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Investigating student teachers` use of *Cinderella 2.8* in primary classroom through Artefact-Centric-Activity Theory (ACAT) framework

Rationale behind the study

The use of ICT in German primary schools is still perceived to be controversial. There are various reasons for this and the crucial point from technological perspective is that several technologies (for example, computer based dynamic geometry) offer only indirect manipulation through the computer mouse (Ladel & Kortenkamp, 2014, p.237). The fine motor skills of the young children are not fully developed yet (for example, the eye-hand coordination) to take full advantage of the dynamic nature of interactive geometry. On the other hand, interactive geometry turns out to be a difficult subject. Richter-Gebert and Kortenkamp (2012, p.27) highlighted two main reasons: 1) problems that come from special cases that occur even in a static setup, and 2) problems that are of a genuinely dynamic nature. Hence, using computer based dynamic geometry software in primary geometry instruction could be a complex instructional situation both in terms of construction of interactive lesson plans and implementing them. This calls for a theoretical framework that is able to capture the interactive dynamic environment and gives more orientation to teachers and learners.

Recently, ACAT framework has been used in the virtual manipulative studies (Ladel & Dimartino, 2017; Ladel & Kortenkamp, 2016) to interpret the interactions mediated through artifacts between the *subject* (learner) and the *object* (learning objective). These studies suggested that ACAT framework provides useful insights about the internalization and externalization process that occurs during the interactions with the Apps.

ACAT model for dynamic geometry environment

The study uses ACAT framework (Ladel & Kortenkamp, 2013) based on activity theory and activity systems (Engeström, 1987) which places the artifact as a central component in the activity system. An activity is a form of acting directed towards an object (Bottino & Chiappini, 2008). In this paper, the activity is to produce interactive geometrical learning environments using *Cinderella.2,8*. The activity is carried out through an artifact, here a computer, and is orientated to an object, here the interactive geometrical learning environment. The "ACAT model for dynamic geometry environment" is adapted from ACAT framework as shown in Figure1. The framework is guided by the research question “How optimally could a dynamic geometry learning environment be constructed?” in order to gain a more holistic understanding of the teaching and learning situation through ACAT where dynamic geometry software *Cinderella.2,8* is being used by student teachers in classroom.

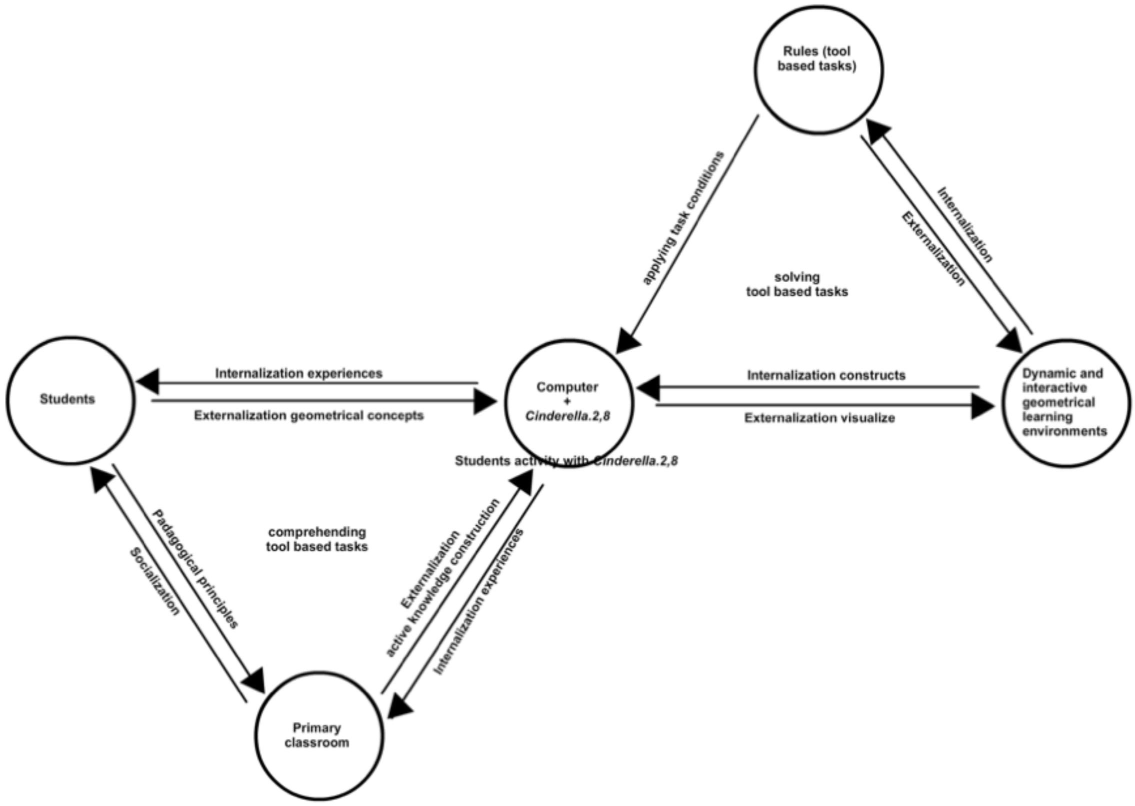


Figure1: ACAT model for dynamic geometry environment (adapted from Ladel & Kortenkamp, 2013)

Within this ACAT model for dynamic geometry environment, the geometrical concepts are mediated through the artifacts (Computer + *Cinderella.2,8*). Using the theoretical framework of ACAT, it is possible to point out the different processes of internalization and externalization that take place while learning with Computer + *Cinderella.2,8* and to focus on the mediating role of the artifact. The whole activity is based on interaction between *subject* (student) and *object* (dynamic geometry learning environment). Primary class 1 students learn to construct dynamic geometrical figures using the functions of *Cinderella.2,8*.

