

# FOSTERING TEACHERS' ADOPTION OF MOODLE: AN ACTION-RESEARCH FRAMED ON EVOLUTIONARY GAME THEORY

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Despite several studies' conclusions about the great potential of Learning Management Systems like Moodle for educational and professional practices in schools, many authors find a reduced use of this tool in school's pedagogical and organizational contexts. This article presents an action-research carried out in a Portuguese school, where it was intended to understand, from an Evolutionary Game Theory perspective, the survival and expansion of the using-Moodle behavior in a population of teachers. Some mechanisms studied in this theory influenced the actions negotiated with school leadership and implemented throughout the investigation, and the analysis of their impact. School leadership use of Moodle forums and the frequent interactions between Moodle users proved to be catalysts of the desired change, suggesting the importance of social reinforcement for the adoption of this tool.

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## 1 Introduction

Moodle is an online learning management system, created by Martin Dougiamas and aimed to educational and collaborative environments management (Lisbôa *et al.*, 2009). In such platforms, teachers are exposed to a wide range of resources, ideas and perspectives, which helps them to understand the instructional value available and to expand their knowledge about opportunities to change or improve, thereby contributing to their professional development (Harasim *et al.*, 1995). Fernandes (2008), understanding the potential of Moodle's tools, suggests a wide range of uses for other school practices at the organizational level. Thus, it is possible to understand Moodle as a Public Good, in which school leaders and teachers can enjoy and learn – and contribute to school development – by sharing resources and experiences.

However, despite the adoption of Moodle by a large number of Portuguese schools (Pedro *et al.*, 2008), its effective use is still limited for most schools and teachers, in number of users and quality of use (Pedro *et al.*, *op. cit.*, Lisbôa *et al.*, *op. cit.*). Brinkerhoff (2006) identifies four sources for the barriers that hinder the integration of technology into teacher practices: attitudes/motivations, training/experience, institutional/ administrative support, and resources. Perceived usefulness is an important component of teachers' motivation to use computers (Mueller *et al.*, 2008). Regarding teacher's motivation, Baek, Jung and Kim (2008) present an unexpected result: from the six factors most pointed by teachers as justifications - seen here as perceived benefits - for the inclusion of Information and Communication Technologies (ICT) in their practices, the "adaptation to external requests and other expectations" was the most mentioned one, especially by teachers with more professional experience, in contrast to the expected factor, the "use of improved technological tools", mentioned mostly by younger teachers and advocated by the first scholars of Educational Technology. In other words, regardless of the ICT potential for teaching, learning and professional practices, their effective adoption by teachers is due, according to these authors, to the convenience to attend to external requirements, whether they arise from legislation or from other actors' social pressures. These results point clearly to a social network dynamics, where behavior is conditioned by the reputation that comes from it.

Studying factors affecting technology uses in schools, Zhao and Frank (2003) highlight the need of an ecological perspective to address such problems:

Just as in a biological ecosystem, the teaching ecosystem exhibits diversity that it contains many types of species, each having a different set in of characteristics and playing a different role (occupying a unique niche) in ecological terms. The

species' characteristics and roles constantly affect one another, thereby constantly modifying their interrelationships (p. 812).

Within this theoretical framework and aiming to understand different technology uses and institutional factors that may affect technology use, Zhao and Frank (2003) collected data from school administrators/ technology staff interviews and surveys administered to all school staff, suggesting, in their final conclusions, that the approach to school change should be “evolutionary rather than revolutionary” (p.839).

In fact, and analysing the problem of teacher's adoption of Moodle from an Evolutionary Game Theory (EGT) perspective – being EGT a mathematical theory that studies the evolution of behaviors adoption in populations, when the resulting costs and benefits of such behaviors are formally defined – it seems appropriate to define an LMS like Moodle as a public good: all teachers can take advantage of it to share materials and experiences and develop their practices. Even the school leadership, according to Fernandes (2008), may take advantage of its potential for the development of organizational and professional practices, fomenting its use among teachers and improving school as a whole. Thus, the low use of Moodle problem in a school may mean that few individuals cooperate to maintain this public good, and the spread of this cooperative behavior does not occur in the population.

