

# STUDYING ZPD IN ICT LEARNING ENVIRONMENTS

Aikaterini I. Mavrantonaki

Department of Primary Education School of Education University of Crete, Greece

*Abstract- In this paper the findings from a two year action research study are presented. The focus of the study was the use of ICT in the subject of 6<sup>th</sup> grade History. Groups of students studying History were assigned different tasks and their interaction was transcribed and analyzed. Patterns of collaboration were observed and two theoretical frameworks were implemented in studying them. The first was the use of ICT as a cognitive tool. The second was a scheme describing the Zone of Proximal Development (ZPD) in group work. Three research cycles were designed and implemented. The results showed that only in the 2<sup>nd</sup> research cycle the suggested ZPD scheme was applicable.*

**Keywords** – ICT as cognitive tool, Zone of Proximal Development, Concept maps, History teaching

## I. INTRODUCTION

History as a scientific discipline is an ever changing dynamic interpretation of facts based on the remaining evidence (Leinhardt, Staiton & Virji, 1994). On the contrary, History as a school subject in Greece is considered as a fixed set of information. Traditionally, teaching History in Greece mainly involves encyclopedic enrichment with facts and dates (Kokkinos, 2002) and, like in other countries, is dedicated in strengthening national identity (Ferro, 1984). Thus, the problem with the traditional teaching of history is that it involves no dynamic interpretation of the past and that its' material is treated as an indisputable truth. It's no surprise that students find History boring and difficult (Spoehr & Spoehr, 1994). This study aimed at changing this view, by approaching History not as a set of pieces of information for students to passively memorize but as a set of concepts to actively construct. ICT environments were designed and used as cognitive tools for this purpose.

Cognitive tools are tools that help students construct, organize and represent knowledge (Jonassen, 1992, 2004). The use of ICT as a cognitive tool helps students gain a deeper understanding (Mayes, 1992; Jonassen, 1996 Robertson et al., 2007). These tools have great affordances for supporting learning, as they can carry out the cognitive processing required for task completion, partly or wholly. A number of different software applications can be used as cognitive tools. This study chose two of them. The first ICT tool was Inspiration, a concept mapping application. Concept maps are graphical representations of information. They consist of nodes containing concepts and links connecting the nodes. The second ICT tool was a Wiki, a web application.

Wiki is a web site that is created directly in the web browser, allowing groups of editors to collaborate.

## II. ZONE OF PROXIMAL DEVELOPMENT IN GROUP ACTIVITIES

The process of learning is inherently social in nature (Karasavvidis, 2002). Thus, the role of others (parents, teachers and peers) in the context of cognitive development is crucial (ibid). The Zone of Proximal Development (ZPD) is defined as “*the distance between the actual developmental 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, p. 86). This is depicted in figure 1. The nucleus represents whatever a person can achieve individually. The surface around the nucleus represents the potential accomplishments when there is support by a “more capable partner”. Figure (1) represents ZPD of one person and of a group of people in a collaborative activity (Borthick, Jones & Wakai, 2003). In group work, part of the ZPD areas are covered by the nucleus of one or more members of the group, making learning possible. In other words, students can help one or more fellow students to complete a task. By doing this, students contribute both the outcome of their team work and to each other's cognitive effort. It has been argued (ibid) that groups of students achieve higher learning gains compared to students working individually.

Having the above in mind, the main research question of this study was the following: Does group work in ICT learning environments, designed in the present study, afford active engagement in content-related dialogues and work in the ZPD of the students?

### Publication History

Manuscript Received : 2 November 2016  
Manuscript Accepted : 4 December 2016  
Revision Received : 12 December 2016  
Manuscript Published : 31 December 2016

