre outras dinâmicas. Demonstro também a natureza fractal dessas comunidades e discuto como esses resultados lançam luz à criação e ao desenvolvimento de desenhos pedagógicos de cursos para grandes grupos.

PALAVRAS-CHAVE: desenho pedagógico *on-line*; tecnologia; complexidade.

ABSTRACT: Drawing on complexity theory, this work discusses the complex dynamics and emergent patterns of on-line learning communities based on a doctoral study in the area of Applied Linguistics. The analysis will center on the interlocutions of fifty students who interacted in small groups without the teacher's direct intervention, in an undergraduate course offered by the School of Languages and Literature at the Federal University of Minas Gerais. By analyzing the data, I demonstrate that out of the interactions among the peers of autonomous on-line learning communities arise opportunities for the construction of shared meaning, distributed leadership, as well as other dynamics. I also demonstrate the fractal nature of these communities. Moreover, I discuss how these findings shed light on the creation and development of course designs for large groups.

KEYWORDS: on-line pedagogical design; technology; complexity.

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[1] Name coined by Dr. Vera Menezes to describe a course design with groups of fractal nature.

Introduction

The first great research contribution to complex emergence was the recognition that a class of phenomena cannot be simply understood as cause and effect dynamics. According to Davis and Sumara (2012), this recognition was formally announced in the Western world around the year 1800, through the work of Charles Darwin and his contemporaries, but it took more than a decade to produce ramifications for other areas of science. This change in mentality became a mark in science at the end of the 1970s when a critical mass of researcher ideas spread out into diverse areas promoting new insights based on similar dynamics, such as the brain, ant colonies, cities and cells from the perspective of principles known today as the complexity theory.

Davis and Sumara (2012) call this phase Complexity 1.0, as it is a phase that focuses on phenomena description. This phase's greatest gain is a trans-disciplinary recognition of an emergent phenomena class that cannot be investigated by classical analytical science tools. This new movement was permeated by images and metaphors to describe these diverse phenomena. Representations based on Euclidian geometry and actions rooted in Newtonian physics were gradually replaced by images based on fractal geometry and on the dynamic structures of biology, such as ecosystem organization, for example. The visual metaphor was based on nestled systems reflecting important *insights* showing that systems are inter-related and demonstrate complex qualities that cannot be reduced and comprehended based merely on their parts.

As the phenomena began to be recognized more and more as emergent and complex, and as more areas of knowledge developed research projects on the behavior of complex phenomena, the focus of investigations advanced to the analysis of structures and consequence of complex system dynamics. Complexity 2.0, according to Davis and Sumara (2012), a phase between 1980 and 2000, is characterized by the use of the notions of dynamics and recursive processes aimed at the evolving comprehension of systems – systems that learn. This process was marked by an explosion of research on complexity and resulted in several Nobel prizes in physics, medicine, chemistry and economics – the era of complexity.

Since then, complexity research has become decidedly more pragmatic in its emphasis, and the foci of discussions today revolve around themes such as connection networks and the manner in which these networks promote learning systems – a phase called Complexity 3.0 by Davis and Sumara (2012).

Along this line, I would stress that the complexity perspective encourages us to recognize the existence of relations that sustain phenomena, as well as the patterns that emerge from these relations. Motivated by the new perspective and by the studies of Larsen-Freeman (1997, 2002, 2006), van Lier (1996, 2000, 2004), Paiva (2002, 2005), among others, a group of researchers has been using complexity theory as an epistemological base to comprehend diverse phenomena related to teaching and learning processes, particularly in the context of on-line education (PARREIRAS, 2005; BRAGA, 2007; MARTINS, 2008; SILVA, 2008; FARIA, 2010; SOUZA, 2011).

Concerning the on-line learning context, this paper, based on the author's doctoral study, aims to discuss the relations established in on-line autonomous communities, their dynamics, their patterns and how these system qualities can promote insights for the development of pedagogical designs for large groups. These issues will be addressed in the following sections by identifying: a) the complex dynamics of the groups investigated; and b) whether the groups present self-similar patterns and fractal nature.

