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# Participatory methodologies to promote student engagement in the development of educational digital games

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ABSTRACT

Engagement is a fundamental condition for learning, which the outdated educational system is failing to sustain for the current generation of students, born in a world permeated with digital technologies. This article presents an analysis of high school students' engagement while playing the roles of programmers and designers of educational digital games in the Community of Practice of the DEMULTS project, which aims to provide an alternative within the traditional educational system. Data collection was performed within an ethnographic approach with participant observation, questionnaires and social network interaction, and analysis was based on the constructs of Activity Theory. Four groups of students were identified with similar needs and motivations, each engaged at different levels according to the nature of the tasks, interaction with peers and educators, and personal expectations. Results reveal that, even in a supposedly fun and innovative context, the relationship between the object of the activity and the students' needs is crucial to promote engagement and learning. Identifying and taking into account students' needs and expectations is reinforced as an indispensable step in educational interventions.


## 1. Introduction

Despite the boom of information and communication technologies (ICT) designed for and/or used in education in the last years, the dominant paradigm of the educational system worldwide has not changed: it remains fundamentally based on transferring knowledge to passive learners, consisting of a structure lacking democratic principles, where contents and methods are imposed by teachers on students. Technologies have been simply aggregated to this outdated structure, regardless of the radical changes they have provoked in people's lives. The discrepancy between the classroom and the world 'out there' has been aggravated as the first generations of learners born in the ICT era entered school, many of them bringing along new ways of processing, searching and dealing with information (Prensky, 2006). The need for approaches that are more appropriate for the current generation of learners has become too evident to be denied.

Several authors (Prensky, 2006, 2008; Lim, 2008; Vos, Meijden, & Denessen, 2011; Yang & Chang, 2013) highlight the potential of digital games as one of the most promising innovative approaches for children and adolescents' education

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nowadays, as the games 'speak their language' and are part of their lives, besides being associated with fun, immersion, sense of belonging to a community (of gamers), motivation and engagement. Reinforcing the potential of games, the concept of engagement has attracted growing interest as a way to improve academic achievement and reduce boredom in the classroom (Fredricks, Blumenfeld, & Paris, 2004). Currently, many initiatives - such as the democratisation of the school environment to encourage participation - explicitly or implicitly focus on engagement, seeking to increase learning and decrease evasion in schools. School engagement can be promoted by interpersonal relationships, intellectual endeavours and opportunities to share knowledge. Engaged students seek information, are willing to participate and actively collaborate (Fredricks et al., 2004) - and these are aspects easily identified in teenagers playing digital games for fun. However, the integration of educational games to 'real', everyday classes hardly ever goes beyond the instructionist paradigm (Valente, 1997) of conveying information and verifying students' answers, once more conforming to the system in vogue (Lim, 2008).

DEMULTS is a longitudinal, school-based research project (Educational Development of Sustainable Multimedia) envisioned as an attempt to encourage schools to move away from traditional paradigms. It integrates learners as active agents in the development - not only the use - of educational digital games in the school context, through participatory design and end-user programming, placing learners in the position of decision-makers and autonomous creators of the games. According to Lim (2008, p.1002), "If educators design learning experiences based solely on their own vision, goals and circumstances, they may be merely imposing their set of values upon their students; engaged learning is unlikely to happen in such an environment. (…) It is only when students are empowered to take charge of their own learning by co-designing their learning experiences with teachers and other students that they are more likely to engage in their learning process".

Previous findings from projects involving game development by students show evidence of enhanced academic achievement (Yang & Chang, 2013), development of logical thinking and problem-solving competencies (Vos et al., 2011); critical thinking (Yang & Chang, 2013); student empowerment (Triantafyllakos, Palaigeorgiou, & Tsoukalas, 2011); and engagement (Robertson & Howells, 2008; Vos et al., 2011). However, particularly regarding the scope of this article, analysis of engagement is mostly superficial and short-term, making it subject to the novelty effect bias. We present a longitudinal analysis of engagement in the DEMULTS project, framed by the constructs of Activity Theory.

Activity Theory (Leontiev, 1972, 1978) guides the construction and understanding of the DEMULTS process of development of digital games overall, aiming to reveal aspects of knowledge construction and mediation that cannot be observed through abstract and behaviourist models. The social practice experienced in a community and organised in a school context is a concrete phenomenon, an intersubjective and dynamic system, whose daily processes are interconnected with the environments and particular operations of the process. In this theory, there is a disruption of the dichotomy involving individuals and society, for Leontiev extends the psychological relationships within the activity to a more aggregated model, that considers human needs, their motives and conditions, as being part of the activity structure.

Aligned with this argument, the approach taken in this research project treats cognition as a cultural-historical process. The cultural-historical perspective, based on the ideas of Vygotsky, Luria and Leontiev early in the twentieth century, was reinforced from the 1980s by studies of situated and distributed cognition (Hutchins, 1991; Lave & Wenger, 1991; Lave, 1988; Suchman, 1987). Strengthened by these approaches, this work understands human learning in close relationship with others and with the use of artifacts. Therefore, although the methodology is anchored in Activity Theory, it has in the concepts of Communities of Practice (CoP) (Lave & Wenger, 1991) its cornerstone, according to which learning is an aspect of social practice, directly related to the actions of individuals in a context, and based on co-participation. The main idea on this approach is the relationship between beginners and veteran participants (here called novices and experts), but it also considers aspects of the activity itself, of the identity processes and of the artifacts in the CoP. Thus, there is a structure of participation in which individuals acquire skills through their concrete engagement in the process.

This article presents an investigation of the aspects that increase or decrease engagement of learners throughout the development of educational digital games, analysing them as novice members of the DEMULTS CoP taking place at their own school. Engagement is analysed in terms of the object of the activity and the needs of the novices, as Activity Theory constructs. The article is organised as follows: initially, the theoretical underpinnings of DEMULTS are presented, as well as the methods that are used to structure the practical activities (Section 2). Then, the discussion on engagement in educational contexts is deepened in Section 3, drawing from central considerations of the cultural-historical perspective. The phases of a DEMULTS cycle are described in details in Section 4. Section 5 presents the method for data collection and analysis, followed by the derived findings on engagement (Section 6). The article ends with closing remarks and potential routes for future research in Section 7.

## 2. Theoretical frameworks of the DEMULTS project

DEMULTS is a transdisciplinary research project which takes place in a public secondary school since 2011, and investigates the relationships between learning and technology within a process of development of educational digital games by a CoP. Aiming at making students develop games that include curricular contents, but are more motivating for them than the average games known as 'educational', DEMULTS adopts participatory design (Bodker, Ehn, Sjögren, & Sundblad, 2000; Ehn, 1988) and end-user programming (Barbosa, 1999; Morch, 1997). From an educational point of view, DEMULTS aims at promoting learning of curricular contents included in the games, but also abilities of game development, i.e. graphical design and programming (the latter of which enables the development of computational thinking (Wing, 2006), considered an essential ability in the contemporary society). The theoretical basis on which the methodology of DEMULTS was conceived and is

continuously analysed and adjusted is Activity Theory, and the activities are structured within the organisation of a CoP, as explained next.

### 2.1. Activity Theory

Activity Theory is a multidisciplinary approach with origin in the historical-cultural psychology of Vygotsky's school (1962), at the beginning of the 20th century. Advancing and relying on Vygotsky's ideas, Leontiev (1972) deepened the work on the role of the collective activity and its practical relations with the subjects' actions in the world. The concepts brought by Leontiev relate to the understanding of object-oriented collective systems mediated by artifacts, making the link between individual subjects and society. Despite the theoretical disputes involving Activity Theory (Daniels, 2001; Duarte, 1999; Kaptelinin & Nardi, 2012; Van der Veer & Valsiner, 1991), it is possible to consider continuity between Vygotsky's and Leontiev's ideas, and their theoretical and methodological orientations became very relevant to studies and discussions on Human-Computer Interaction and Information and Communication Technologies in education.