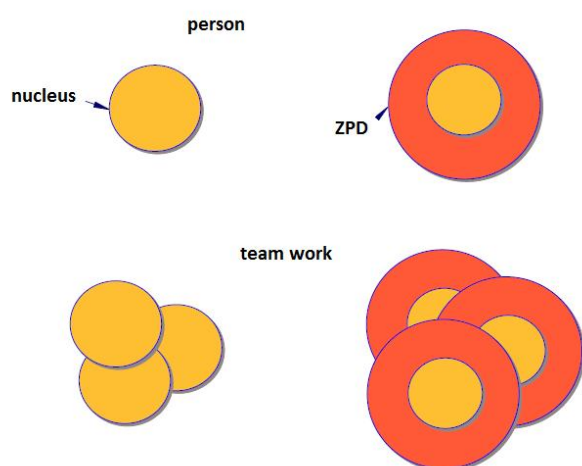


Fig. 1. Borthick, Jones & Wakai 's model of ZPD

### III RESEARCH METHOD

An action research method was adopted as a suitable framework for this study. The subjects were 51 6<sup>th</sup> grade students (around 12 years old), in an urban Elementary school of Greece. Over the course of two school years (2007-2009) 3 research circles were designed and implemented. 27 students (12 female and 15 male students) took part in the first year's two circles and 24 (13 female and 11 male students) participated in the second's year 3<sup>rd</sup> circle. Modern Greek History, from the period of the Greek revolution against the Ottoman Empire (1821) until the Second World War, is the topic of the 6<sup>th</sup> grade's History textbook. Every student in Greece follows the same curriculum. Traditionally, students' learning in History consists in memorization of the textbook content.

The 1st and the 2nd research circle design involved students creating concept maps about historical figures, facts or pictures. In the 3<sup>rd</sup> research circle the students created a Wiki, drawing on historical information sources. As opposed to the former two cycles, in this one the students produced texts rather than concept maps. The produced texts were cast in either textbook like genres or narrative ones.

**More specifically, the tasks in the three research circles were the following:**

1. Students collaborated in groups of two, employing ICT as a cognitive tool in order to construct concept maps about selected units of their textbook.
2. Students collaborated in groups of two, employing ICT, their schoolbook and historical sources in order to construct concepts maps about historical concepts or images containing historical information.
3. Students collaborated in groups of two to produce historical texts or narratives using a Wiki, their textbooks and historical sources.

Group discussion was tape recorded, transcribed and analyzed using discourse analysis. The utterance was the unit of analysis. Overall, the transcripts involved 4860 utterances.

### IV. RESULTS OF THE 1<sup>st</sup> RESEARCH CIRCLE

Students were asked to construct concept maps, about different units from their textbook. The main idea of each

concept map was the title of the unit. Students' task was to select the key ideas of the text, put them on screen and connect them with links, thus representing the text in the form of a network of nodes.

The analysis of the dialogues revealed three patterns of collaboration:

1). "Equal contribution". The two members of the group contributed to the task in such a way that it was impossible to determine which of the two was the "expert partner". This is reflected in the following excerpt.

i.e.

A: Destruction of Greece. What do you think?

B: (Going over his notes. Reads:) There was chaos in Greece.

A:What should we write?

B: Poverty and

A: Anarchy?

B: Yes, Anarchy... Problems in Greece, a gap over here and then you'll see. Problems in Greece and then two arrows and then Anarchy and Poverty.

A: So, Kapodistrias... problems... Anarchy... Poverty.

2). "Mentoring". One member of the team was "dominant" and encouraged and helped the other member.

i.e.

C: What have you read? Do you want to write? Come on.

D: (silent, going over his notes)

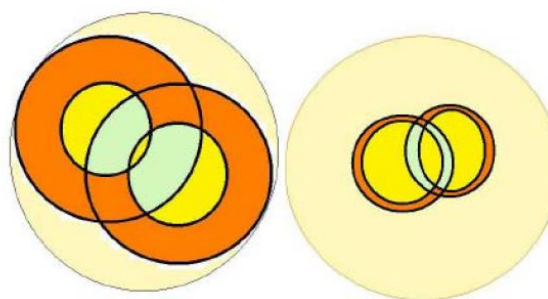
C: (Looks at his notes too). Fine. Speak!

D: Otto and the... the..

C: Come on.

D: .. and the.. I don't remember. Let me look it up here.

3) "Domination": Like "mentoring", there was a "dominant" member in the group, but in this case there was no help or encouragement. The dominant student left no room for participation for his/her fellow student. He/she completely



ignored or "used" the other member, giving orders.

Fig. 2 Expected ZPD and ZPD as observed during the 1<sup>st</sup> research circle.

i.e.

E: (Write) liberation movements. Good. Liberation.

F: Liberation?

E: Movements. Yiota, ita (spells the word).

F: Ok.

E: Ok. We have to match (create a link than connects two nodes) now. Take the mouse.

F: Is it ok if I write this time?

E: (Ignores the question). Make the box! (i.e. create a node).

F: Ok.

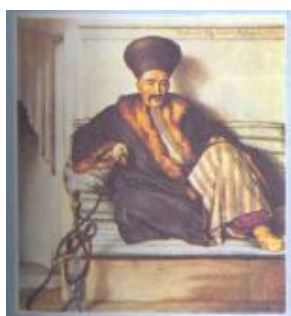
E: Let me see what's in the text.