Qualities of systems that learn

The science of complexity is focused on the observation and description of systems that adapt, self-organize and maintain themselves, that is, for our purposes: systems that learn. With regard to phenomena that occur in the educational area, such as in language learning, autonomy and learning communities for example, some descriptive aspects of the phenomena are still relevant in the researching and understanding of these system dynamics. In the case of this work, some qualities of the complex systems will be briefly described to facilitate discussions on the emergence of recurring patterns in on-line learning communities.

A **complex system** is any system that involves elements or agents, not necessarily in great number, that interact and form one or more structures that originate from interactions among such agents. The construction of a system's structures is intimately linked to the behavior that emerges from the interactions of these agents and to their constant action and reaction, generating processes of change which cannot be described by one single rule, nor reduced to one sole level of explanation.

The constant actions and reactions of the agents make the system become **dynamic** and, as a result, nothing in it is fixed. An **adaptive** dynamic complex system has various levels of organization with agents from one level

serving as building blocks for agents from/in an upper level. For example, a group of proteins, lipids and nucleic acids form a cell; a group of cells form tissue, which forms an organ, whose association forms an organism, which, along with other organisms, forms an ecosystem (WALDROP, 1992).

A relevant aspect is that this type of system is constantly revising and reorganizing its building blocks as it gains experience. Successive generations of organisms will modify and reorganize their tissue through the evolution process.

The control of an adaptive dynamic complex system tends to be **distributed**, that is, not centralized, and its coherent behavior is produced by the competition or cooperation between the system's agents. A complex system is considered **open** in that it exchanges input or energy with the environment and is susceptible to the resulting feedback changes, adapting itself to the new environment and learning through its own experience.

Another fundamental characteristic, highlighted by Palazzo (2004, p. 4), is the capacity it has for natural selection and **self-organization**: "Organization arises spontaneously based on disorder and does not appear to be guided by known physical laws. In some manner, order arises out of the multiple interactions between the component units".

Adaptive complex systems may also present patterns that repeat themselves throughout their existence. According to Bar-Yam (2000), **fractals** are "self-similar" entities. This characteristic refers to the fact that a fractal is similar in several scales and implies that the whole contains all the properties of the part, just as the parts contain all the properties of the whole. More specifically, a geometric fractal is constituted of parts which when enlarged have the same original format. The author cites the example of a seacoast contour line which basically shows the same form when enlarged. Other examples of fractal properties include trees or other similar structures of ramifications and hierarchical organization structures.

Bar-Yam (2000) also stresses that fractal forms are important for modern science since much of traditional science is founded on calculation and assumes that all becomes uniform when measured on a detailed scale. The recognition that certain forms are not uniform and that these can be studied and analyzed mathematically, and observed in nature, has been a great contribution to the evolution of science.

When system agents work individually, or with little or no interaction, what is achieved is simply the completion of the tasks assigned to them.

However, when agents interact among themselves and with the environment, something new and different can result; something that is more than the sum of the individual results, a coherent pattern that is born out of the interaction among the agents of a system. This coherent or global pattern, originating from local patterns of a certain adaptive dynamic system, is commonly called **emergence** (ODELL, 1998).

Based on these assumptions, I consider that the characteristics of the adaptive complex systems can assist in understanding the recurring patterns that emerge from the relations between the agents of a complex system, especially the emergent patterns in on-line communities

To paraphrase Cilliers (1998), the worlds of science and philosophy never existed in isolation, but the relation between them is entering a new phase, influenced by applied research and mainly by the increased importance of technology. That which was considered very complex to be analyzed as a whole, now with the advent of technology, for the most part, does not need to be fragmented.

