Concept Maps: Making Learning Meaningful
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# USING CONCEPT MAPPING AS A NOTE-TAKING TOOL IN COMPUTER SCIENCE

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**Abstract**. First-year studies in higher education indicate the future success in studying. As in other disciplines, also in computer science the first two to three years seem to be critical. Adjusting to academic settings seems to be difficult for many computer-savvy young people, and, on the other hand, the successful students are drawn into business life at an early stage of their studies. In order to prevent dropouts several interventions were initiated in the curriculum. One of them was Studying Techniques as an obligatory module in an introductory course to computer science. The module consisted of four themes with individual and group assignments. One of the themes addressed note-taking techniques and students were introduced to concept mapping. The purpose of this study was to find out how useful the students in computer science found concept mapping in note-taking during lectures or studying in general. The data rests on written assignments by the students. In this article, we evaluate the student experience of concept maps in the light of their reflective group essays. The results indicate that many students found it easy to take notes graphically by hand or using CmapTools, but on the other hand, the rhythm during the live lectures was the found to be too hasty for map drawing. Coming back to the notes afterwards and going though them before tests were found useful.

## 1 Introduction

In this article, we highlight the student experiences in using concept maps in their studies. The assignment looked into was about note-taking techniques and the students were asked to use concept mapping to take meaningful notes at lectures. The collected data rests on written reports and graphical notes taken by the students. In these documents the students explicate how useful or unusable these newcomers in computer science found concept mapping in note-taking during lectures.

Note-taking techniques can be divided roughly into two categories: non-linear and linear note-taking techniques (Makany, Kemp & Dror 2009, 621). Concept mapping is one of the non-linear techniques along with, for example, mental mapping (Buzan 2010). Examples of linear note-taking techniques are Cornell Notes (2010) and traditional bullet points.

In a recent study by Makany, Kemp and Dror (2009, 633-634) the underlying cognitive mechanisms behind effective note-taking and knowledge representations were assessed. As a result, students using the non-linear note-taking learning strategies seemed to overall increase their academic performance through deeper understanding and highly integrated knowledge management. Participants with such a learning strategy represented information in a semantically more connected and meaningful way than their peers with a traditional, linear note-taking strategy (Branbrand & Dahl 2009).

According to Piolat, Thierry and Kellogg (2005, 297, 303) note takers have to tackle several problems related to the flow of information, particularly when taking notes from lectures. They must maintain an active representation of what they are hearing in order to get sufficient time to exploit and to transcribe a portion, while being faced with a continuous updating of the message content as it is spoken. Piolat et al. point out clearly, that when listening, more operations are concurrently engaged and, thus, taking notes at a lecture places more demands on working memory resources.

## 2 Background and Setting of the Course

The Department of Computer Science at the University of Helsinki is well known for its high quality research and student counseling.. During recent years, the department has twice gained the status of Centre of Excellence in Finnish University Education by the Finnish Higher Education Evaluation Council. Constant research and development of studies, curriculum development, student counseling and putting student feedback to use are providing a high quality, constructively aligned frame for studies (Computer Science Research 2007, Hiltunen 2009).

However, the student engagement in studies is a constant worry of the staff. The experience and research results indicate that approaches to studying are often surface? oriented and the students find the following teaching and instruction difficult (Biggs & Tang 2007). In computer science the first two to three years seem to be critical.

Adjusting to academic studying settings turns out to be difficult for some computer-savvy newcomers, and, on the other hand, the successful students are drawn into business life at an early stage of their studies. In order to prevent dropouts, several interventions have been initiated in the curriculum and student counseling. One of these is the two European Credit Units Studying Techniques Module. This course was embedded in an introductory course on computer science and the students attending the course were starting their first year of studies. However, many of them had gained experience on studying in other higher education institutes, like polytechnics, or they returned back to their studies after several years in business life in order to gain official qualifications.

The studying during the Studying Techniques Module course was organized as follows: the head, the senior lecturer in computer science, was in charge of organizing the course and addressing the key issues and objectives. He also gave personal counseling to the students and took care of building up a network of assistants, who were responsible for guiding and instructing their own student groups. The weekly agenda consisted of one lecture, one study session guided by the assistants, and co-operation in small peer groups of three to four students. The lectures introduced the core concepts of computer science and the development of the discipline. The students in each peer group met on a regular basis in between the supervised lectures and study sessions. Several of the assignments were organized in order to encourage the students to work co-operatively. Each peer group was in charge of presenting their ideas and findings on some of the topics in the guided study sessions at least once during the course. Additionally, they also served as opponents for other peer groups. The teachers gave feedback and the issues were discussed animatedly during the group sessions.

This studying module of two European study credits (about 55 hours of student work) was embedded in an introductory course of computer science (4 European study credits). The learning objectives were planned to guide the students to taking studying seriously. The most important underlying outcome of the activities, however, was to help the students to acclimatize themselves into the cultural atmosphere and conditions of the department and the science campus. All learning assignments were stored on the Moodle platform. The course consisted of traditional lectures in computer science accompanied by three shared lectures by the authors of this paper. These lectures included instructions and discussion about study skills and general information about time management, academic writing, ethical questions and the students' self-evaluation about their studying skills etc. The themes of the module were Self-evaluation of approaches to studying, Introduction to academic writing, Note-taking techniques, and Reflective summary ‘What did I learn?’

## 3 The Data Collected and Methods Used

There were 76 students actively engaged in this course during the autumn term 2009.The data for this study consists of 30 joint reports of the peer groups. In this paper, we concentrate on one of the learning assignments with the non-linear note-taking tools.