The task in the 1st circle turned out to be a “mission impossible” for most of the students. The interpretation of the schoolbook's text and the representation of its content in the form of a concept map revealed serious problems in grasping the text's content. Every page of the schoolbook was full of new concepts, dates and names, thus hindering comprehension (Kokkinos, 2002). As a result, the task did not afford active engagement in meaningful content-related dialogues. This finding is represented in figure 2. The area signifying proximal development is depicted small. The big circle enclosing the smaller ones represent the knowledge and skills required to complete the task. The task far exceeded students' capacity, although the sources of historical information were provided through the textbook. To sum up, the evidence suggested that the answer to our research question “Does group work in ICT learning environments, designed in the 1st research circle, afford active engagement in content-related dialogues and work in the ZPD of the students?” was not affirmative. In consequence, the task was modified in the 2nd research circle, in a way that would demand more active involvement of the students.

## V. RESULTS OF THE 2<sup>nd</sup> RESEARCH CIRCLE

Specific concepts and pictures were chosen as main ideas for the concept maps in the 2<sup>nd</sup> research circle. The topics were relative to the textbook information, but gave new insights to certain historical facts. For example, the picture of a Greek wealthy land owner was presented (fig. 3). Everybody assumed he was an Ottoman. Then the groups were provided with historical sources, that contradicted the false assumption of the man's origin, and were asked to construct a concept map about him.

All three patterns of collaboration that were identified in the 1st research circle were also observed in the 2<sup>nd</sup> one. However, there was one major difference: the students were



more actively engaged in content-related dialogues.

**Fig. 3 Picture of a rich Greek land owner during Ottoman occupation.**

i.e.

G: No, not up there (referring to the position of a node).

H: It doesn't fit anywhere else.

G: Couldn't you bring that node up there and this node here?

H: Ok. Are you satisfied now?

G: Oh, good.

H: It looks nicer. Don't you like it better now?

G: No!

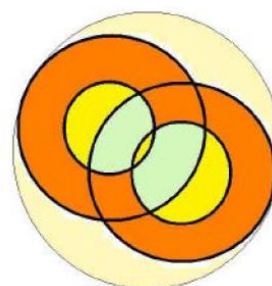
H: Well, there's nothing I can do! What about the Turks?

Write that he was collaborating with the Turks.

G: What was his connection with the Turks?

H: He was responsible for collecting tax money for the Turks.

In the 2<sup>nd</sup> research circle the task required not only the study of historical sources, but also critical thinking, imagination and hypothesis formation. While in the 1st circle, incomprehensible information was plainly collected and inserted in a concept map, in the 2<sup>nd</sup>, the students frequently elaborated on historical sources through dialogue. The students clearly contributed to the development of each other's understanding. Thus, the ZPD image in figure 3 resembles the one proposed by Borthick, Jones & Wakai (2003). To conclude, the data collected in the 2<sup>nd</sup> research circle showed that the answer to the question “Does group work in ICT learning environments, designed in the 2<sup>nd</sup> research circle, afford active engagement in content-related dialogues and work in the ZPD of the students?” was an affirmative one. This is depicted in Figure 4.



**Fig. 4 ZPD as observed during the 2<sup>nd</sup> research circle.**

The central nucleus representing what students can do on their own overlaps with an area of the ZPD of their fellow students. Hence the tasks afforded students' contribution to each other's historical understanding. The big circle enclosing the smaller ones, representing the knowledge and skills needed for the completion of the tasks, is covered by the nucleus and the ZPD of the students to a great extent.

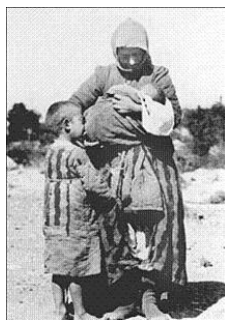
However, there were two important limitations that led to the re-design of the task in the 3<sup>rd</sup> research circle:

1. In spite of the positive evidence in the 2nd research circle, students found the task boring. While they were quite enthusiastic at first, after using the same program for some time, they were not motivated anymore.
2. Some of the concept maps produced were characterized by a linear narrative structure. In two cases, students chose to create one large node, that contained all the information they chose to import, instead of a network of interconnected nodes.