## 2 Evolutionary Game Theory

Game Theory is a powerful theoretical tool of social sciences (Axelrod, 1984), crucial to understand the evolution of social behavior in animals as well as the notion of altruism and justice among humans (Erickson, 2006). It studies various types of games, and some elements are needed to define them: a set of players, a set of strategies or behaviors, and, for each strategy, a set of payoffs received by each player. Some games characterize many social dilemmas, which reflect the conflict of interests between the welfare of a community and of each individual (Hauert, 2006). In this class of games lies the Prisoner's Dilemma, which is, according to Axelrod (*op. cit.*), the paradigm of formal game theory to analyse prosocial behaviors: it has inspired several lines of research in psychology about factors that promote/inhibit cooperative behavior, also serving as a diagnostic tool for social orientations such as individualism/altruism, and cooperation/competition (Axelrod, Riolo & Cohen, 2002).

In a population of players, Game Theory gives rise to Evolutionary Game Theory: it studies the spread of strategies or behaviors within the population, known the mechanisms used by players in the decision to adopt a given strategy or behavior, like trial and error or the imitation of successful strategies. Keeping

the same mathematical structure of the Prisoner's Dilemma, EGT studies the Public Goods dilemma, having demonstrated in this case the importance to the emergence and maintenance of cooperative behavior of changing the payoff, volunteering, communication, social reputation and clustering (Axelrod, 1984).

The adoption levels of a behavior increase when there's a high personal benefit obtained by that behavior, and a small benefit that comes from not adopting it (Kollock, 1998). For the emergence of cooperative behavior Axelrod (*op. cit.*) recommends to leaderships changing the payoff of cooperation, making it an attractive behavior. Sigmund (2010) also suggests that the payoff resulting from the adoption of a particular behavior depends on the percentage of the population of individuals who adopt it.

Changing game's feature from mandatory to volunteer brings gains for social welfare (Hauert, 2006): cooperators are the ones who respond positively to the announcement of a volunteer cooperative game, revealing more comfortable to play than the non-cooperative ones (Orbell & Dawes, 1993), which increases the probability of socially productive relations. The frequent interactions between cooperators reinforce their optimism, and the improvement of social welfare attracts new participants – loners – to the game (*Ibidem*).

Communication is a prerequisite for the evolution of cooperation, because the ability to communicate and meet other players' intentions allows the development of alliances and even a morality that transcends the individualism of the rational player (Axelrod, *op. cit.*). Access to a record of cooperation of each individual - the maintenance of a memory game - also allows the development of social reputation, another important mechanism for the evolution of cooperation. Centola (2010) investigated the spread of behaviors in an internet community and found out that social reinforcement resulting from the receipt of emails with notifications of "friends" behaviors resulted in a propensity to adopt those same behaviors.

Communication also allows the creation and reinforcement of a sense of group identity and ethical standards (Kollock, 1998; Kirschbaum & Iwai, 2011). In fact, in a population of local interactions (such as a neighbourhood) that faces the Public Goods dilemma, cooperation can emerge by the natural formation of clusters of cooperators, where individuals, by repeated interactions within these groups, show altruistic behavior (Kollock, *op. cit.*) and maintain the levels of cooperation. The interactions in which cooperative behaviors are adopted result in benefits for each of the individual agents, promoting a social welfare that results in the desire to repeat such interactions, forming and thus keeping the cluster of cooperators. Several studies (such as Axelrod, *op. cit.*; Alves *et al.*, 2004) suggest that organizational leadership must focus on the deliberate formation of such teams.

### 3 Methodology

To understand the educational phenomena underlying the identified problem, an action-research seemed to be an appropriate methodology, as it “can serve as an organizational strategy to aggregate people to actively deal with particular issues” (Bogdan & Biklen, 1994; p. 297) and can be seen as an adaptive-evolutionary process of change (Noffke & Somekh, 2009).

#### 3.1 Context

Favourable to this desired change regarding ICT adoption in schools, the Portuguese Ministry of Education identified in 2011 the need to establish school structures to support a Technological Plan for Education (TPE), which could respond more objectively to the problems and needs of each school. Such a structure was called TPE team, constituted mostly by school teachers.

The research took place from July 2010 to March 2011 at the school where the researcher worked as a mathematics teacher. It was a public school, where about 90 teachers were working with 900 students between 10 and 15 years of age. The school leadership was constituted by a director, a vice-director and 3 other members, including the TEP Coordinator (TEPC), an ICT teacher. All of the 36 class-rooms had 1 computer for teacher use, and 2 classrooms were also equipped with 14 computers for students. In the school library 6 computers were available to any user, and teacher’s room had 8 computers for their use.