A central idea to Activity Theory is that there is a relationship between the objective structure of human activity and the subjective structure of consciousness. In other words, humans develop through activity. Thus, the development of psychic functions stems from a process of appropriation, which transforms external activity into internal activity. In this manner, the process of appropriation of knowledge happens in social life, from one generation to another, taking the form of social consciousness. Therefore, humans appropriate not only material mechanisms, but also a whole system of meanings that have been formed historically (Leontiev, 1978). With internalization, social consciousness becomes individual consciousness, and meanings begin to have a personal sense, linked directly to the human motives and needs. Although personal consciousness is formed by social consciousness, it maintains particular values, because not every sense (personal) has a meaning (social). An activity must involve a relationship with the environment and the satisfaction of some personal need. This requires three crucial elements that characterize the shift from external activity to internal activity: the need, the object, and the motive.

When an object enters in a human activity, it loses its apparent naturalness and emerges as an object of collective social activity. This implies that for each activity there is a corresponding motive; that every activity is carried out by actions with corresponding objectives; and, in more detail, what happens through operations dependent on specific conditions.

Engeström and Middleton (1996) observed various contexts where research based on Activity Theory aimed at understanding cognition in concrete situations of collective work, attesting the multidisciplinary nature of Activity Theory. In the educational context, authors such as Davydov and Markova (1983), Hedegaard, Hakkarainen, and Engeström (1984), Wenger (1998), Peres and Oliveira (2013) highlighted different emphases of Activity Theory that can guide school practices in ways that move away from instructional models of education.

The central object of investigation of DEMULTS′ methodology is the relationship between the objective structure of activity of game development by students and the subjective structure of consciousness of these students. The collective structure of the activity takes a mediated form of complex structure composed of different individual contributions. In terms of a technical division of labour, in a project of development of digital games for learning, we understand that the mediation during the process will be internalised by the subjects and will transform them, as the process progresses. However, it is necessary to understand the process of change and its effects on the subjects' engagement in the activity.

There are several works that use Activity Theory as an overall framework to investigate the use of serious/educational games in learning contexts, such as Law and Sun (2012), Carvalho et al. (2015) and others cited by them. However, these works focus on analysing how the games per se can be designed (by professionals and/or researchers) to support learning when *used* by students. Differently, the focus of DEMULTS is on the *process of development* of such type of games and how this process can contribute to learning, but also to innovation in education.

Hence, Activity Theory (Leontiev, 1972, 1978, 1981) guides the present research in: (i) understanding the structure of the educational activity designed (development of educational digital games by secondary school students); (ii) clarifying the procedures and defining actions to increase the effectiveness of the project in learning processes; (iii) promoting the transformation of institutional spaces involved in the research; and (iv) proposing conceptual frameworks and methods for examining engagement during social practices - which is the focus of this article, and is further discussed in Section 3.

### 2.2. Communities of Practice

With the goal of offering a highly participative and hands-on environment where all participants are constantly presented to learning opportunities through interaction with one another, DEMULTS' structural organisation lays on the concept of Community of Practice (CoP), firstly introduced by Lave and Wenger (1991), and in this work adapted to the educational context. This theory has been successfully applied in many work environments worldwide (Engeström & Middleton, 1996), usually connected to Activity Theory due to their complementary concepts and the importance attributed to social practice. A CoP can be defined as a group of people who share a mutual interest, and hence get together in order to learn, discuss and develop their domain of interest. Through these interactions, individuals are able to build their identities as a result of negotiation of meanings (Peres & Oliveira, 2013).

In other words, a CoP is a group of people who recognise each other as related to a set of actions, develop ways of doing something and, over time, come to be recognised by others as representatives of a specific category of practitioners. Individuals who are truly involved in a CoP are given the opportunity not only to develop their theoretical knowledge, but also

to learn new practical abilities that are common to their community; thus, there is a shortcut between theory and practice that only active subjects are able to achieve. There is no passive learning in a CoP, for theory and practice are strongly associated (Lave & Wenger, 1991).

To refer to the practitioners in DEMULTS' educational CoP, we adopt the terminology of experts and novices, where experts (undergraduate and graduate students) have a greater domain of relevant areas of knowledge, and novices (secondary school students) are newcomers. Learning happens as a novice interacts with an expert and through this interaction acquires more elaborate ideas and experiences. Novices learn through access to discursive forms, actions and operations, due to their participation and integration in the community. This set of performances would not be available without co-participation. The intentions of the novices are taken into account: they are involved as legitimate participants, beginning with peripheral practices, and through increasing engagement and growing competences, develop more identification with the community until they become full participants, thus at the centre of the given practice. As time develops, it is expected that the novices share their knowledge with newcomers to the community, becoming experts themselves (Lave & Wenger, 1991; Wenger & Snyder, 2000; Wenger, 1998).

### 2.3. Participatory methodologies

DEMULTS is based on participatory design (Bodker et al., 2000; Ehn, 1988) and end-user programming (Barbosa, 1999; Morch, 1997), as novices design and develop games whose target audience are themselves, their peers, and other students of similar profile. In participatory design, people should be co-creators, which should promote positive feelings and attitudes towards the artefact in production (Bodker et al., 2000). With a long experience in undertaking participatory design with children, Druin (2002) classifies their roles in: user, tester, informant and design partner. Particularly as design partners of the experts, children are able to contribute with ideas, collaborating with adults and engaging in mutual learning (Druin, 1999). Inspired in participatory design, DEMULTS goes beyond by actually having learners as leaders of the design of the games, with experts as helpers.

The codification of the game by the programming team is based on end-user programming - a technique that allows non-programmers to create software applications by using tools with built-in coding structures that can be extended and modified. According to Morch (1997), this can be done through: customisation (students modify pre-defined options); integration (students connect pre-defined components to build and modify the system); and extension (students insert new code using a programming language).

Participatory methodologies are expected to promote learners' autonomy through active participation, within an innovative approach for formal education, increasing motivation and internalization of competencies and concepts (Druin, 2002; Hansen & Iversen, 2013). In DEMULTS, novices are encouraged not only to contribute with ideas, but actually lead the process of game creation. The role of the experts is to contribute with general guidance and technical support, helping to make novices' ideas 'come true'. For this reason, the concretisation of the product of the CoP (the game), as well as students' learning, heavily depend on their active participation and engagement in the process. Being the focus of the analysis presented in this article, the concept of engagement is discussed in the next section.

## 3. Engagement in educational contexts

In Communities of Practice, engagement is the most immediate relation to practice - it is the reason for the existence of a social practice, for without mutual commitment of participants, practice cannot occur. Engaging in activities (working alone or together, talking, using and producing artifacts) means having direct experience of regimes of competence, whether this experience is one of competence or incompetence and whether they lead to the development of identities of participation or non-participation (Wenger, 2000). Engagement varies according to the level of participation of subjects, which is how much people commit to the actions of a practice. Participation reflects the quality of what subjects are doing and the meaning it has in practice (Lave & Wenger, 1991). In the school context, engagement - as the decision to participate in an activity - is seen as a necessary phenomenon for learning.

Yonezawa, Jones, and Joselowsky (2009) suggest a perspective that goes beyond engagement as participation, also taking into account the autonomy of the learner, e.g. the learners themselves should be able to decide where and when to study. In this article, participation and autonomy of subjects (who in the context of this work have simultaneously the role of learners and game developers) are considered the main aspects of engagement.

