Individual and Collective Activities in Educational Computer Game Playing

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Abstract

The Fifth Dimension is an afterschool setting where collaborative learning is organized around computer game playing. Learning and cooperation in the Fifth Dimension are analyzed in the paper from the point of view of Activity Theory, a conceptual approach originating from Russian cultural-historical psychology. It is proposed that the mechanisms underlying the influence of social context on learning and development are mutual transformations between individual and collective activities. Three distinct phases of intersubjectivity "life cycles" are identified: (1) external coordination of individual activities, (2) emerging group identity, and (3) transfer of group experience to individual activities. Implications of the study for design and evaluation of CSCL environments are discussed.

Keywords —activity theory, computer games, educational setting

The social nature of learning: Implications for CSCL

There are two distinct (though not mutually exclusive) views on the role of social context in human learning and development. According to the first view, learning is an entirely individual process which can be facilitated or inhibited depending on how individuals interact to each other. For instance, the need to communicate an understanding of the problem at hand to other participants in a joint problem solving can force people to formulate their ideas more carefully and, thus, improve reflection and planning (cf. Blaye & Light, 1995).

The second view holds that social context cannot be reduced to a set of external "modifiers". It advocates that individual learning and social interactions are different aspects of the same phenomenon. This view is often associated with Vygotskian notions of "inter-psychological" functions and the "Zone of Proximal Development" (or ZPD, Vygotsky, 1978), which are becoming more and more popular in the field of CSCL (e.g., Kaptelinin, in press; Koschmann, 1996, O'Malley, 1995). Vygotsky claimed that there are always two steps in acquiring a new ability: first, the ability emerges as distributed between people (i.e., it exists as an "inter-psychological" function) and, second, it is mastered by individuals (i.e., it becomes an "intra-psychological" function) (Vygotsky, 1983).

Having acquired a new ability, the individual can contribute more to socially distributed processes. Therefore, intra-individual and inter-individual functions mutually constitute each other. In other words, not only does collaboration between the learner and other people change some pre-existing individual phenomena, but it also directs and shapes both the general orientation and specific content of individual development. Participation in a collective activity lays the foundation for the next step in individual development or, according to Vygotsky, creates the Zone of Proximal Development, which is defined as "the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky, 1978).

Undoubtedly, these ideas have profound implications for education, including those related to development and implementation of computer-based environments intended to support collaborative learning. The attempts to apply these ideas in the field of CSCL

have revealed, however, the need for a more specific and concrete understanding of the mechanisms underlying learning within the Zone of Proximal Development (e.g., Kaptelinin, in press). Vygotsky's original definition of the ZPD allows for different interpretations (see Valsiner, van der Veer, 1991), which imply different strategies for creating computer-based environments for collaborative learning.

In an earlier paper entitled "The Zone of Proximal Development: where culture and cognition create each other" Cole (1985) discussed the unique role of the Zone of Proximal Development as a mediator between individual and social phenomena. According to this analysis, the notion of ZPD can help to bridge the gap between the individual and the social by introducing a mechanism of their mutual determination. In the present paper we elaborate on this idea by bringing in concepts from Activity Theory, developed by Vygotsky's disciple Leontiev (1978), as well as empirical data collected within the Fifth Dimension project. From our point of view, these data may indicate some specific ways individual and social phenomena mutually determine each other.

The rest of the paper is organized into four sections. The first two sections are brief overviews of, respectively, main concepts used in this paper and of the Fifth Dimension project. The third section introduces the "life cycle" of the individual/ social dynamics in the Fifth Dimension and illustrates it with a number of examples. Finally, the fourth section focuses on the implications of the study for Computer-Supported Collaborative Learning.

Individual and collective activities

According to Activity Theory (Leontiev, 1978), human mind can only be understood within the context of interaction between individuals ("subjects") and the world ("objects"). This interaction takes place at three hierarchical levels: (1) activities, which correspond to human needs and are directed towards objects (i.e., "motives") which can fulfill those needs, (2) goal-oriented actions, which should be carried out in order to achieve a motive, and (3) situationally determined operations, which should be performed to attain a goal. In human activities motivation, emotions, goal setting, cognition, and motor processes are integrated into coherent wholes.

Two main ideas are underlying Activity Theory. First, the mind does not exist prior to and without activities, but develops as a component part of human interaction with the world. Activities constitute individuals as subjects by situating them in the objective world. Second, activities are social in nature. They are determined not by the straightforward logic of biological survival, but by various aspects of the social environment, for instance, norms, routines, expectations, etc., of a specific culture.