The context of research and pedagogical design of autonomous on-line communities

The context of this study involves a pedagogical design whose central idea was to promote the completion of tasks shared in an on-line asynchronous environment. This proposal involves the interactions of students who participated in a teacher development course, named "Communicative Dimensions", offered to two disciplines by the School of Languages and Literature at a public university in Brazil. The two groups, consisting of twenty-five pre-service teachers each, were named respectively UFMGPRAT and PRATUFMG. The course design involved the division of the pre-service teachers into small groups of two to six students according to their majors: English, Spanish or Portuguese.

The course promoted tasks in an on-line asynchronous environment and it relied on a careful elaborate website with links to interactional environments such as: course management discussion lists, forums for task discussions as well as links to pages with information about the content of the course, names of participants, tasks and evaluation procedures. A triggering procedure for task discussions included individual and collective contributions. The individual work posted in the subgroups served as a discussion starting point as well as input to the consolidation of a collective task they were to post

in a forum for feedback from the teacher and from members of other communities.

The interaction in the subgroups took place autonomously without the teacher's direct intervention. In addition to interacting in the subgroups, students interacted with peers from the other groups and with the teacher when they were to give and receive feedback about the collective tasks.

This pedagogical proposal of a distributed nature allowed for the investigation of complex dynamics, relations established based on these dynamics, and the patterns that emerge from these relations. The discussions presented will be based on the analysis of the messages posted in the subgroups discussion lists and in the forums of the disciplines.

Complex dynamics and emergence of recurring patterns

Over the life of a complex system, three levels of dynamics shape it continuously, namely: local, global and contextual dynamics. Such dynamics are imbued with the properties of adaptive complex systems, working in synergy therewith and with the systems agents. The system is a living one and is constantly learning, as is the case of on-line learning communities.

The emergence of recurring patterns generated from the network of relations established in the UFMGPRAT and PRATUFMG learning communities and respective learning sub-communities demonstrates the fractal character of these groups.

The interactions of sub-community participants show that, as in any complex system, the on-line learning communities rearrange and reorganize themselves as they adapt and gain experience. The following messages illustrate how the communities and their agents adapt to the new events and from this process the distributed leadership and behavior rules of the groups emerge.

An example of this adaptability is related to the leadership alternation proposed by a large part of the sub-communities. The leadership distribution in the groups emerged from the necessity of adapting to the course requirements for posting collective contributions on a weekly basis.

As can be seen from examples 1, 2, 3, 4 and 5, the subgroups seem to choose leadership alternation as one of their rules.[2]

[2] The names are fictitious to preserve the identity of the students involved.

1) I agree with the idea of leader alternation. How about this:
15/4 – Lauro
22/4 – Fátima
30/4 – Celso
07/5 – Letícia
(UFMGPRAT-English-2)

2) If you want, I can be the "leader" of this assignment and I will be in charge of posting assignment 2 in the forum. For the next ones we can alternate – what do you think? (PRATUFMG-English-1)

3) If you all agree, I will be the leader for next week, is it okay? If you agree, please send me your participation as soon as possible and, seeing as we have to do a glossary, before I post our assignment, I'd like to send it to you to have a look. (UFMGPRAT-English-2)

4) I feel we need to talk a bit more about our own group. What do you think of rotating the group leadership so that each week one person is responsible for preparing and sending the assignment? It is not that I am unsatisfied with our situational leader, Flávio. On the contrary, Flávio, you have been brilliant in your role. I just think that it would be fairer and also clearer with the participation of each one. (PRATUFMG-English-2)

5) I liked the suggestion by Flávio and Gilda on alternating. For me, the order is great. (PRATUFMG-English-2)

The next excerpt demonstrates that when the leader, for personal circumstances, could not assume the responsibility for posting the collective considerations of the group about a certain assignment, another agent voluntarily assumed the weekly leadership and the group adapted to the new condition. The message sent to UFMGPRAT-English-2, example 6, shows that the sub-communities experience moments of unpredictability, but adapt themselves to conditions naturally:

6) Due to Guta's problem with her mother, I'll be in charge of activity number 3, if there isn't any problem. (UFMGPRAT-English-2)

The need to receive individual contributions in time to draft a summary led the groups to opt for a deadline for handing in tasks.