Novices' autonomy in DEMULTS is sought through the participatory methodologies described previously, within an approach of learning by building digital games (Prensky, 2008; Lim, 2008; Yang & Chang, 2013), as opposed to learning by using games. Among other benefits aforementioned, providing the opportunity for students to create and personalize learning artifacts in the form of games is expected to increase motivation and engagement. In a quantitative study, Vos et al. (2011) compared a group of children who used an educational memory game with another group who developed their own memory game, and found a significant difference in intrinsic motivation in favour of the game construction condition. The authors relate this finding to characteristics of constructive and active learning, due to greater recruitment of critical thinking skills and self-regulated learning. Robertson and Howells (2008) qualitative analysis of children's participation in the development of an educational game showed high levels of enthusiasm and motivation for children with different profiles (i.e. high and low achievers, students who usually resisted engaging in traditional tasks, etc.). The authors suggest a strong

relationship with the element of challenge, but acknowledge that it could also be significantly attributed to novelty. Indeed, despite the recurrent argument that dealing with games (playing or building) is 'naturally' engaging for the young generation, there is still a lack of deeper investigation, particularly going beyond the novelty aspect.

Analysing DEMULTS through the lenses of Activity Theory reveals that each subject-participant is motivated by different needs, which are the ultimate cause behind an activity - the internal condition for it to occur (Leontiev, 1981). In DEMULTS, novices and experts engage in an activity whose object is the development of a specific educational digital game in each cycle. Activities cannot exist without their objects, i.e. an 'objectless' activity is impossible (Leontiev, 1981). Being the object what motivates the subject to engage in the activity, it can be said to be the motive of the activity, the entity that directs the activity. In his original writings, Leontiev used the Russian word “predmet” for object (and not the Russian word “objekt”). Predmet associates the notion of human purposes or interests to the concept of an objectively existing entity (“objekt”). Although often lost in translation due to the lack of appropriate English words, the word predmet reinforces the motivational nature of the object in Activity Theory (Kaptelinin & Nardi, 2012) - in Leontiev's words, the object is the 'true motive' of the activity (Leontiev, 1978).

An activity emerges when a need becomes coupled with an object (a moment of extraordinary importance, according to Leontiev (1978)) - at this time the object becomes a motive, and the need is 'objectified'. In other words, “a motive is an object that meets a certain need of the subject” (Kaptelinin & Nardi, 2012, p. 25). Subjects' level of engagement in the activity is thus proportional to the extent to which the object of the activity meets their individual needs (Jorge & Moreira, 2012).

However, needs are subjective and determine the meaning that is given to the object of the activity (Leontiev, 1981). The meaning of the activity is expressed through the articulation of actions and their goals, which are directed towards and justified by the object. The meaning of the activity involves, among other aspects, personal expectations, role in the community and in the process, expected results and consequences of the activity, and social relationships (Pontelo & Moreira, 2009). Every activity has a significant unity with individual consciences in the process, carrying objective and subjective aspects concomitantly. Engeström's extension of Leontiev's theory helps to account for social aspects by bringing the community and division of labour into play (Engeström & Middleton, 1996; Engeström, 1987). Engeström analyses the subject as socially constructed through interaction with the community (including rules and rituals), within activities mediated by instruments and signs, oriented towards an object.

Fig. 1 depicts Engeström's diagram instantiated to DEMULTS. It is fundamental to consider that, as much as students' autonomy is encouraged in DEMULTS, the latter remains a school project, and schools are contexts with very particular rules and demands. Thus, the components 'rules' and 'community' of Engeström's diagram acquire particular relevance, with superposed semiotic networks. Procedures, regulations and accepted behaviours in school communities are normally rigid and clearly communicated. School calendars, room bookings, etc., are not among DEMULTS' internal rules, being out of our control, but have a direct impact on the activities. At the same time, DEMULTS has its own rules, being a smaller community contained in the broader school community. This also entails that, although participation in DEMULTS is voluntary, students must opt for one school activity at that time slot, within limited options - they do not have the choice of idle time, for example, or engaging in an activity of their own creation. More often than not, subjects' engagement in activities is enforced by the requirements they need to fulfil to pass grades. DEMULTS can be chosen for lack of interest in other options, besides other

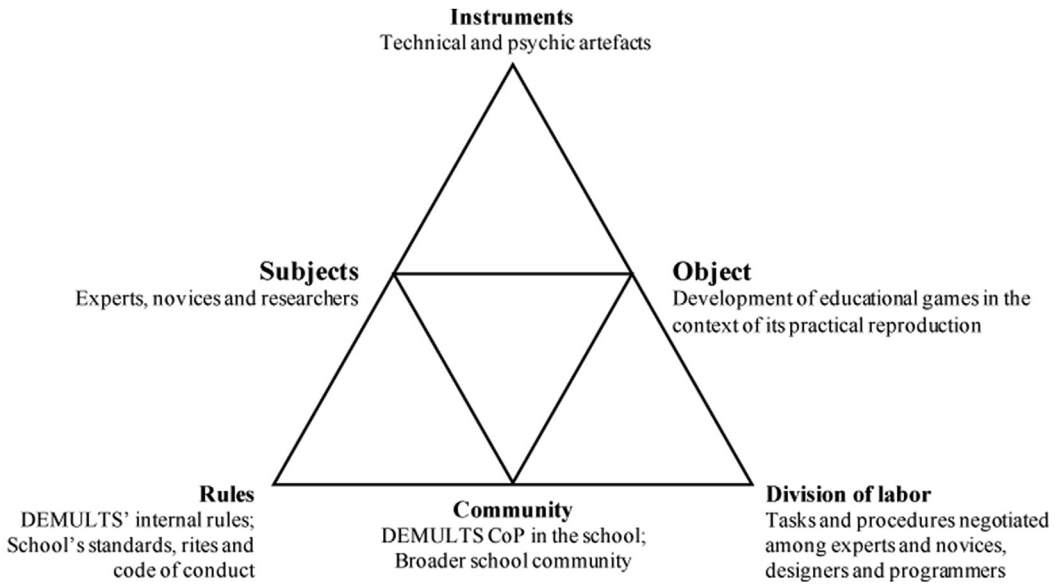


**Fig. 1.** DEMULTS represented through Engeström diagram.

common reasons related to students' behaviour in schools such as affective relationships with peers and preference for activities that supposedly involve minimum effort (Fredricks et al., 2004).

As for the division of labor, the organisation of student designers and programmers, and other arrangements in collaborative actions of novices and experts, emerge internally from the DEMULTS CoP, and not from the broader school community. As the analysis shows later in this article, the profiles of DEMULTS' subjects emphasize different mediation aspects in the process, and these emphases seem to impact directly on their engagement.

On a related note, Fredricks et al. (2004) present three dimensions of student engagement: behavioural (conduct and level of participation in classroom and extracurricular activities, both academic and social); emotional (feelings towards the school, teachers and peers, which may create a sense of belonging to the school community); and cognitive (comprehension of the concepts involved in the activity; desire of learning and going beyond intellectual demands, sought for challenges, self-regulated learning). Although learning - which is the ultimate goal of most school activities - is mostly resultant of cognitive engagement, the three dimensions are clearly intertwined. Fredricks et al. (2004) argue that examining these three dimensions individually is equivalent to separating students' behaviour, emotion and cognition. According to the authors, "in reality these factors are dynamically interrelated within the individual; they are not isolated processes" (Fredricks et al., 2004, p. 61).