## VI. RESULTS OF THE 3<sup>rd</sup> RESEARCH CIRCLE

Based on the observation that the students seemed to prefer narrative structures, the main task in the last research circle involved the creation of a narrative. For instance, Figure 5 presents the picture of a Greek refugee with her children after the Minor Asia Disaster in 1922. That picture was assigned to the students. The students were provided with historical sources of the period and were asked to write a narrative based on the picture. Stories students created were posted on a class Wiki and the fictional character of a Historian, Mr Historikos, commented on them. Students were given time to

correct and improve their narratives, based on the feedback they had received.



**Fig. 5 Picture of Greek refugees after the Minor Asia Disaster, 1922.**

Discourse analysis revealed four different patterns of collaboration. These patterns appeared to be different compared to the preceding cycles.

1) "Building on each other's thoughts". One subject started developing an idea and his/her partner continued this line of reasoning, elaborating the ideas further.

i.e.

K: Streets were empty.

L: Shops were closed.

K: (Types) Shops... were... closed.. And then came

L: Some people came...

K: The police came and arrested him.

2) "Arguing". Partners conversed, disagreed and discussed alternative solutions.

i.e.

M: They couldn't survive over there. They went back to their village

N: Or, they went some place else. They found a better place to stay.

3) "Split task". Partners divided the work, each taking over different sub-tasks. This pattern is not characterized by much dialogue. In the following excerpt one student is occupied with writing and the other with thinking.

S: Two friends were in the house next door.

T: (Writing) were.. in the house... next door. Then?

S: (silent)

T: Tell me what else? What else?

S: Oh let me think! (Small pause) The tanks were coming.

4) "Seek teacher help". Subjects constantly referred to the teacher as an information source, posing questions and incorporating teacher's answers into their texts. In the following example they prefer not to read the historical source provided.

Teacher: Have you read the text?

V: Yes.

Teacher: So? Who is this dead man?

(no answer)

Teacher: Have you read it? No.

(Teacher reads aloud the text to the students)

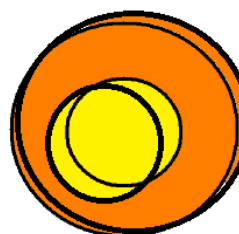
Teacher: Who's that man over there?

W: Imbraim pasha. (A Turkish general)

Teacher: And who's the dead man?

V: Papaflesas (A Greek hero).

All the groups produced texts and the collaboration was evident in the dialogues. However, there was almost no content-related discussion pertaining to historical facts or concepts. When historical information came up, it was simply inserted in the narrative. The purpose of the students was clearly to complete the task, not to construct historical meaning. It is evident in their dialogues that they chose to simplify the task, so that they wouldn't have to elaborate historical information. As a result, regarding the 3<sup>rd</sup> cycle, subjects' ZPD circles appeared almost identical. Students appear to share knowledge, thoughts and ideas to a great extent. This is presented in figure 6, where both the nucleus and ZPD area of the partners' almost overlap. There is no bigger circle containing the knowledge and skills necessary for the completion of the task. This is to show that students altered the task in such a way that the bigger circle fitted their own circles.



**Fig. 6. ZPD as observed in the 3<sup>rd</sup> research circle.**

In conclusion, the analysis showed that the answer to the research question "Does group work in ICT learning environments, designed in the 3<sup>rd</sup> research circle, afford active engagement in content-related dialogues and work in the ZPD of the students?" was not affirmative.

## VII A KEY FACTOR: STUDENTS' MOTIVATION

Clark (1989 p. 64) argues that "in general, evolved creatures will neither store nor process information in costly ways when they can use the structure of the environment and their operations upon it as a convenient stand-in for the information-processing operations concerned. That is, know only as much as you need to know to get the job done". That is exactly the case in the present study and especially in the 3<sup>rd</sup> research cycle. The researcher took for granted the enthusiasm that students showed when they worked in the computer lab. She expected that students would find the tasks much more fun than the traditional activities and that they would be deeply engaged in them. The fact is that although the activities were more interesting and engaging compared to the usual teaching practices, students approached most of them as yet another assignment to complete. Their overall motivation was minimal.

## VIII DISCUSSION

Making the study of the past meaningful turned out to be the biggest challenge in teaching modern Greek History to our 12 year old students. Borthick, Jones and Wakai's pattern of ZPD in collaborative activities (fig. 1) was implemented in the 3 circles of our two year action research aiming at helping

students actively engage in content-related dialogues while studying History.