Through a brief exploratory case-study grounded in semi-structured interviews it was possible to understand that in September 2008 the TEPC conceived a strategic design to foster Moodle adoption and its dissemination, implemented in the scholar years of 2008/2009 and 2009/2010. It relied on the constitution of a PTE collaborating teachers team, whose 16 members belonged to various curricular departments, benefiting from a reduction of 1 hour of weekly working time to serve as hubs among their peers, spreading practices of using Moodle. Selecting PTE collaborators had been first conditioned by service requirements, and motivations and skills in using ICT were secondary conditions. Between September 2008 and June 2010, the TEPC provided these teachers with some sessions of formal technical training to use Moodle, and some moments of informal training by individual requests. This strategy showed to be unfruitful, for there was no significant increase in the number of accesses, resources, activities, disciplines or users of Moodle, according to some PTE collaborators.

#### 3.2 Data Collection

The methods/tools used in this study to collect data were (i) a questionnaire, (ii) reports and statistics generated by Moodle, (iii) a diary and (iv) two semi-

structured interviews.

The questionnaire was meant to deepen the knowledge about teachers' motivations and feelings, to better define the first actions to implement in that school. Diary data was collected from informal and natural conversations with various teachers, including PTE collaborators and leadership members. Two structured interviews were carried out, aiming to understand perceptions of the TEPC and a collaborating professor about the actions undertaken and their impact.

Given the naturalistic condition of the investigation, data analysis was done throughout the investigation.

Given that the researcher developed her professional career at that same school, interactions with teachers occurred perhaps daily in informal meetings, during breaks between classes and other encounters.

#### 4 1<sup>st</sup> cycle of Action Research

It was designed and applied to school teachers in July 2010 a questionnaire with a Likert-type scale (1 – low; 4 – high) in order to understand frequencies of some ICT practices in teaching, and also feelings (at ease and enthusiasm) about ICT integration in teaching practices in general. There were no significant differences between the two groups with regard to ICT practices in teaching (Figure 1); however, and regarding their feelings, Figure 2 shows that PTE collaborators revealed, on average, values slightly lower than those revealed by the other teachers' group.

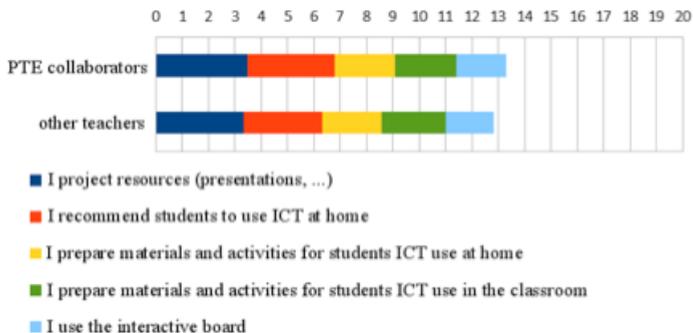


Fig. 1 - Frequency of different ICT teaching practices.

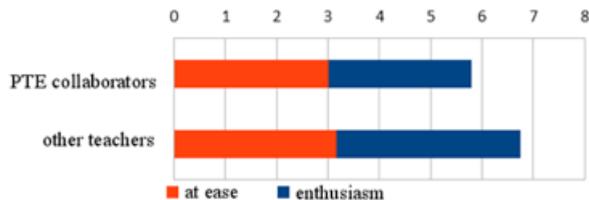


Fig. 2 - Feelings about ICT pedagogical use.

After collecting and analyzing data, some actions were negotiated with the school board and implemented at the start of the academic year 2010/2011:

- The researcher became Moodle's administrator, with six hours of work per week for this purpose;
- To promote frequent interactions with the researcher and PTE collaborators, their working time at school contemplated a weekly moment common to all, to provide informal training moments of using Moodle.

The researcher also performed some changes in Moodle's site configuration:

- Manual enrollment of all school teachers, and most of the students;
- Creating disciplines specifically to teachers with forced subscription to Forums, such as "Department of [...]" – to be managed by PTE collaborators along with their curricular department coordinators – and "Teachers Room" – a forum type discipline, to be boosted mainly by the school leadership, working as a "virtual bulletin board".
- Making available on the main page of Moodle's site the resources "contacts" (with the identification of 16 PTE collaborators) and the sideblock "active users".
- All school computers had their browser's homepage set to Moodle's site.

#### 4.1 Results

Figure 3 shows the evolution of the use of Moodle in the population studied, since the Moodle instance was created in September 2008 until the end of the investigation, March 2011. The increase of accesses during the action-research study is quite significant, observed the black line which refers to all users' accesses. The researcher and the PTEC were the only users assigned with the administrator profile.