Situating the three dimensions of engagement within the frame of Activity Theory, Pontelo and Moreira (2009) suggest that they can be observed at two levels: operational and comprehensive. Engagement at the operational level refers to actions and operations: the characteristics of the actions involved in the activity are key for students' engagement. These characteristics include: balance between actions' level of difficulty and students' abilities; collaborative or individual nature of the action; conceptual domain where the action falls; infrastructure available and others. Engagement at the comprehensive level refers to the activity, i.e. is related to the object of the activity. A comprehensive engagement, for Pontelo and Moreira (2009), implies self-regulated actions, metacognitive strategies, autonomy, investment in learning, and quest for attaining the expected results.

Engagement, in its three dimensions, must also be considered as evolving and mutable as an activity develops. Aligned with the Marxist perspective of Activity Theory according to which subject and object form a dialectic unit, with an inherent potential of change, Engeström's diagram is dynamic in essence. In particular, schools are environments where there is a permanent tension between conforming and confronting (Roth, 2004). Students' engagement is responsive to variations in this environment, changing in intensity and duration as an activity develops: it can be short-term and situation-specific, or long-term and stable (Fredricks et al., 2004).

The research presented in this article takes into account all the aspects aforementioned to analyse the variation of students' engagement in the DEMULTS CoP, and how this mediated learning.

## 4. The structure of a DEMULTS cycle

DEMULTS runs in cycles of 6–8 months, depending on the performance of participants in developing the games. Each cycle will have different participants, but in fixed roles, and four phases, described in this section.

### 4.1. Participants

There are three types of participants in the DEMULTS CoP: novices, experts and observers. Novices are secondary school students who have none or little experience in developing digital games and are recruited in the school where the project takes place. Experts are undergraduate and graduate students in three or more domains of expertise: computer programming, graphical design, and the conceptual domain(s) that the game will address in that particular cycle (i.e. the curricular content). Depending on their profile and interest, experts can be participant researchers, or volunteer practitioners who do not undertake research. The number of experts varies according to the volunteers recruited and the amount of financial resources for student scholarships. Experts are recruited through public calls at the university and selected through interviews and curriculum vitae analysis[1] by DEMULTS' permanent researchers.

Observers in DEMULTS CoP are academic researchers that lead or collaborate in the project. Their interaction with the novices and experts during the activities is minimal, although they are recognised as members of the community, and may intervene if necessary. Their main role is to collect and analyse data.

### 4.2. Phases

Each DEMULTS cycle is composed of the phases shown in Fig. 2. Novices' recruitment takes place in the beginning of the school term. The project is presented at the school for all potential participants and, on the same day, students that show interest are asked to fill a paper form which includes general questions about their hobbies and interests (that implicitly relate

[1] The interviews and C.V. analysis aim at verifying if the candidate has interest and/or experience in academic research and in the respective areas of knowledge. The DEMULTS principal investigator, possibly helped by other collaborators, undertakes unstructured, informal interviews mostly with the aim of getting to know the candidate. These do not have a fixed format, and this is not a formal selection process.

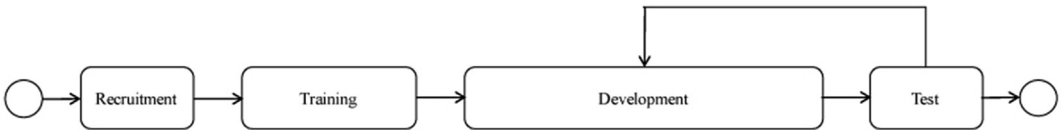


**Fig. 2.** The phases of a DEMULTS cycle.

to the curricular contents of that cycle); an exercise on algorithmic thinking (for example, describe the steps to fry an egg); and the request to draw something specific (like a castle for instance). The answers to these forms serve as a way of doing a pre-selection based on students' interests and their abilities on drawing (potential ability for game design) and algorithmic logic (potential ability for programming).

Finally, the last step of the selection is based on students' performance and engagement in a workshop mainly designed to briefly introduce them to activities and techniques of game development to be used throughout the project, such as brainstorming, storyboard, sketching and low-fidelity prototyping. The students are divided in groups of 5–6 students and have about 2 h to come up with an idea for an educational game. The DEMULTS team takes the students through the quick-and-dirty phases of ideation and prototyping by giving them instructions and time limits, and at the end of the session each group shares what they have produced. This workshop gives students a taste of the project and, besides being a way of selecting students, it is also an opportunity for them to decide if they really want to join. The workshop is usually scheduled for a week or so after the project presentation, depending on the school's calendar and the DEMULTS team's availability. It is important to say that, even after being selected, students are free to accept or refuse to participate in the project, and even if they join, they can still opt out at any time, as long as they enrol in another extracurricular activity offered by the school (following school regulations, they must be involved in some activity during that time slot).

After the group of novices is formed, they are divided in two groups: designers and programmers. This simulates professional environments of game development, where teams are mainly composed by people with these two expertises. In addition, it would not be viable, within the timeframe, to expect students to learn both graphic design and programming and develop a game. The group division is made according to students' preferences and abilities in drawing or in algorithmic thinking, pre-identified in the selection phase.

In the training phase, both groups are given basic training on the software tools they will be using to develop the game. Programmers are presented to the Stencyl[2] environment for end-user programming, with demonstrations of how to use the software, introduction to algorithmic thinking for problem solving, and lessons on the basic structure of the visual programming language and on how to use its components to build the code. In parallel, in a separate room, designers are given lessons on how to use the Inkscape[3] tool for creating the game scenarios and characters, including basic tools like pencil and brushes, vectorization, colour grids and perspective. All novices also attend a workshop on the basics of digital games (mechanics, characters, narrative, etc.) and game design, which comprises theoretical explanations and practical activities that develop further the techniques they experienced in the first workshop during the selection phase. All workshops are conducted by the experts in DEMULTS team. The goal of these lessons is to give novices a general idea of the tools and get them started in the process. It is expected that they will learn much more throughout the remainder of the cycle, through practice and interaction with experts. In the cycle analysed in this paper, the training phase lasted for one month, with one-and-a-half-hour meetings twice a week.

The longest phase of DEMULTS (development) thus consists of programmers and designers, novices and experts, interacting in one-and-a-half-hour meetings twice a week, at the school, to develop a digital educational game. As each DEMULTS cycle targets a specific school subject, the team must choose a curricular item within that subject to address, and integrate it into the game narrative. Domain experts have a key role in helping novices to select curricular contents and integrating them to the game narrative, while experts programmers and designers guide the novices in the development of code and production of images for the game interface. The procedures and characteristics of the expert-novice interaction vary according to needs, context and personalities. Overall, the novices are aware of their objectives and seek expert's help as they feel the need when working on their activities of game development, while the experts supervise their work, give guidance, instructions, and sometimes practical help in writing code or drawing characters and scenes. This phase is the most variable in length, due to the many factors that determine the progress of game development. In the cycle analysed in this paper, it took five months. Also in this cycle, each student received an educational notebook computer from the school to develop the activities (they were also allowed to take the computers home).

The last phase of DEMULTS consists of testing the games with peers that are not in the project, and making adjustments if necessary. The tests are planned collaboratively by the community, based on user tests techniques from the field of Human-Computer Interaction, and conducted by the novices, with the support of experts if necessary only. In the cycle analysed in this paper, there was only one meeting for user testing, and the method used was thinking aloud, where the users played the game freely and were encouraged to say out loud what they were thinking. Novices made notes about the users' difficulties,

[2] http://www.stencyl.com/.
[3] https://inkscape.org/en/.

impressions and opinions, but no quantitative metrics were used. Derived adjustments were made by experts during the following month, as we decided to end the cycle with the beginning of school holidays and thus there were no more meetings to assist novices in further programming.