There has been a growing interest in Activity Theory in such diverse areas as developmental work research, industrial design, human-computer interaction, and education, including CSCL (see, e.g., Favorin, 1995; Teasley and Roschelle, 1993)

Originally, Activity Theory was developed as a psychological approach dealing almost exclusively with individual activities (Leontiev, 1978). However, there have been several attempts to extend this approach to cover activities of supra-individual entities, for instance, groups, organizations, and communities, as well (e.g., Engeström, 1992).

So far, there has been little overlap between studies of individual and collective activities from the point of view of Activity Theory. A possible explanation of this gap could be that these two orientations are associated with two levels of analysis and deal, in a sense, with two different realities (cf. Leontiev, 1978). From our point of view, this explanation is valid, but only to a certain extent. It does not rule out the need and the possibility to study how individual and collective activities interact to create each other. Such interactions can take place at either individual or supra-individual levels. For instance, an information system can fail even if it fits into the general structure of an organization. If people using the system see it as a threat to their own interests, the system will most probably be rejected (see Grudin, 1988). On the other hand, differences between individual and collective activities seem to exist within the subjective plane, too. Requirements and demands related to participation in a collective activity may come into conflict with personal goals and motives of the individual. In our view, such conflicts and their resolution can partly account for learning within the Zone of Proximal Development. In particular, such conflicts can result in a revision of individual values, goals, and strategies at the same time that it creates new forms of joint activity.

To sum up, our hypothesis about the mechanisms underlying ZPD is based on the assumption that learners are simultaneously involved in two hierarchies of actions. On the one hand, they pursue their individual goals, and, on the other, together with other people they strive to formulate and achieve goals of collective actions. These hierarchies have to overlap, so that some goals belong to both of them; otherwise people would not participate in collective activities at all. This overlapping, however, cannot be complete, so the learner has two (or more) potentially conflicting perspectives. Such contradictions can be a driving force behind emergence of new individual activities, actions, and operations[1] . This hypothesis will be discussed and elaborated on below on the basis

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[1] These contradictions do not necessarily take the form of a conflict. The learner, for instance, can simply extend his or her repertoire of activities.

of empirical data collected within the Fifth Dimension project.

The Fifth Dimension Project: An overview

Objectives.
The Fifth Dimension project was initiated in 1986 as an alternative to the technology-centered approach to educational computer use dominant at that time. The focus of the project was not on technological innovations but on the social context of the use of technology which would provide optimal conditions for children's learning and development (Nicolopoulou, Cole, 1993) Sustainability was one of the guiding principles of the project from the outset; an explicit goal was to design a generic social setting which can potentially be incorporated into existing institutions and can survive without special support from researchers. Computer tools -- more specifically, educational computer games -- were considered as just a component of the target system. Creating an educationally beneficial computer-based setting for children was not the only purpose of the project.

Setting design.
The target setting was designed as a "model culture," it has its own rules, norms, artifacts, and mythology. Collaborative computer game playing is the central activity in the setting. This activity is regulated by a set of specially created artifacts, including (a) "task cards," which structure the game playing process and emphasize the educational component of game playing by offering additional game related tasks and stimulating writing and reflection; (b) "the consequence chart," which determines game playing sequence by providing the child with a choice of available games after a certain performance level in a certain game is achieved; and (c) "the Constitution of the Fifth Dimension," which contains the basic rules of the setting. Children are supposed to play together with undergraduate students attending the site. To minimize the power differences between the children and the adults in the Fifth Dimension, a mythical figure of "the Wizard" was introduced into the system. All the conflicts between the Fifth Dimension "citizens" can only be resolved by the Wizard who can be contacted via email.

Games
A wide variety of computer games is used in the Fifth Dimension, including knowledge games (e.g., the "Carmen Sandiego" series), simulation/ modeling games (e.g., "SimSity", "Designasaurus"), drill-and-practice games (e.g., "Word Munchers"), logical games (e.g., "Pond", "Gerthruda's Puzzles"), math games (e.g., "Shark"). Even arcade-style games (e.g., "Choplifter") proved to be beneficial when used in an appropriate context. For instance, task cards associated with each game often require that children describe strategies their strategies and write hints to others. Therefore, even a simple, "non-educational" game can stimulate reflection and development of writing skills.