Fabíola responds to a colleague's individual contribution posting problem and proposes deadlines for handing in individual tasks:

> 7) To avoid this type of problem happening again, and that the leader becomes overloaded, I suggest that we stipulate a date limit for sending our weekly activities to the leader. How about Thursday by midday? This way, the leader has more time to contact those who have not sent their material or even take measures in the case of some problem with the arrival of messages, as happened to me this week. (UFMGPRAT-English-2)

The need for deadlines was also a contextual demand in other communities such as PRATUFMG English-2, UFMGPRAT-English-3 and Portuguese-3 sub-communities:

> 8) I liked this idea of Lis' (can I call you that?) – let's do our part within the dates set out by her. (PRATUFMG-English-2)
>
> 9) I also think we should post the assignment by Wednesday, so that we have time to discuss and that the person in charge of sending the final report has time to prepare it well. (UFMGPRAT-English-3)
>
> 10) Let's set Wednesday as the deadline for book analysis and Thursday for each one to send their thoughts on the final answer? (UFMGPRAT-Portuguese as a foreign language-3)

The on-line learning communities and sub-communities process internal and external exchanges during their whole existence, a characteristic of an open system. The most commonly identified external exchanges occur in the form of feedback from the teacher and colleagues from other learning communities, which may be noted in excerpts 11 and 12.

Teacher feedback to assignment 8 of UFMGPRAT-Portuguese posted in the forum:

> 11) Your activity was excellent. You were objective, answered the questions well and showed that you had read the texts well.

UFMGPRAT-Spanish-1 feedback to assignment 8 of UFMGPRAT-English-1 also posted in the forum:

> 12) I think it's interesting that your text is very similar to our group's text (Spanish – Group 1). We also thought that the reading should not be an end in itself but could also be used as pretext for other activities. I think it is a temptation to use reading to teach grammar and, consciously or unconsciously, we all do it or have done it. The reading of the texts seems to have given the reading a status that it had almost lost and made us rethink our practice of reading in the classroom.

An external input source may be noted in the suggestion of supplementary reading. Many students send their groups reading suggestions and even entire articles pasted in the body of e-mail messages. Contributions from diverse sub-communities were passed on to the UFMGPRAT and PRATUFMG communities and posted in their respective virtual libraries.

Like the external exchanges, the internal exchanges produced contributions for the group as a whole. The synergy resulting from the input exchange process between students of an on-line learning community, mediated by textual language and cultural artifacts (resources such as tasks and articles, technological resources etc.), brings about the emergence of group *feedback*.

Therefore, the susceptibility to external and internal contributions provides the on-line learning communities with the opportunities to learn through the constant exchange of experience with internal and external agents, as well as the context in which they are inserted. Likewise, we may affirm the same of an adaptive complex system.

I would like to draw attention to the constant feedback found in the messages extracted from the lists of the learning communities and the forum. See feedback regarding a colleague's text:

> 13) I agree with Hugo when he says that reading aloud may be questioned in that it is not very productive due to the student worrying more about pronunciation than the message transmitted by the text. But, at the same time, I think that reading aloud can be productive in evaluating pronunciation. Reading aloud, in my case, works very well (I know this is not the case for the majority of students), I focus my attention more when reading aloud. (UFMGPRAT-English-3)

In this example, the week leader suggests that compact texts be sent to help in the drafting of the collective summary:

> 14) André did a compact and practical summary of his individual contribution. I'll send it to you to have a look so that, if possible, we could all do a similar sized text. I think that the text might end up being too big and I'll have to cut out some things. Let's try to do a summary OK! (UFMGPRAT-English-2)

These examples also reveal the alternating state of on-line groups, that is, the dynamic and evolving character of the adaptive complex systems. The exchange of ideas and the *feedback* from group participants promote changes of state in the communities and favor their evolution over time. A group, like an adaptive complex system, is dynamic and in constant change.