## 5. Method

Our research is aligned with an interpretivist epistemological perspective, according to which meaning is not an absolute entity to be unveiled, but is constructed by people based on their context and cultural background (Schwandt, 2003). In other words, we believe that researchers' previous knowledge, even if subconsciously, affect and inform the research (Dey, 1993), and research findings represent a combination of the understanding of the researcher and of those being researched. The researchers themselves are data-construction instruments, whose skills of listening, observing, and understanding are crucial (Rubin & Rubin, 2005). Within this perspective, scientific rigour is obtained through a solid link between theoretical interpretations and empirical data, provided by appropriate methodology (Laperrière, 1997), which seeks systematic knowledge of the empirically valid (Pires, 1997). In this sense, we state our choices, theoretical beliefs and values to allow a proper contextualization of the results. The results in this paper correspond to the latest DEMULTS cycle (August 2015–April 2016).

### 5.1. Participants

Participants of the cycle analysed were: six experts (five undergraduate students and one graduate student); two observers (project researchers); 19 novices[4] (10 girls and 9 boys, average age of 15–16 years). The experts were: an undergraduate student-teachers in Mathematics and another one in Language - Portuguese (which were the themes of this cycle's two games); an undergraduate student-teacher in Biology who had taken part in the previous cycles and acted as a project manager; an undergraduate student-teacher in Computer Science; an undergraduate student in Design; a master student in Computer Science who was performing his field research as a participant observer in DEMULTS. The observers were two university researchers from the fields of Psychology and Education (project leader) and Human-Computer Interaction (project collaborator).

All novices were in their second-last year of secondary school. They were informed that DEMULTS is a research project and had their participation formally authorised by a parent or legal guardian, through an informed consent form. Anonymity of participants is guaranteed.

### 5.2. Data collection

Participant research was undertaken by experts and observers of the DEMULTS research team, in the school context. Data collection followed an ethnographic approach with participant observation (Atkinson & Hammersley, 1994). This method enables researchers to observe a group of people and the activities within this group in its natural environment, while engaging in them. It requires a systematic description of all the events occurring in the observed community, providing the observer with a "written photograph" of the studied group (Erlandson, Harris, Skipper, & Allen, 1993) apud (Kawulich, 2005). From a broader ethnographic perspective, the aim is to characterize the structural organisation of participation in DEMULTS that enables subjects to construct meanings and abilities by actually engaging in the CoP. So, observations focus not only on the relevance of different aspects of the activity, but also on how these aspects are organised in the community and mediate novices' actions.

There are several records of data in DEMULTS: field notes; photographs; videos of relevant parts of the activities and of semi-structured interviews with novices about specific topics of investigation; online questionnaires at the beginning and end of the cycle, where novices are asked for their expectations, feedback and opinions; and posts in DEMULTS' two closed groups in the Facebook social network (being one for the whole group and another for the experts/researchers exclusively). The analysis presented in this article was based on: field notes describing the activities, including novices' actions and operations, at each meeting of the CoP; Facebook posts with researchers' discussions and comments about the meetings and the development of the project; and online questionnaires distributed to the novices after the initial workshop phase. These questionnaires covered topics such as: personal interests and life goals; expectations about the project and own trajectory in the project; reasons for interest in the project; likes and dislikes about the project so far; and relationship with peers and in the school in general after joining the project. Photographs of novices and experts in the meetings and novices' contributions in the Facebook group aided to fill in some gaps in the data (e.g. novices sharing their work in the social network).

[4] These 19 novices are those who remained until the end of the cycle, from 30 students initially selected. We do not have enough data to analyse the dropouts, but they include: students who never actually joined DEMULTS; students offered scholarships to join other projects; students with poor performance in mandatory school subjects that had to attend extra classes at coincident times; among others.

### 5.3. Process of analysis

The analysis of novices' engagement was oriented by Activity Theory, in particular the relationship between DEMULTS' main object (the development of an educational game) and the individual needs of novices in the CoP. However, it is important to note that the activity analysed carries historical and collective meanings, permeated with ambiguities, surprises and resistances (effects of systemic contradictions). As discussed previously, the subjective issues and particularities involved in the meanings that each individual conveys to the collective activity indicate that the analysis of their engagement must consider not only their particular needs, but also the organisational phenomena, related to the social group, the community in a broader sense (i.e. the school), the CoP specific of DEMULTS, division of labour, rules and instruments of mediation. More specifically, the analysis has as premises that when individual needs do not coincide with the object of the activity, the object cannot be characterised as a motive, and subjects focus on their actions (engagement at the operational level) instead of the overarching activity (engagement at the comprehensive level) (Pontelo & Moreira, 2009). On the other hand, engagement at the comprehensive level represents greater and more meaningful participation, which in the community of practice corresponds to a movement of the novice from the periphery to the centre of the activity, closer to the position of an expert.

The unit of analysis was the meaning of individual actions/operations and their practical relationships within the motivated activity, including technical artifacts and the cultural organisation of the process. Such meanings are distributed and interpreted from several sources: posts and comments in the social network; meaningful chunks of field notes (i.e. describing an episode with a novice or a group of novices); and novices' answers to each item of the questionnaires. The data were compiled in a separate file, organised chronologically per novice, so that evidences of engagement could be identified for each individual (i.e. aspects that have positive or negative influence on novices' engagement throughout the project). Analysis of this textual data (supported by photographs for contextualization only) was performed by the first author of this paper, discussed with and revised by the other authors.

The meaning of actions were analysed in terms of the main theoretical underpinnings that support this paper: dimensions of engagement (Fredricks et al., 2004); novices' needs within the context of the activity and its object (Leontiev, 1981); and roles, collaboration and contradictions within Communities of Practice (Lave & Wenger, 1991). This analysis of the trajectory of each novice throughout the project, from the initial questionnaires, through the workshops and following meetings, revealed patterns in behaviour and engagement among novices that indicated four groups with similar characteristics. To present these four groups and discuss their implications, we opted for the format of personas (Cooper, Reimann, & Cronin, 2007), which are archetypes based on observed behaviours that convey the fundamental characteristics of a group of people that are relevant for the context in study. In other words, personas are fictional characters based on real people. They are commonly presented in a narrative style, whose flow includes people's attitudes, feelings, opinions, activities, and so forth. Very popular in the field of Human-Computer Interaction, personas help researchers by providing embodied and concrete references of the people they are studying and developing for. In this paper, the four personas help us presenting novices' situated action, in relation to the activity, and discussing it in the light of the theoretical underpinnings aforementioned.

## 6. Results and discussion

Four personas emerged from data analysis: Agatha, the team player; Julie, the task-accomplisher; George, the self-centred; and Alan, the time-killer. In this section, each persona's description is followed by a discussion that relates individual needs, object of the activity and engagement, in the context of Communities of Practice. Novices' needs that were not specific of a persona are discussed in the last part of the section.

### 6.1. Novices' personas

#### 6.1.1. Agatha, the team player: "you girls are gorgeous, and you can do it!"

At the beginning of the project, Agatha says she likes DEMULTS very much. She bought a notebook to be used exclusively for the project and asked for an expert's help to organise a timetable to keep track of the phases of development and tasks of all members. She takes the initiative to make records of group discussions and decisions, for example using the audio recorder of her mobile phone. Sometimes, she stays after school hours to discuss possibilities and ways forward for the game with other members. She is emotionally involved and often gets joyful and excited about the project and its possibilities. However, meeting after meeting, she worries about the progress of development and the scope of the game, and is aware that it will not be completed unless each member does their part. Therefore, Agatha gets frustrated as not everyone demonstrates the same level of commitment as herself. She complains that peers do not perform their tasks, do not share their productions, and do not communicate properly, making the project drag itself. She puts effort into doing her part of the game production - which is not easy either! - and sometimes she feels isolated and overloaded with work and responsibilities. The school infrastructure does not help either: more often than not, the Internet does not work and they cannot search for needed information, or upload and download the group's productions from shared repositories. Entire meetings have turned out unproductive due to the lack of resources. As time goes by, Agatha gets quite tired of trying to get things to work out. So, near the end of the project, realising that the game will not be finished, she loses interest in the activity. Why bother, anyway?