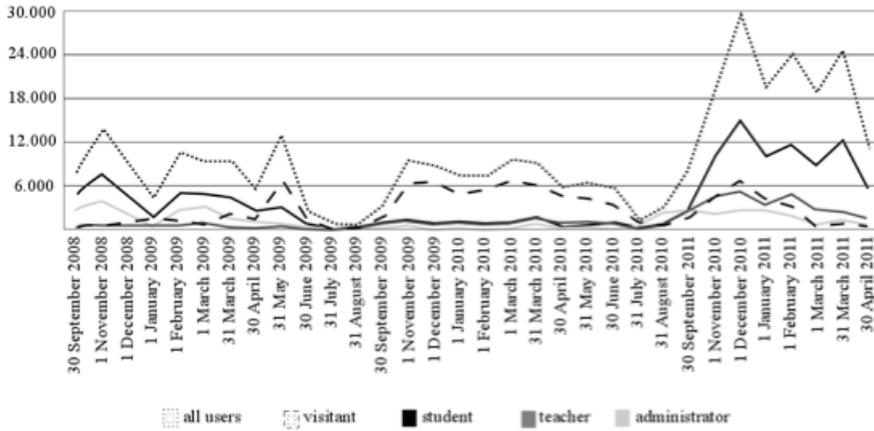


Fig. 3 - Evolution of the accesses to school Moodle's site from September 2008 to March 2011.

The dynamic nature of the action research methodology implies a strategic and intentional temporal sequence of data collection, being the reporting and interpretation crucial stages of the reflexive process that characterizes this methodology. Therefore, data will be presented in their chronological order of collection, followed by the interpretations that led to the new actions.

The first cycle of research was characterized by Moodle's administrative work (to configure and manage the platform) and also by several moments of technical support to its users, mostly new Moodle users. Also, and permanently, in formal and informal meetings at school, the researcher focused on showing the potential of Moodle to improve school practices.

Some PTE collaborators were less assiduous to weekly meetings with the researcher. For many participants, the existence of these weekly meetings functioned as a kind of "policing", making it mandatory for many to work for the platform at that time. The TEPC stressed the organizational constraints in forming such a team: "The most important qualities of a PTE collaborator are autonomy, technical skill and creativity. Not all colleagues reveal them, but the preparation of teachers working schedules involves so much ... Many became PTE collaborators because they had time available ... It's not me who chooses them, their working schedules do. [...] Some people may have the suitable profile but do not have time to be a PTE collaborator: they have to spend time giving support to this student, or in this coordination" (TEPC).

During those weekly meetings participants accessed Moodle site and expressed their concerns or raised questions aloud, and others intervened sharing

knowledge or raising other questions. Excepting for one PTE collaborator, all the others – including Anna – had clearly defined a considerable distance between their ICT skills and those revealed by the researcher, perceiving her as a trainer. The researcher promptly attended requests, in an informal and collaborative way, suggesting activities which could promote efficient and effective Moodle use. Nevertheless, the greater interest of PTE collaborators during the first cycle of action research was to master the technique required to add resources to their Moodle disciplines.

Some PTE collaborators were Moodle enthusiasts; others showed increased interest and motivation when realized that technical problems and concerns were addressed and solved in every session. “For years and years and years I rejected the idea of computers, and then, for a moment, I realized: maybe it is interesting... Now I could not live without my computer! One can implement strategies to make lessons more enjoyable. [...] In my [Moodle] discipline there is a clear change from last year to this one. [...] The 45 weekly minutes? I was with you, but every Friday I was with my colleague [from the same Curricular Department] and we stayed in school working on the platform.”(Anna)

Other school teachers showed interest in using Moodle, requesting technical support: “This [Moodle] is very interesting ... [...] Can you create a discipline for me? [...] Are you here at this hour every week? [...] Can you help me?” (5<sup>th</sup> grade teacher).

Curricular Department’s coordinators showed little interest in adopting Moodle to develop their practices in Moodle’s Curricular Department’s disciplines, since its adoption was defined by school leadership as volunteer.

“An area [Moodle discipline] for teachers to share and collaborate? They won’t go there. First, because we are increasingly required to do many things, many roles in school... There’s no time. [...] We have to take it easy ... I value older people, because this is an absurd change for them... We must have patience and calm, they are slowly joining. We cannot be so demanding. But that doesn’t mean we have to stop there: let’s sow the seeds, this will eventually bear fruit” (Anna).