Among the events observed, divergence or conflict is imbued with local behavior that produces turbulence capable of stimulating the emergence of a new state in the community. This type of recurring pattern was detected in a large number of learning communities as the following examples show.

PRATUFMG conflict: interpretation of feedback

One of the main conflicts that occurred during the "Communicative Dimensions" course was driven by the interpretation of the teacher feedback relative to one of the assignments posted in the forum by PRATUFMG-Portuguese for foreigners-1. According to course rules, the students had to post a summary of the individual assignment discussions in the forum. On verifying that one of the subgroups chose to post the two individual tasks instead of one collective assignment, alleging that both had interesting reflections on the subject, the teacher posted the following feedback for the subgroup:

> 15) It appears that you don't understand what group work is. The group must produce one single text based on individual reflections. If the two contributions are interesting, that is great. Use whatever is interesting of the two and produce one single text. (*Feedback* to PRATUFMG-Portuguese for foreigners-Forum-PRATUFMG)

The teacher's *feedback* about the collective tasks, which apparently concerned small adjustments in course direction, provoked the following reaction:

16) Ok, ok, ok! I'm tired of getting stressed out over these final texts. I don't want to do them anymore. Class based group work is already difficult, imagine via internet where not always (or rather, almost never) one is on-line at the same time as the other. Yes, I'm methodical. All or nothing. Either very good or forget it. Either a final text done by two and well in advance, or I won't write anymore [...] I would like to know what the other students think [...] Maybe it's a problem with me, maybe I'm doing something wrong. Even so, I would like comments. (PRATUFMG management list)

In the light of some students' declarations, the teacher opened up space to hear the opinion of all the course students:

17) I would also like to know what your colleagues think and so I am sending the e-mail to the two class groups and I will forward the messages that come from the other class group (the UFMGPRAT students should read from the bottom up to understand the context). (PRATUFMG management list).

The declarations of some students and the silence of others, taken to mean support of the dissatisfaction with assignment deadlines and group work, led the teacher to reformulate course rules, demonstrating once again that, as with the adaptive complex systems, the on-line learning communities are sensitive to changes and susceptible to unpredictability.

All this turbulence produced by the discontent of some agents gave way to the emergence of a new global pattern, that is, new rules that remained in place until the end of the course.

The repercussion of the conflict (local dynamic) and the emergence of new rules (global dynamics) generated the self-organization of the on-line communities and sub-communities. With the implementation of the new rules, the sub-communities began to receive collective feedback from the teacher, previously posted on the forum for each sub-community. The on-line learning sub-communities in turn, despite having the opportunity to dissolve in the face of new opportunities, organized themselves and opted to continue to work in groups, adapting to the new condition of receiving collective feedback.

This type of divergence also occurred in other communities. For example, in the UFMGPRAT-English-1 sub-community, one group participant complained that the weekly leader excluded her ideas from the collective summary.

In UFMGPRAT-English-1, the divergence of opinion with respect to assignment content may be noted in the same sub-community:

18) Hi Célia, sorry if I offended you. I didn't mean to say that your phrases were bad, the opposite actually! What I meant to say is that we had (overall) a lot of sentences and that we would have to be selective because if we bombard the students with visual resources we could end up not producing the desired effect. Regarding that phrase – What's this called in English? I just thought that it sounded strange, the construction, understand? Because generally what I hear is – How do we say this in English? Or similar phrases – that's why I commented on your phrase but I'm not sure if I'm wrong – maybe I am. As I said before, when I answer e-mails in a hurry (more often than not unfortunately) I end up simplifying the text and it becomes kind of cold and very direct. Don't take it in a bad way, please. I love working with you girls! (UFMGPRAT-English-1)

UFMGPRAT-English-3 conflict: delay in handing in individual contribution

UFMGPRAT-English-3 went through several tense moments in the performance of one of the tasks, apparently produced by the delay in handing in individual contributions. The non-resolution of this conflict resulted in participant dissatisfaction and in the loss of one of the sub-community's components.