Eight out of 19 novices were identified as team players. Team players are novices whose needs are mainly related to the progress of the CoP. They are motivated by the need of attaining the object of the collective activity, i.e. developing an educational digital game. Thus, they engage at a comprehensive level and take on the role of leader or enthusiastic collaborator. Team players are motivated by community interest and a kind of moral obligation (Wasko & Faraj, 2000). They behave pro-socially most of the time, and their compensation is the satisfaction to see the progress of the work. They present strong emotional engagement, mainly perceived through their sense of belonging and the variation of their emotional state between extremes of excitement and frustration according to the progress of the work at each meeting. According to Etzioni (1988) apud (Wasko & Faraj, 2000), people with this kind of motivation are willing to work harder and are more likely to persevere in the face of adversity than people acting out of self-interest. However, as demonstrated by Agatha's story, disengagement of team players in DEMULTS does not come from the distance between individual need and activity's object, but from the failure of the CoP to meet their personal expectations - in other words, the disbelief that the CoP can reach the object of the activity in due time. Team players' disengagement indicates that they have quit persevering and lost hope in the capability of the collective activity in the CoP.

Fig. 3 illustrates the team players' immersion in DEMULTS. The circle on Engeström's triangles indicates the extent of this persona's situated action and consequent engagement. Team players engage at the broad level, including subject-object, subject-community and object-community mediations.

*6.1.2. Julie, the task accomplisher: "what am I supposed to do, again?"*

Except when she is in a particularly bad mood, Julie is willing to collaborate. She joined the project because it seemed a good opportunity to do something different and learn new things. As the project develops, Julie mostly expects that someone will tell her what to do, because she is not aware of the progress of the team as a whole. Sometimes because she does not understand the whole thing very well, other times because she does not care to try. Julie does not see herself as one of the best members of the team, so she prefers to wait for the tasks to be given to her, and tries to accomplish and deliver them satisfactorily. She believes that this strategy will make her complete her mission. She can be a busy bee, but if nobody gives her any work, Julie might as well do other stuff, or give a hand to a friend. She hopes the team will reach its goal and she is happy to help, but she needs not worry too much - someone else will!

Five out of 19 novices were identified as task accomplishers. Although they contribute to the work of the CoP, their individual actions are less engaged than the team players'. Furthermore, they mostly engage at the operational level, performing actions whose results will be dealt with by others: they do not necessarily make the connection of their actions to the overarching activity (the development of the game as a whole). Their needs are harder to perceive from field notes, but could be derived from the initial questionnaire, and include: learning skills involved in developing a digital game; building a good game; being with friends; trying something different out. Task accomplishers' engagement clearly varies according to the extent to which the activity is allowing them to satisfy their needs. Thus, engagement decreases, for instance, when: they are not able to learn programming in the short-term; the game is not turning out as expected; or for social reasons like the absence of their friends, and boredom as novelty fades.

As illustrated in Fig. 4, the level of immersion in the activity, in the case of the task accomplishers, is not sufficient for the emergence of the particularities and rites of DEMULTS as experienced by the team players. They also avoid meaningful

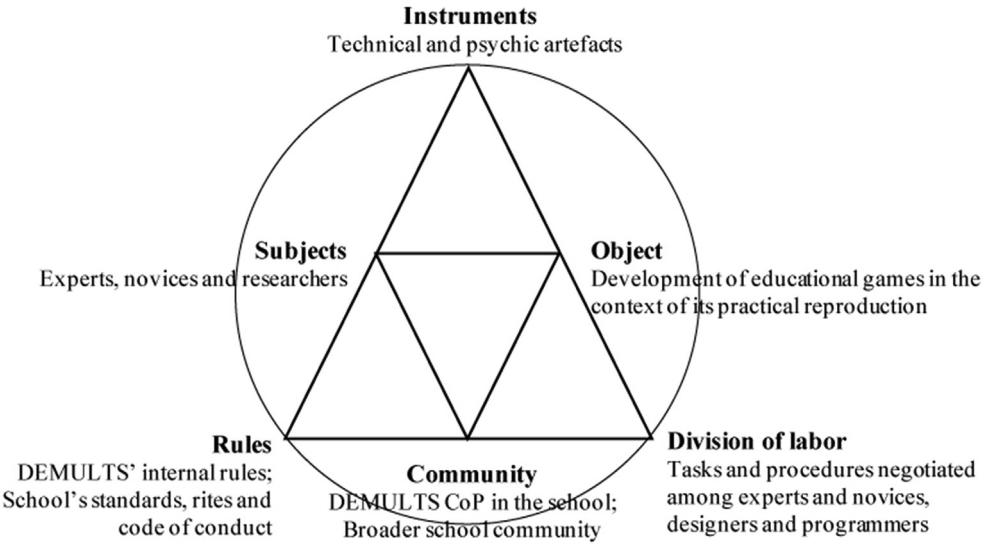


**Fig. 3.** Team players' situated action in terms of Engeström's diagram.

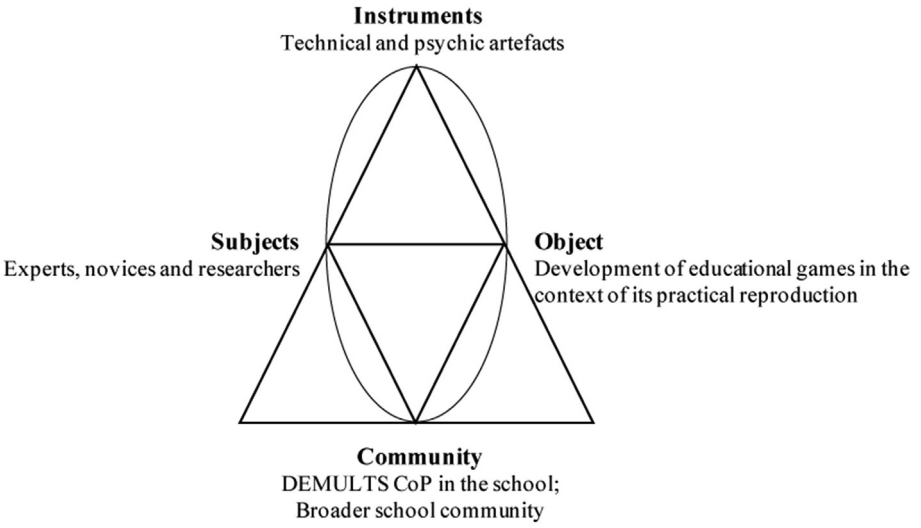


**Fig. 4.** Task accomplishers' situated action in terms of Engeström's diagram.

involvement in the negotiations of labor division, waiting to be told what to do, i.e. they only receive the results of such negotiation. Although their needs may relate to the object of the activity (development of educational games), these subjects are not behaviorally and emotionally involved in the activities that provide full engagement in the CoP.