Implementation strategy.
To become sustainable, a Fifth Dimension setting has to obtain necessary resources from external sources on a long term basis. In other words, it has to meet long term needs of some institutions. So, the problem was to identify institutions motivated enough to provide necessary support. The specific solution to this problem was establishing a university - community partnership. It was assumed that communities were interested in extending educational opportunities for the children while universities were interested in increasing the quality of undergraduate education. The Fifth Dimension offered a way to meet these needs by combining complementary resources: children, space, and some equipment (community) and undergraduate students to help children learn (university). This strategy proved to be successful. The network of the Fifth Dimension sites has been steadily growing and now there is a number of sites in the USA and other countries, including Russia, Sweden, and Finland.
Focus on the Zone of Proximal Development. The high ratio of grownups in the Fifth Dimension provides a unique possibility for using the Vygotskian notion of the Zone of Proximal Development in organizing learning processes in the setting.

Three phases of intersubjectivity

The main source of empirical data about learning and development in the Fifth Dimension are fieldnotes written by undergraduate students after each site visit. A small subset of these fieldnotes will be used below to provide examples illustrating the "life-cycle" of inter-subjectivity.

Phase 1. External coordination of individual activities ("pre-intersubjectivity")
People come to the Fifth Dimension with their individual goals. Children may, for instance, want to play their favorite games, socialize with undergraduate students, or just find out what the Fifth Dimension is about. Undergraduate students may want to learn more about child development, complete course requirements, or have fun playing with children. In the Fifth Dimension people cannot attain their goals alone. The structure of the setting requires that they form teams and get what they want only as a result of

coordinated teamwork. In many cases team formation presents no problems, especially when both children and adults are experienced Fifth Dimension citizens:

> I entered the Fifth Dimension at about 3:15 and I was immediately approached by Paul. He did not say anything to me, he just pointed at me and then at the computer. I asked him if he was ready to play and he said yes.
> Tami K., 4/20/95

However, in some cases team formation does present a problem. A child can be interested in a game and wishing to follow the rules of the Fifth Dimension, but uncooperative, for instance:

> She was quite confident that she was able to complete the task independently. <...> It wasn't like "go away I can do it myself," it appeared to be more of an automatic reaction for her just to do it herself.
> Colleen M., 03/05/94

Even more serious problems emerge if the child does not want to follow the rules of the Fifth Dimension and/or rejects any help.

> When I said 9/4 is the answer he said to me, "you are wrong, that's wrong, that's not the answer." He did not even know that you can divide with fractions and he was not willing to pay attention to me while I told him. I even tried to make a ruler out of paper but he did not want to hear how we could use it to help us.
> Marly Z., 05/17/94

Phase 2. Emerging group identity ("intersubjectivity")

When individuals just start acting together, there is usually little indication of intersubjectivity, even when individual activities are relatively well coordinated. In problematic cases, described in the previous section, lack of coordination makes intersubjectivity even more difficult to develop. However, eventually most groups enter the phase of true collaborative activity.

> The change that came over Jonathan was remarkable. <...> He increased his interaction with me 100%. We joked about the game, and he was constantly filling in any missing background noises, cheering his successes, laughing at or berating the enemy.
> Michael R., 02/05/94

Collaborative game playing at this stage is characterized by efficient coordination of individual efforts, and is often associated with strong emotions, both positive and negative, shared by members of a team. Also, in such cases undergraduate students often use "we" when they describe joint efforts of a team, for example:

> We were very careful and suddenly with the move of one square, we completed the puzzle...Jennifer cheered and I was just as excited. There we did it, moved Jennifer on up but with the help of Ben and the Wizard of course.
> Marly Z., 05/10/94

Note, that in the above example "we" refers to the team, consisting of a child and an adult, which is contrasted to "external persons", who also contributed to the achievement (i.e., a boy from another team, Ben, and the Wizard). The outcome of the team effort was a "promotion" of the child, Jennifer, to the rank of a "Young Wizard Assistant".

Phase 3. Transfer of group experience to individual activities ("post-intersubjectivity").

From children's point of view, the most important features of collective activities in the Fifth Dimension are, probably, the requirement to follow the rules of the setting and the emphasis on educational activities specified in the task cards. In many cases newcomers to the Fifth Dimension consider meeting these requirements an inevitable price they have to pay for the opportunity to have fun, that is, to just play computer games they like. In the previous sections we gave some examples , which illustrate the resistance to what children consider as distractions from having fun and how this attitude can be overcome by involvement in a collective activity. Moreover, most children (at least, on some occasions) start paying attention to the specially designed "side" activities and following the rules of the setting without being prompted to do so.