It was always difficult to meet with school leadership members to show Moodle’s potential to develop organizational practices. Only at the end of October the school director began to use ‘Teachers’ Room’ discipline, posting in a Forum information, notices and other scholar resources, which were, in turn and automatically, sent to all teachers by e-mail. This leadership use of Moodle proved to be catalyst for the desired change: after receiving the first email, many teachers approached the researcher requesting username and password to access platform, and also expressing technical constraints in accessing it, which was perceived as necessary and inevitable given the school director use of Moodle. “The school direction, by using Moodle, sets the example and shows

that it is a good tool to quickly access and share information” (TEPC)”. The coordinators of other leadership structures – being among these one particular teacher always very reticent to scholar ICT adoption – requested the creation of disciplines on the platform similar to ‘Teachers’ Room’ in their capability to communicate with teachers through emails. The attention and interest of other teachers in the school Moodle site increased substantially since that time: there was a significant increase of requests for the creation of disciplines to work with students and for support in accessing and browsing the platform. During this cycle the platform underwent a major restructuring in its categories and disciplines.

Despite the success of the actions implemented from September to December 2010, some refinements were negotiated with the TEPC in order to improve Moodle’s adoption, conducting to a 2<sup>nd</sup> cycle of action research: to raise awareness among school leadership members of Moodle’s potential for the development of professional practices, seeking the increase of that use and, therefore, frequent interactions of school leadership with all teachers through Moodle itself.

In this 2<sup>nd</sup> cycle, leadership members gradually understood the potential of Moodle to the development of their practices, especially in collecting information through Moodle’s questionnaires, which could allow them to save paper and systematically collect and process data. Nevertheless, despite the interest shown by these participants, their lack of time availability to develop technical skills to use the Moodle was frequent, which is confirmed by the TEPC: “we still need to improve a lot, but there are also many resources that we have not, there are many obstacles ... Too much work, for example.”

## 5 Discussion

In general all disciplines managed by PTE collaborators had a major increase in students’ accesses.

The school director clearly functioned as a hub of interactions with all school teachers, signaling his Moodle-use behavior through frequent emails sent through “Teachers Room”. The initial assumption that PTE collaborators would be responsible for the dissemination of Moodle was quickly supplanted by the dynamics of a social network, where, for many teachers, the behavior of using Moodle was acquired by imitation of that single hub: though, in theory, each PTE collaborator had a strategic position in the population - at least one belonged to each curricular department - the reality had shown that these participants did not functioned exactly as hubs, for their positions didn’t necessarily meant interactions with their peers.

The variable most privileged in this study and which effect had a most

visible impact was communication. It seemed crucial to focus on that process to transcend Moodle adoption barriers, aiming to understand teachers' professional interests in ICT and raising awareness of the benefits of using Moodle. Through one of the most interesting Moodle's features, communication between participants was also established via email, where each post in a forum was automatically sent by email to subscribed users. Regardless of the different perceptions of Moodle adoption's benefits, knowledge about the actual state of the spread of use of the platform in the school population seemed to have some impact on the population of teachers as a social network.

Exposure and visibility of PTE collaborators work resulted in some cases into a greater commitment to its realization, which resulted in an increase in their use of Moodle. By forcing the creation and maintenance of social reputation, they could validate their PTE team membership and their acceptance in the community as using Moodle hubs.

## Conclusion

One of Game Theory's main result is the importance of the 'shadow of the future' in the emergence of cooperative behavior: the perception of the possibility of future interactions allows the emergence and sustainability of cooperation in a "selfish individuals" population. In this particular study, involving the professional and educational use of ICT, the evolution of technology itself and of its integration in school practices do provide a future where ICT will be most certainly present in the school, hence facilitating school leadership and teachers decisions to adopt exploratory behaviors and accept technology, even with some individual and/or group resistances. As pointed out by Zhao and Frank (2003, p.3), schools are "said to have a structure that prevents wide spread uses of computers"; nevertheless, and integrating the fact that effective adoption of ICT can only be visible after some years of dedication (Balanskat, Blamire & Kefala, 2006) reinforces the need to develop in the whole school community this prospect of future with ICT and for ICT, stressing the need, as refers Axelrod (1984), to establish frequent and lasting interactions between individuals, which allow the emergence of cooperation around the use of ICT, particularly the use of an LMS such as Moodle.

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