*6.1.3. George, the self-centred: "my own game phase is awesome!"*

George is eager for knowledge that helps him achieving his personal goals. He joined the project to learn how to develop games. It's an opportunity to acquire skills that will be useful for him to develop his own game and, who knows, found a startup company in the future. So, George is focused on doing his own thing. He arrives early at the meetings, sits somewhere quiet, and works preferably by himself, or with the company of a good buddy who will not get in the way. He loves that feeling of self-pride and satisfaction whenever he overcomes a challenge. He wants to excel. He wants the game to be really good, not just some school project. He'll do his best for that, regardless of how the team is going, and might even do some tasks that are not his responsibility. Peers know that George is good, and he knows they talk about it. Deep inside, George believes he can do the whole game on his own, and wishes this was an option.

Three out of 19 novices were identified as self-centred. Self-centred novices are totally driven by personal interests, which are, in theory, compatible with the object of the activity. Their main need is to learn as much as they can in the CoP, so that they can use this knowledge for their own side projects. In addition, they need to feel that the product to which they are contributing is good enough, according to their own judgement. They become recognised as experts-to-be in the community, closer to the centre of the activity. On the other hand, being self-centred make these novices engage at an operational level: they have a vague idea of the progress of the project as a whole, but their attention and efforts are focused on the task they have set for themselves.

Despite being motivated by intangible returns such as reputation and status in the community, self-centred novices possess an intrinsic motivation that makes their cognitive, emotional and behavioural engagement less susceptible to variations in the community, and more dependent on the means that are available for them to satisfy their own needs. So, the self-centred novice will disengage in two situations: when they realise the CoP cannot help them learn what they want; and when they judge that the product that will be the result of the work of the community does not come up to their standards. In other words, although their needs remain compatible with the object of the activity, this does not guarantee that the CoP will be a profitable environment in the opinion of these novices.

Fig. 5 illustrates how the self-centred persona moves away from the CoP aspects, ignoring division of labor and DEMULTS rites and rules, to focus on their individual actions in detriment of the collective ones, seeking to fulfill their own personal needs.

*6.1.4. Alan, the time killer: "I'll show you what my talented friend has done"*

Since the beginning of the project, Alan feels lost. He joined out of peer pressure, to be with his best mates. They seem pretty into it, but Alan never really connected with the project. However, he thinks that leaving will be worse, as he will have to opt for another school activity, by himself. So, his strategy is to remain as unnoticed as possible. He wanders through the meetings, and makes sure to have something to show if an expert asks him - even if it is not something he did. Alan shows just enough enthusiasm for the project in front of the experts so that he can get away with it. Still, he gets in trouble sometimes when he is put in a position where he must discuss responsibilities with peers. Other than that, he hangs out with his friends.

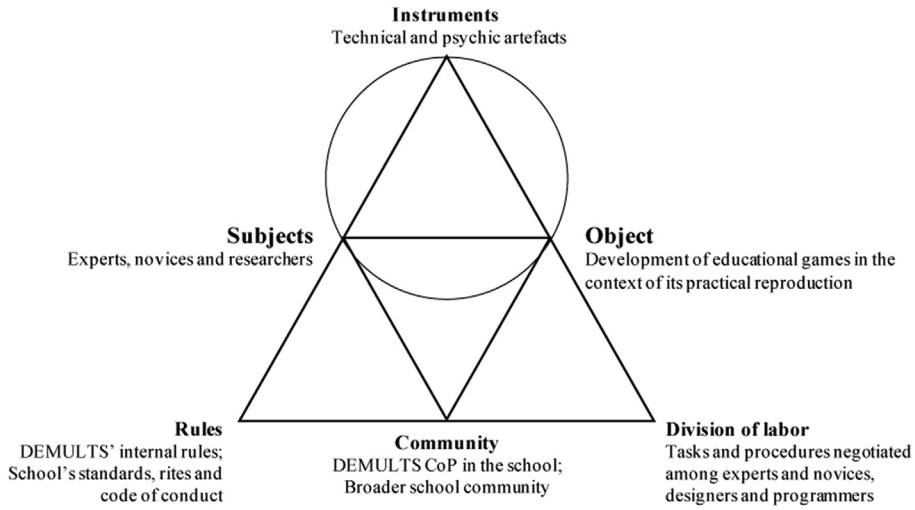


**Fig. 5.** Self-centred's situated action in terms of Engeström's diagram.

Three out of 19 novices were identified as time killers. Their need is not at all connected to the object of the activity: they just need to get to the end of the project, together with their friends, having thus accomplished a school activity, and proceed to the next school term. Therefore, time killers may present some emotional engagement as they seem very attached to the company of friends, but this is not sufficient to make them actively participate in the project. They do not take responsibility for activities, and will only collaborate with the work if they are enforced by the experts in the community. Although this could be considered a minimal operational engagement, the time they dedicate to the work is very brief, only sustained in the presence of the expert. In this case, the experts find themselves more in the traditional/instructional position of school-teachers, in surveillance and forcing students' work, than as members co-participating towards a common goal. The concept of the CoP itself is broken: the novices are not moving towards the centre of the activity, but rather remaining in a peripheral position.

Fig. 6 shows the time killer persona's actions situated within the community, taking into account the rules involved. However, for the time killer, the emerging aspect of the subject-community mediation is mainly related to the broader school community, as opposed to DEMULTS' particularities. This drives the object of the activity away from the time killer's actions in the process.

### 6.2. Transversal needs

Two main general needs were identified that cut across the personas described and deserve a deeper discussion: the expectations around the game to be developed, and the desire to learn. These needs reveal general motivations of the CoP, verbalised or demonstrated by the majority of novices.

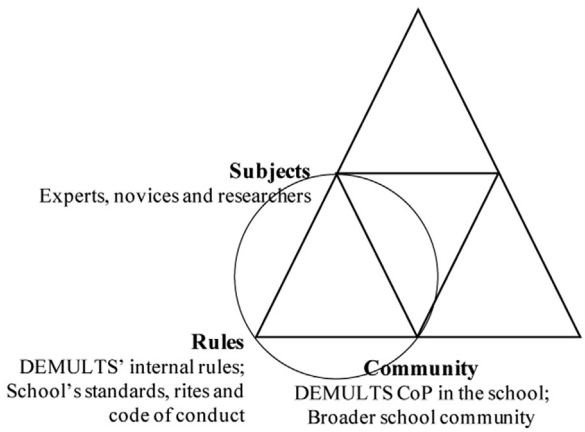


**Fig. 6.** Time killer's situated action in terms of Engeström's diagram.

When novices were first told about the project, they joined with high expectations that the game to be built would be played by people 'in the real world', being publicly recognised as good and fun. When asked about their expectations in the project, novices said they expected “that my game will have the appreciation of the general public”; “that at the end we are together and have developed a good game”; “that most gamers like the game we create”; “that our game will be among the top downloads”; “having developed a game that is appealing and fun”.

However, above the dream of becoming the creators of a successful game, the main need of novices perceived from the questionnaires was learning, per se. Novices expected “a new way of learning”; “to acquire more knowledge”; “to acquire experience and knowledge”; “what I really seek is knowledge”; “to broaden my knowledge in Computer Science”; “to get to know programming”; “to learn what it takes to build a game, because I have no idea”; “being able to create a game has always been my dream”; “be a great designer”; “learn by creating and having fun”.