Illustration

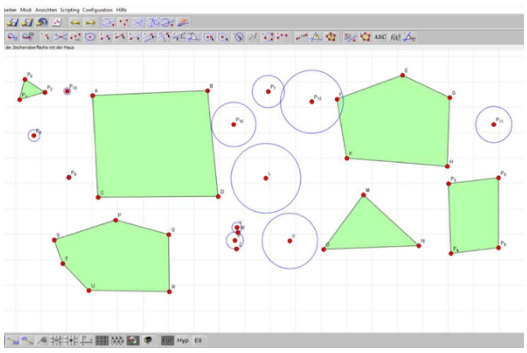
The software *Cinderella.2,8* comprises of many functions and tools to perform the functions. The illustration here uses a very few functions that are essential to the discussion as described below.

Polygon construction with sequenced points. For example, a triangle is constructed by selecting a sequence of 3 points and then finish the definition selection of the first point again (A→B→C→A). Similarly, a quadrat is constructed with 4 points (A→B→C→D→A). 

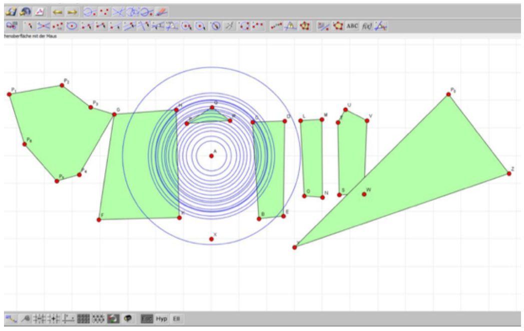
A circle is constructed around its center point.  The Move mode allows objects (e.g., points, lines) to be selected and to be moved around.  These functions and the tools are used by the students in the internalization process to construct the plane shapes on computer.

In this illustration, students (N=11 of Class 1) are the *subject* and the *object* here is to “construct plane shapes” on computer. *Cinderella.2,8* represents the *artifact*. The students engage themselves with the computer to construct circles and polygons using the above-mentioned functions of *Cinderella.2,8*. Every time the student make inputs through the mouse (using the functions point/circle/polygon/move mode), the corresponding action shows up on the computer screen (output). Each output guides the student to the next input which forms a unique cyclical process.

Before setting out to work individually with computer, the students sit together with the student teacher to practice the tools of *Cinderella.2,8*. Every student comes with different levels of prior knowledge and experiences with respect to computer and social backgrounds. The student teacher here has a challenging role to bring all the students in a combined social form. Sitting in circle, the students help each other to identify the shapes (quadrat, triangle, circle) and their properties and to use the *Cinderell.2,8* functions for 20 minutes. Each of the 11 students had a chance to test the tools and verbally explain it to others while performing the function on the computer which was displayed on a projector. Students with difficulty to explain are helped with other students. This preparation phase took place 20 minutes. All the components of the lower triangle of ACAT (viz. teacher, students, *Cinderella.2,8* + computer, peer group) as seen in Figure1 comes into play in this scenario. Afterwards the students started to work individually with computer for 20 minutes. As shown in the upper triangle of ACAT (Figure1), students individually use the computer to construct plane shapes through the functions of *Cinderell.2,8*. Only two (out of the 11 students) computer screenshots are shown here due to space limitation. Maria (pseudo name), a class 1 student, the youngest in her peer group, has used computer only one time in the school as informed by her class teacher.



Maria could work good with the selected tools of *Cinderell.2,8*. She followed the instruction carefully and performed the functions on her own on the computer screen. With minimum help from the student teacher, she herself constructed the circle and polygons. She had, though, difficulties to handle the mouse with her tiny hand and sometimes used both hands to complete the polygon. Specifically, moving the mouse was harder for her.



Ali (pseudo name) has had experience with computer according to his class teacher. Unpredictably, he had problems with the computer and with the software. While other children had already created many figures, Ali´s computer screen initially was blank. As can be seen in the figure, he started constructing some polygons in a row and then circles inside circles. He had no problems constructing circles, squares and triangles. However, he could not use the "move mode" on his own. It is not quite clear here whether the problem lies in the *artifact* (computer/software) or with the task (plane shapes) or Ali´s attitudes and beliefs.

Conclusion

From the above illustrations, it is evident that the ACAT framework could guide the design and implementation of dynamic geometry environment. ACAT framework synchronize the components (teacher, students, dynamic geometry, tasks) on a linear platform. The interpretations are very specific to particular instances as in the cases of Maria and Ali. Due to the dynamic nature of the evolving internalization and externalization process, it is rather hard to generalize the findings.

References

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