Development of Software for Educational Activities

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The problem

There is a lack of specific methodologies targeted to educational software development
Goals

- Propose an approach to educational software development based on Activity Theory

- Analyse the application of the approach on constructionist education and, more specifically, on a practical activity using the Cocoa software
Key ideas

- No given software or technology is, by itself, able to educate a person.

- If we believe that education is the result of a set activities that create favorable conditions for teaching and learning, then computational systems will be more or less “educational” depending on the kind of support that they offer to those activities.
Hypothesis

- Activity Theory can help describe important aspects of educational activities and guide the development of software for education
Points to consider

- What is understood by “educational activity”?
- How to describe it for educators and software engineers?
- What is the specific role of computers within the activity?
Activity Theory

- Theoretical body that studies human activities and, in special, the sociocultural dynamics and the importance of tools within this context.

- Is gaining space in education and in the area of software engineering that deals with human-computer interaction (HCI).
The activity diagram
(based on Engeström’s)
Aspects analyzed by Activity Theory

- Hierarchical structure of the activity
- Internalization and externalization
- Object-orientation
- History and development
- Mediation
Constructionism

- Theory that studies the use of technology in the creation of educational environments

- Developed in the early 1970s by Seymour Papert

- Most well-known by Logo, an education software used by millions of people all over the world
Logo’s turtle geometry

forward 100 right 30
forward 80 right 50
right 10 forward 70
Construcionism

Problem: there is too much focus on Logo

The constructionist practice goes beyond the mere use of a tool

How to develop software to support the constructionist approach of other domains?

There is a lack of methodologies for the development of constructionist software...
The proposed approach

- Is based on a sociocultural and historical analysis of the educational activity
- Identifies the specific contributions of the computer
- Opens space for the other “more technical” software engineering methodologies
The traditional software development life-cycle
The proposed development cycle

- Analysis of the Educational Activity
- Design of the Computational Artifact
- Implementation of the Computational Artifact
- Test of the Computational Artifact
- Maintenance of the Computational Artifact
- Analysis of the Computational Artifact
The analysis of the educational activity

- Describes the educational activity in all its dimensions
- Is oriented by guiding questions
- Has both a generic and a specific part
The generic and specific parts of the educational activity

- **Generic Educational Activity**
  - Specific Educational Activity A
    - Domain: English
    - Environment: Uninformal, home
  - Specific Educational Activity B
    - Domain: Economy
    - Environment: Formal, company

- Generic theoretical principles
- Context-specific restrictions
The analysis of the computational artifact

- Describes the role of computers within the activity
- Distinguishes among computational artifacts, digital artifacts, digital objects and applications
- Is also driven by guiding questions
“Activity hierarchy” questions

- What is the activity?
- What are the actions that each actor will perform in each role?
- Which actors and roles will the tool support?
- What kinds of operations should be automatized?
“Internalization and externalization” questions

- What concepts, skills, attitudes are to be internalized by each actor?

- What concepts, skills, attitudes are to be externalized by each actor?

- How is the tool going to support that?
“Object orientation” questions

- What’s the object of the activity?
- What are the objects being transformed by each actor?
- What aspects of those objects are the most relevant for each actor?
- How is the tool going to support that?
“History and development” questions

- How does the activity evolve over time?
- How do different elements evolve within the activity?
- What historical elements of the environment affect the activity? How?
- How is the tool going to support that?
“Mediation” questions

- What elements are going to mediate the interaction between actors and between actors and objects?

- What aspects of the interaction is the tool going to enhance?

- What aspects of the interaction is the tool going to limit?
A Generic Constructionist Learning Activity

- **Computerized and non-computerized artifacts**
- **Learner**
  - Rules (duration and amount of sessions, relationship among participants, …)
- **Community**
  - Teacher, other students, reference authors, visitors
- **Division of Labor**
  - Learner, facilitator, source of reference, actor, activity designer
- **Transitional objects**
- **Personally meaningful and shareable product**
A Graphical Logo Activity

Turtle commands, editor commands and additional language commands

Picture in the computer screen

Graphical turtle and procedures

Graphical Logo

Rules

Community

Division of Labor

Learner
Learner actions

- Idealization
- Construction
- Assessment
- Debugging
- Description
A practical case: The Game’s Workshop

- Institute of the III Millennium - Ibirapuera Park

- “Development of games about the park using the Cocoa software”

- Served as an object to think about this work
A Cocoa screen
Why Cocoa?

- Considered a successor of the Graphical Logo
  - A programming language for kids
  - Created within the concepts of multimedia, Internet, windows and mouse

- It was relatively easy to adapt it to Portuguese
The Workshop activity

- **Subject** (III Millennium student)
- **Rules** (schedule, write on personal diary, etc.)
- **Community** (teacher, other students, authors of examples, guests)
- **Division of Labor** (facilitator, actor, learner, source of reference, activity designer)
- **Mediating Artifacts** (planning sheets, computers with Cocoa, camera, etc.)
- **Objects** (Cocoa components, annotations, etc.)
- **Outcome** (game about the park)
Conclusions from the workshop

- Computers should be seen as components within a larger context

- Applications (such as Cocoa) should be analyzed as part of the computational artifact

- There is a lack of tools to support the facilitator (assessment, annotations)
Conclusions from the workshop

- There is a lack of tools to support the development of long activities (backups, student’s notes)

- It is important to allow time for the appropriation of the artifact (instrumentalization)

- Cocoa could offer tools to avoid student’s distraction and to facilitate the description of student’s actions
Overall research conclusions

The proposed approach addressed important aspects of the educational activity:

- Theoretical orientation
- Specific characteristics of the environment
- Social dynamics (relationship between roles)
- Development of the participants
- Analysis of the computer against and in partnership with other technologies
In relation to Constructionism

- Helped organize the theoretical concepts
- Opened space for discussion with other fields of research
- Made explicit Logo characteristics to be explored in other applications
- Raised questions for further research
Questions raised about Constructionism

- Student motivation for action description
- New understanding of computers
- Cycle of idealization-construction-assessment-debugging-description actions
- Importance of the instrumentalization phase
- Lack of tools to support facilitators
Major challenges

- Interdisciplinarity
- Lack of references
- Areas that are recent and in constant evolution
- Translation problems
Major contributions

- Made explicit the need for a methodology for the development of software for education
- Proposed an approach for that
- Reinforced the idea that computers should be analyzed in relation to a context of use
- Critically revised the concepts of Activity Theory and Constructionism
- Articulated the theories studied
Open questions

- Can the proposed approach be used with other educational theories?
- Can it be applied to non-education areas?
- How to turn it into a real methodology?
- How to make it more useful for educators and engineers?
Next steps (as of 1999)

- Write articles to spread and improve the ideas
- Use the proposed approach in the creation and analysis of new applications
A neighborhood mapping activity

- **Mapping tool commands**
- **Maps, landmarks and annotations**
- **Personal neighborhood perspective on screen**

**Learner**

**Rules**
(duration and amount of sessions, relationship among participants, ...)

**Community**
(YAN members, YAN mentors, other residents, reference authors, ...)

**Division of Labor**
(learner, facilitator, source of reference, actor, activity designer)
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- Mapping tool commands
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