In theory, these two main needs of most novices in the CoP should be met by the object of the activity, i.e. developing an educational digital game. Nevertheless, along the way, several barriers drove these needs apart from the object of the activity, and thus led to novices' disengagement, associated with the realisation that it is very hard to create a good and fun game: it takes a lot of effort, and the result may not live up to expectations. Novices got themselves to believe that the CoP, with its experts, would be an environment that would somehow easily allow them to produce games with a level of quality comparable to the games they download and play. However, when they found themselves with the responsibility of having and organising ideas and transforming them into code and interfaces, they realised the process would be much harder and complicated. One of the most exigent novices became very frustrated with the quality of the game they were producing: “I don't see any progress there. I look at the game we're doing and then I look at this [a professional game on the computer] and I … I want to quit DEMULTS”.

The two main problems faced by the novices in the process of developing the game were: the lack of knowledge on the educational content they had to address in the game; and the difficulty that several of the programmers had in learning programming in the short-term (more than the designers).

Regarding the first problem, experts in the educational contents addressed were present to help the novices, but were not expected to give ready solutions. The novices had to research and study about the topics autonomously - which barely happened. They were not motivated to do so, and insisted on trying to build the game while lacking comprehension of the contents. In particular, one of the self-centred novices, who was very keen on developing an outstanding game, could not be convinced that a good game could contain educational content, and put a lot of effort in trying to escape such obligation, as can be seen in the following statement taken from a Facebook chat with the Maths expert: “We must rethink the gameplay, to make the game fun. What's the use of a good narrative, if the game is boring? You must be thinking that I don't care about the Maths involved. You're right, I don't”.

The 'educational' nature of the game, therefore, was an aspect of the activity that was not compatible with novices' needs. They wanted to learn different things, like programming and design, or supposedly fun things, like building a game, but they did not want to learn Maths or the structure of a language, which were the curricular contents chosen for this cycle of DEMULTS. In this sense, it is important to say that in this cycle, the curricular subjects of maths and language were imposed by the researchers, as they resulted from a negotiation with international partners that will replicate the project. On the other hand, students were aware of the subjects since the presentation of DEMULTS to the general school audience. Above all, this result indicates that enforcing the integration of curricular contents into the games has not, in the cycle analysed, achieved the goal of making students learn 'naturally' or motivating them to seek that particular piece of knowledge.

A second barrier was the learning of programming, desired by many, but achieved by few. Even using a simplified language through the Stencyl tool and end-user programming techniques, the process proved very hard. Learning how to program is known to involve high levels of complexity (Caspersen & Kölling, 2009). Novices complained that the time available for the activities was too short, as well as the duration of the project, to allow them to program a real game. Novices with no previous experience on programming progressed slowly and presented a strong dependence on the programming experts. This was clearly perceived from the constant calls for help and questions for the programming experts (“what do I have to do now?”), as well as complaints whenever they walked away (“where is he, now that I am making some progress here?!?”; “we need you and your intelligence!”). The level of difficulty of the tasks to be performed seemed too high for the novices to reach, and they started to feel they were not capable of achieving (“we have a problem here, the computer is slow, just like me”; “I fear we won't be able to do this. I don't believe we can … ”). To worsen the situation, some of the initially assigned programmers gave the role up and engaged in ideation and content generation, which reduced the team (as no one migrated to the programming team). Learning how to program is deeply related to developing computational thinking, considered one of the necessary abilities of the twenty-first century (Wing, 2006). However, analysis showed that this learning process still demands a lot of research and better comprehension on how to structure effective learning opportunities.

The difficulties with programming and developing a good game put most novices in a position where they were not learning what they expected to (so their need for learning was not being met), which caused a feeling that they were “wasting their time”, and that the project was “useless for their future”.

On the other hand, at the end of the cycle, when asked about the project through a second online questionnaire, novices demonstrated a much more optimistic perspective that their behaviour during the project conveyed to the researchers. All seven novices that answered the questionnaire said that DEMULTS helped them to learn programming or design and the school subjects involved in the game. Six of them said the interest in these subjects increased with the project (while one said it did not change, but she liked the subject previously). Novices said that they remained in the project for: curiosity about how

a game is made; interest for programming and games; interest for learning more; affective relationships with experts; the opportunity of being part of an amazing project; and “seeing the end of it, where it was leading to”. They also declared that they developed more patience to solve problems; more responsibility and focus; and better attitude in group work. When asked about what they did not like in DEMULTS, one novice said: “there was nothing I didn't like. I loved it all.”. And the only two other responses for this question were “it was a bit hard at the beginning”; and “the time was too short”.

## 7. Final considerations

The historical-cultural perspective from the beginning of the twentieth century, along with more recent contributions from Activity Theory, distributed cognition and situated action are at the basis of the central idea of the present work: cognition exists in the interaction between mind and context, being linked to specific situations where it emerges.

The activity structured in DEMULTS, in the form of a Community of Practice in an educational context, points to a valid form of learning through interaction between veterans (experts) and beginners (novices), which leads to learning based on co-participation, moving away from traditional models of formal instruction where students are mostly passive. The proposal of working with ICT in the school context in a way that promotes students' engagement in a process of development of digital educational games seems to broaden the view according to which the great value of educational games lies in their ludic aspect.

Engagement was identified in DEMULTS CoP as a key component to be analysed in order to reach better comprehension of how to promote learning in this particular context. The choice to structure the project as a CoP means that without engagement, learning does not occur and tangible goals (like the production of the game) are not achieved. It is thus fundamental in the context of DEMULTS to keep novices engaged.

Qualitative analysis of engagement revealed patterns in the data that indicated groups of novices with similar needs. Each group was motivated by different aspects within the CoP, and therefore engaged at different levels according to the nature of the tasks to be performed, interaction with peers and experts, and personal expectations, among other factors. In more technical terms, the level of engagement varied according to the extent to which the object of the activity (development of an educational digital game) and the dynamics of the CoP met the needs of the novices.

Transversally to novices' profiles, the most striking results relate disengagement to frustration of personal expectations of two kinds: the dream of being the creators of a fun, successful game; and the desire to master design and programming skills in the short-term. On the one hand, novices seemed to build too high expectations from the project description, which they slowly came to realise were not attainable in the short-term. On the other hand, the format of the project may need adjustment, as the tasks to be performed by novices in order to reach the common goal presented a level of difficulty too high for the short time available.

In addition, although this could not be covered by the present analysis due to scope restrictions, novices' engagement in DEMULTS also suffered the consequences of external ruptures, such as infrastructure, school holidays, period of exams and general school events, and lack of support from the school administration. Infrastructural problems, for example, interfered by hindering online research due to the frequent lack of Internet connection; making novice's work harder due to the computers' technical issues; and causing demotivation due to the lack of physical space for the meetings. Furthermore, many events took place at the school during the semester that interrupted DEMULTS activities, such as sports tournaments, commemorative dates, or week of exams. This indicates the need to bring into future analysis aspects pointed out by Engeström: rules and environmental characteristics of the school, instruments and artifacts, and labour division. Some of these aspects also relate to a temporal analysis of engagement, e.g. it was noticed that engagement levels dropped considerably after a month of school holidays.

Other future work includes a formal analysis of subjects' formation of personal identities within the CoP - which can help identifying how individual needs can be better met to sustain engagement; and restructuring of the technical flow of phases of game development, in order to: (i) provide a clearer picture of the process as a whole to novices - so that they know where they are going and adjust their expectations; (ii) better support novices in their tasks, by providing well-defined artifacts of team communication, storage and sharing of productions; and (iii) increase autonomy (and consequently, engagement) by promoting novices' empowerment, as a way to force them away from the traditional teacher-student authoritarian hierarchy that they still reproduce in the interaction with experts.

Analysis showed the complexity of promoting engagement in educational contexts, even in the scope of a project that breaks paradigms to try and become more interesting for learners. Although there is no magical solution to be derived from this article, its main contribution is to point to promising directions to be pursued in the road towards improving education.

## Acknowledgements

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