The subsequent interactions illustrate part of the conflict that UFMGPRAT-English-3 went through when performing assignment 11.

Lauro, one of the group participants, was abroad at the time and manifested his anxiety and concern in relation to the assignment to be carried out:

19) Guys I am worried. Our assignment is still far from being ready and we have to hand it in tomorrow, at the latest. Cris and Fabio, where are you? Hugo, your activity is missing some parts. (UFMGPRAT-English-3)

Lilia's reply to Lauro mentions the lack of collaboration from some colleagues and her intention to prepare the assignment regardless of her colleagues' participation:

20) Lauro, the unit must be finished by tonight if I'm to print and hand it in tomorrow. If Celina and Flávia don't send anything, it's too bad. It's 20 marks and I don't want to lose them. Connect what you got so far and let's move on. It's 3:20 here, you said you'll have some time at four. I'll be at work and will print the assignment at night. See ya, Lilia. (UFMGPRAT-English-3)

Lilia asks for greater organization from the members of the sub-community.

21) Hugo, what do you mean by "meeting"? We are supposed to hand the ass in tomorrow! There are two activities about disability (is one of them yours?). Why don't we all go the same way? Read them and send the rest of the contributions ASAP. See ya, Lilia. (UFMGPRAT-English-3)

It is interesting to note the contextual dynamics of this sub-community such as: the delay in posting collaborations and the anxiety to hand in the assignment generated the following imbalance of local dynamics: friction between sub-group participants, difficulty in dialoguing and in resuming the collaborative process and, consequently, the emergence of major dissatisfaction within the community as a whole and a new sub-community that goes from 5 components to just 4.

Another type of conflict took place in UFMGPRAT-Portuguese-1 produced by the excess of messages demanding the participation of colleagues. As a result, a kind of "system repulse" formed in this sub-community represented by a student who often used authoritative expressions such as "slaps on the wrist" in her message titles. The climate of member dissatisfaction can be observed in the messages below:

22) I think Tania is very worried. Calm down because there is time to do everything and have a coffee as well. Let's divide up the assignments as we have been doing and it'll work out fine. (UFMGPRAT-Portuguese for foreigners-1)

23) I don't think I'm "very" worried. I think I'm worried enough about the way things are going. (UFMGPRAT-Portuguese for foreigners-1)

24) I think that our communication could be more efficient; after all, it should at least be a study group (in principle!). It is nobody's intention to lose marks. The communication of the pseudo-group 1 PLE is becoming more and more discouraging don't you think???? If, on the one hand, 'V' and I had little contact with you in recent days, it is because we are occupied with something important. For my part: if I didn't return your calls it's because I was on the road; besides that, my dad is not doing great and I had to stay with him in the hospital. Just as well he has left the ICU. I only have him now. I don't want to be acting like poor me because of all this. (it's like in the film DOGVILLE: "goodness and comprehension are relative"). Anyway, there is only one assignment left. So the tolerability is coming to an end. I mean to say that despite all the impediments it is good working in this group. Various limitations exist – it's true, but not irresponsibility of the parts (I guess). (UFMGPRAT-Portuguese for foreigners-1)

UFMGPRAT-Spanish-1 conflict: complaints about partner's attitude

Just as with the groups of 25 (PRATUFMG), 5 (UFMGPRAT-English-3) and 3 (UFMGPRAT-Portuguese for foreigners-1 and UFMGPRAT-English-1) participants, the group with 2 members also had divergence, as can be observed in this message from UFMGPRAT-Spanish-1 when one colleague complains about the attitudes of his partner:

25) I would like to make some comments on our work as a team: I don't know what the formatting problem is with the texts that I sent since they are the same as the texts I received from you. If you can give me some tips, I'm waiting. About the texts that I had requested, of course I looked in the Forum before asking for them but they weren't there. If you don't want to send them, bad luck, I'll get by somehow! I can hand in the folder without these texts. That's what I'll do! I didn't like the way you put it as if neither of us had read the book because I read it. Actually, the majority of the concepts I dealt with are from there and I also cited an author of one of the texts that is contained in that book. The next jobs are my responsibility. I'd like you to send your part by Thursday because it would be better that way. (UFMGPRAT-Spanish-1)

Making an analogy between the Complexity Theory and the discussions presented, we can associate the existence of conflicts in diverse scales, for example, 25 participants (PRATUFMG), 5 participants (UFMGPRAT-English-3), 3 participants (UFMGPRAT-Portuguese-1 and UFMGPRAT-English-1), two participants (UFMGPRAT-Spanish-1) to the fractal character described in adaptive complex systems.

Apart from the conflict, other indications of fractal property can be identified in the composition of the sub-communities, in relation to both the local dynamics, as well as global and contextual dynamics.

Regarding local dynamics, problems with local dynamics and problems with technological resources were reported by both the on-line learning communities and the sub-communities. Many times, the working unpredictability of one of the posting environments led the group to search for alternatives in other environments. In this sense, I consider that these events reinforce the fractal character of the on-line learning of the communities and sub-communities.

The same may be said of group feedback. If we take groups of different participant numbers, we can observe the recurrence of *feedback* on a scale that, in a certain manner, demonstrates the self-similarity of the on-line learning communities and sub-communities, a common fractal property in any adaptive complex system.

Indications of fractal property manifested through events that involve conflicts, problems with technology and *feedback* can be identified both in the local dynamics of learning communities and in the local dynamics of the sub-communities. However, some events, which also manifest fractal character, seem to be peculiar to the groups that did not have direct teacher interference during the "Communicative Dimensions" course.

Leader alternation example may be considered an aspect that repeats in sub-communities of different numbers of participants. The same can be said in relation to the local dynamics referring to the deadlines observed for handing in individual contributions in the sub-communities.

Based on the assumption that global dynamics are the result of local interactions, the rules that emerge from these interactions, such as distributed leadership and stipulation of deadlines, may be considered as global patterns, since they repeat themselves in different numerical groups. The same may be affirmed in relation to the adaptability and self-organization of the groups, produced by the necessity to seek technological alternatives for the posting of

assignments and through group feedback coming from colleagues and the teacher.

As previously discussed, both the local and global aspects are imbued with contextual dynamics. As such, factors such as: satisfaction, dissatisfaction and the diverse tensions that drive local actions are present in the global patterns, which may be considered aspects that repeat in various levels and in various communities, thereby denoting their fractal character.

The dynamics observed in the on-line autonomous communities provided new insights for the enhancement of the pedagogical design for large groups, principally concerning the interaction between peers that act in the same areas and the distributed control. I give a brief description of courses created from this perspective in the next section.

Fractal groups: research and teaching dialogs

The characteristics and working of autonomous on-line learning communities indicated here reflect the complex dynamics through which these communities learn. These dynamics of a distributed and interactive nature favored the creation of pedagogical designs for courses in English reading strategies. These courses have a pedagogical design that offers reading development opportunities for large groups, through two disciplines in different levels with 1.500 students each. The disciplines are offered by the Faculty of Letters to students from all areas of a Federal University in Brazil.

The activities, fully on-line, take place on the Moodle platform, a learning management system that has several tools that allow the creation and development of individual and collaborative tasks.

In these courses, control is distributed and the course content has a central axle constituted of individual learning experiences that involve units geared towards the development of reading strategies and a set of text reading activities of general interest. These activities allow interaction with artifacts, colleagues, tutors and teachers. The students receive automatic feedback on proposed tasks and may opt for posting their doubts on a discussion forum, thereby interacting with teachers and colleagues.