> Henry began to fill out the task card with priority. I was amazed at how much attention he finally decided to give the task card. At every interval when we started playing the game the right way, he'd stop and plot his move and whatever the screen said. One time the screen cleared as soon as he finished to game and he said, "damn I missed it, do you remember the numbers or do we have to play again."
> Marly Z., 05/17/94

Sometimes children even start to take responsibility for the coordination of collective activities.

> Christina did very well in this level. She asked me to write the expressions on her task card as she said them outloud to speed up the process.
> Nami K., 05/23/94

Finally, there are numerous documented cases of how participation in collaborative game playing can result in learning outcomes. Children develop basic skills (reading, writing, typing), acquire new facts and problem solving strategies.

> It was great playing this game with Matt because I could tell that he was learning from our interaction. Like I said, eventually he could match the clue to the picture on his own. <...> Sometimes in the game, you would run across the same clue or you would end up taking a picture of a robot that you already had a picture of -- Matt would remember which pictures he had and he would also remember listening to the clue from before.
> Nami K., 05/24/94

Conclusions

The analyses in this paper have two broad implications for the field of CSCL. First, successful learning is promoted when it occurs within authentic activities, i.e., when learners attain meaningful goals and are intellectually and emotionally engaged in the tasks they carry out. In this paper we attempted at demonstrating that this idea, which is currently widely accepted within the CSCL community, applies not only to individual activities but to collective activities, as well. In other words, educational benefits of collaboration critically depend on the degree to which learners are involved in their collective activity. Putting children and adults together is a necessary but not sufficient condition of genuine collaboration. Therefore, creating environments for Computer Supported Collaborative Learning should include evaluation and support of authentic collective activities.

Second, our study indicates a number of factors which should be taken into consideration when setting up environments for collaborative learning. They include:

Meeting a diversity of interests.
People participate in collective activities for a variety of reasons. If collaboration is arranged so that it can accommodate a diversity of individual interests, more people can find it attractive (or the same people can find it more attractive).

Meaningful outcomes of collaboration.
If collaboration cannot help people to reach new goals, that is, if by acting alone they can achieve the same (or better) results, children are less inclined to cooperate, or can even find cooperation a nuisance. So, collective activities should be arranged so that learners can attain goals which are difficult or impossible to reach alone.

Choice.
Genuine collaborative learning rarely takes place when people are forced to collaborate and should follow pre-specified procedures. Positive outcomes of collaboration are usually observed under conditions that ensure that participants take responsibility for their contribution. Therefore, it is important that CSCL systems provide a possibility for the participants to make choices.

Time.
Team identities take time to develop. It is a complex process in which emerging identity, improving performance, and smoother coordination mutually influence each other. Therefore, CSCL settings should allow enough time for development of authentic collective activities.

Initial success.
Our data indicates that initial success can greatly facilitate collaboration, while initial failures often result in a lack of interest in the collaborative endeavor.

Shared emotions.
As mentioned before, authentic collaboration is often associated with strong emotions shared by the participants. A possibility for learners to share their emotions seems to be an important factor of the development of "collective subjects". Since in the Fifth Dimension collaboration is of the "same place/ same time" type, it is easy to express and share emotions there. However, in other types of collaborative environments (e.g., distance learning) limited possibilities for expressing and sharing emotions can be an obstacle for genuine collaboration.[1]

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[1]The main problem is not that people do not express their emotions in computer-mediated communication (cf. the phenomenon of "flaming"). However, such emotions can easily be misunderstood, which negatively influences experiencing shared emotions.

Constructive conflicts.
Genuine collaboration does not mean that participants should always agree to each other. Data from the Fifth Dimension documents a number of cases where conflicts played a constructive role and resulted in efficient collaborative learning. CSCL environments should not prevent conflicts, but rather provide conditions for their constructive resolution.

To sum up, in this paper we employed the conceptual system of Activity Theory in an exploration into the nature of learning in the Zone of Proximal Development. We proposed that this learning is determined by an interplay between individual and collective activities. Cultural settings provide resources, affordances, and constraints to involve participants in new collective activities. While people might enter collective activities for a number of personal reasons, such activities often develop according to their own logic, so that learners have to coordinate two different perspectives -- the individual view and the collective view. In the process of such coordination learners can acquire new personal meanings, strategies, and skills.

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