According to the evidence, only the 2nd research circle replicated the proposed pattern. In this circle, concept maps about ideas or images that contradicted common views and understanding were created. Thus, critical thinking, imagination and hypothesis formation were employed.

In the light of the findings of the 1<sup>st</sup> and the 3<sup>rd</sup> research circle, the initial ZPD pattern was modified (figures 2 and 6).

Concerning the 1<sup>st</sup> research circle, we found that the task was too *difficult* to be meaningful. Students designed concept maps but their collaboration showed almost no evidence of active engagement in making sense of the historical sources provided.

Concerning the 3<sup>rd</sup> research circle we found that the task was treated by the students as yet another assignment to complete. Students didn't discuss historical concepts or facts, although these constituted the core of the task. Instead, they simplified their work, transforming a challenging and demanding task into a procedural one that would be fairly *easy* to complete. They were, obviously, not interested in the activity.

The above mentioned results point to the importance of students' motivation for the successful implementation of ICT in learning environments. In this study, it was evident that, after an initial short period of enthusiasm, the students did not find the tasks particularly engaging. In the typical example of ZPD, where a mother helps her child build a 3D model (Wood and Middleton, 1975), no model would be built if the child wasn't interested in the activity, regardless his/her potential and mother's efforts. To conclude, if we were to elaborate on the proposed ZPD scheme (fig.1), we would add a new circle, the "motivation circle". This circle would provide a list of everything a person is interested in. We propose that this circle is taken into consideration when designing learning tasks and environments (fig. 7).

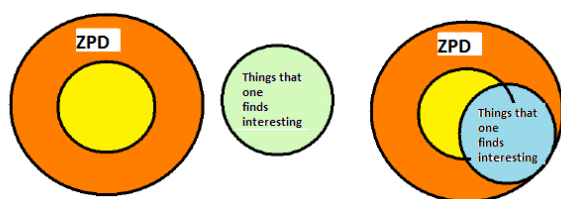


Fig. 7. The "circle of motivation" and the ZPD scheme.

## ACKNOWLEDGMENT

We like to express sincere appreciation and deep gratitude to all participants in this work. Special thanks to Professor Vasilios Makrakis, who supervised our research. Special thanks to Associate Professor Ilias Karasavvidis for the feedback, direction and assistance.

## REFERENCES

- [1] Borthick, A.F., Jones, D.R. & Wakai, S. Designing learning experiences with the learners' Zones of Proximal Development (ZPDs): Enabling collaborative learning on-site and online. *Journal of Information Systems*, 17(1), 107-134, 2003.
- [2] Clark, A. *Microcognition: Philosophy, Cognitive Science and Parallel Distributed Processing*. MIT, 1989.

- [3] Ferro, M. *The Use and Abuse of History: Or how the past is taught to children*. New York: Routledge, 1984.
- [4] Jonassen, D. H. What are Cognitive Tools? In P.A. Kommers, D. H. Jonassen, J. T. Mayes (eds). *Cognitive Tools for Learning*. Berlin, Heidelberg: Springer-Verlag, 1992.
- [5] Jonassen, D. H. *Computers in the classroom. Midtools for critical thinking*. Englewood Cliffs, New Jersey: Prentice-Hall, 1996.
- [6] Jonassen, D.H. *Learning to solve problems: An instructional design guide*. San Francisco, CA: Pfeiffer/Jossey-Bass, 2004
- [7] Karasavvidis, I. Distributed cognition and educational practice. *Journal of Interactive learning research*. 13 (1/2), 11-29. 2002
- [8] Kokkinos, G. History in schools. From ideological function to historical thinking. *Historika* 19(36), 165-200, 2002
- [9] Leinhardt, G., Stainton, C., Virji, S. M.. A sense of History. *Educational Psychologist*, 29 2, 79-88. 1994
- [10] Robertson, B., Elliot, L., & Robinson, D. Cognitive tools. In M. Orey (ed.), *Emerging perspectives on learning, teaching, and technology*, 2007 Retrieved 20 November 2016 from <http://projects.coe.uga.edu/epltt>
- [11] Spoehr, K.T., & Spoehr, L.W. Learning to think historically. *Educational Psychologist*, 29(2), 71-77, 1994.
- [12] Vygotsky, L.S. *Mind in society: the development of higher psychological processes* M. Cole, V. John-Steiner, S. Scribner & E. Soubberman (Eds. & Translators). Harvard University Press. 1978
- [13] Wood, D., & Middleton, D. A study of assisted problem-solving. *British Journal of Psychology*, 66(2), 181-191. 1975