Due to the large number of students and the fact that these students work with different areas of knowledge, students were divided into areas of interest: arts, health sciences, engineering etc. This division by areas allowed students to exchange ideas with peers from the same areas and take part in collaborative tasks, such as the creation of a virtual library, a glossary of technical terms and

selection of scientific texts in English that produced controversial discussions. In this last task, on reading the selected text for their respective areas, the students answered an opinion survey and then posted comments based on other scientific texts, in order to reinforce their opinions on the subjects.

The interactions related to this debate on texts from the large areas demonstrate the open character of the communities and the emergence of opinions, attitudes and values generated from forum interactions. Learning is a situated activity and the students participate in their community, in which the mastery of knowledge and skills demands that the participants move towards total participation in the community's sociocultural practices. The feedback processes stimulate new dynamics in the system and expand possibilities. The systems tend to evolve through their own experience.

The dispersion of control, the adaptability, collective construction of knowledge and the feedback between peers are patterns observed in the 1.000-student classes and in the groups that were formed with the large area divisions. The same may be said with respect to the open character of these communities. The following excerpts demonstrate the learning by means of participation and the entrance of new texts/resources in the communities.

> 26) I agree with your point of view on the use of genetically modified food in benefit of human health. I posted an article in another topic about this specific subject.
>
> 27) João, I think you are looking at the question from one side only. Genetically modified food can really reduce the use of pesticides, but what about the environmental impacts? How do you control a plant that has no predators? How do you guarantee that a genetically modified plant doesn't "crossbreed" with a similar natural species and create a super plant? We must take into account that predators (pests, in the producers' view) feed off the plants and if they no longer manage to feed themselves and disappear it will cause serious impacts on the ecosystems. Think about it.

The opportunity to learn through the opinions of others and to learn what their future colleagues think about a certain subject, in addition to being exposed to different types of arguments, are issues that emerge from the debates and discussions. Student's reports on the Moodle blog identify these issues:

28) The discussion about euthanasia, assisted death and palliative care in the debate section of this module was very productive, since I had the chance to see diverse opinions regarding controversial issues such as these and also express my personal opinion.

29) Of all the activities, I found the discussion proposed in the debate session the most interactive as it opened up a space so that everyone could not only give their opinion on a given subject but also read the opinions of others and debate the proposed theme.

30) By reading other opinions on the relationship between unemployment and suicide in the debate, I was surprised by the variety of arguments on the theme. Moreover, I could see people comparing the theme to things that they had studied in their undergrad courses. It was a great learning experience for me. Nevertheless, people aren't discussing other opinions thoroughly, which could be another great way of increasing learning.

31) I found the debate discussions very interesting, whereby I was able to expand my knowledge about euthanasia and assisted death, as well as making a personal reflection about the subject and discovering the opinion of many future colleagues.

Relying on the examples we can observe that the network established on the courses is open and generates other links as new relations emerge, evolve and transform based on participation in social practices.

Final remarks

The discussions presented here reveal that the instructional design, coupled with the vehicles of interaction, as is the case with Computer Mediated Communication, could promote opportunities for learners to engage in problem-solving and construction of shared meaning.

The preparation of a course design such as the ones analyzed here – which involves distributed leadership, the use of cultural artifacts, individual and collective tasks, as well as *feedback* on tasks and course discussions – promotes learning opportunities.

I share the ideas of Paiva, Braga and Martins (in press) that the design of on-line courses involves, apart from a learning theory, a language theory, assignments and activities, web and/or bibliographic resources, and appropriate

tools for the completion of proposed objectives. I would also add that the dispersion of control and the dynamics that privilege individual and collective issues can mobilize skills in a learning network where the learners reveal their processes and ideas to the community as a whole.

I reiterate the words of Davis and Sumara (2012) which state that discussions on networks and connections from the complexity perspective can foster practical initiatives that consider such networks and connections as systems that learn. The dynamics observed in autonomous on-line learning communities, especially their fractal character, can serve as a starting point for the development of educational experiences that seek to promote learning through participation in a network whose focus transits between situational contexts, local and global interactions alike.

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