The reports were compiled by the peer groups and documented on a Wiki site on Moodle with links to the concept maps and linear note-taking assignments. The instruction of the task was to attend lectures and take notes using non-linear techniques, like concept maps or mind maps. The other task was to take notes using text-based linear techniques, of which Cornell Notes (2010) was introduced as an example. The instructions were given orally during the lecture and in a written form on the Moodle platform. The instruction session was summarized by pointing out ‘seven golden rules’ for concept mapping (Kinchin, De-Laij & Hay 2005, 3). This was done because many of the students were familiar with mind mapping, and we wanted to encourage the students to use active verbs in their maps:

1. Concept labels are written in boxes
2. Major concepts appear at the top of the page and more specific concepts appear?
3. Each concept can only be written in one place on the map
4. Links have arrows to show the direction in which they should be read
5. Links must have labels (words or phrases) to give them meaning
6. There can be any number of links coming from or going to a concept box
7. Do not include so many concepts that the overall structure becomes unclear.

The research interests focused on evaluating how useful did the students in find concept mapping and what kind of arguments did the reserved students have against non-linear note-taking? In order to answer these questions, the reports were analyzed using qualitative content analysis (see, for example, Cresswell 2003, 190-197). We also tried to figure out what kind of learning strategies and approaches to learning the students applied while testing the use of concept maps in real studying settings.

## 4 The Results

### *4.1 Student views about concept maps in note taking*

The positive reflections reported by the students indicate that the non-linear note-taking was, at its best, inspiring and motivating:

> *This task was the most useful for everybody absolutely so far!… After the notes we did not only learn new methods to cope with the lecture but we also learn something from the studying techniques suitable to ourselves.*

Meta-cognitive skills were pointed out by many of the respondents. Revising for exams and understanding 'the bigger picture' was mentioned in several reports. Concept mapping was, however, often found challenging especially during the lecture:

> *It was evident that one lesson learned or pointed out was the need to come back to the notes after the lecture and complete and improve them. This was obvious especially in concept maps, because the rhythm of the lecturing prevents the students from rethinking what they are up to during the lessons.*

> *Also this task was revealed to be valuable. When doing this, we had once again to ask ourselves questions about the matters that are very important from the point of view of studying. The self-evaluation of your own ways of operating is the first step towards the improvement of the operation and in this case the first step towards more efficient studying. It is also nice to see the other students' comments on the matter in a peer group.*

> *In the concept map the problem section is the fact that it cannot be directly used in connection with the lecture but it has to be drawn up only when all the material is already in your head. On the other hand, it also operates excellently in the examination, it is handy to write up with its relations the sectors which are related to the question and to see – on the basis of my own experiences -,if something essential is missing.*

### *4.2 Reserved and negative experiences in concept mapping*

The cognitive effort and the severe time pressure of note taking during the lectures compared with the note taking from books or text in general was recognized by more than half of the students. One of them encapsulated the general mood in her peer group like this:

> *The mind map looked good the first hour of the lesson, but then I tried to connect the different ideas and the mess occurred quite suddenly and as a result I lost interest in taking any more notes. I looked at the two lines I had written in the upper left corner and abandoned the technique immediately...*

Note taking requires that information is both quickly comprehended and recorded in written form. The note taker has to both comprehend the message of the lecturer and produce a new written product at the same time. From books and articles, this process is easier compared to live presentations in lecture halls. The following quotes illustrate the student experience similar to these research findings by Kinchin (2005) and Piolat, Thierry & Kellogg (2005, 306):

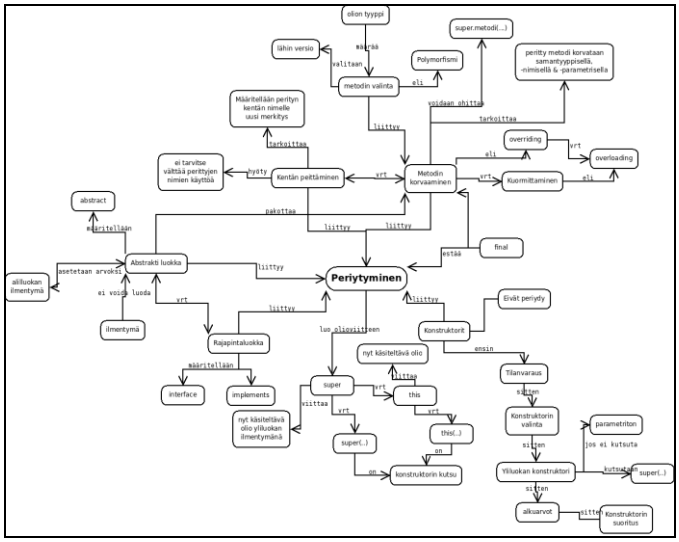
> *It is probably easier to make the concept map based on the text because it can be directly processed after having read the text. But the concept map will be challenging for taking notes because the building of the concepts and chains between them requires strict attention. Of course it would be ideal to supplement and to specify notes after the lecture, but in reality there is not much time for such work in addition to all the exercises and tasks of the courses.*

> *I myself experienced the drawing of the concept map a difficult and time-consuming way to take notes. My train of thoughts will not go when I am forced to think about the layout at the same time. Even though I regard myself as a visually directed human being, I get a better understanding about a well-arranged text than from a concept map.*

*The concept maps and mind maps are best suited for visual people who learn more efficiently with the help of pictures. I myself am not one of this types and I get confused easily with concept maps and mind maps.*

### *4.3 Examples of the concept maps*

The visual images of the concept maps produced by the students' notes were drawn both by hand and computer. The most common digital tools were CMapTools and Buzan's (2010) mind maps. Compared with the list of golden rules of concept mapping (Kinchin, De-Laij & Hay 2005, 3), the concepts were almost always written in boxes, but major concepts did not usually appear at the top of the page. More often than not, the major concepts were placed in the middle of the map and written in block letters (Figure 1).



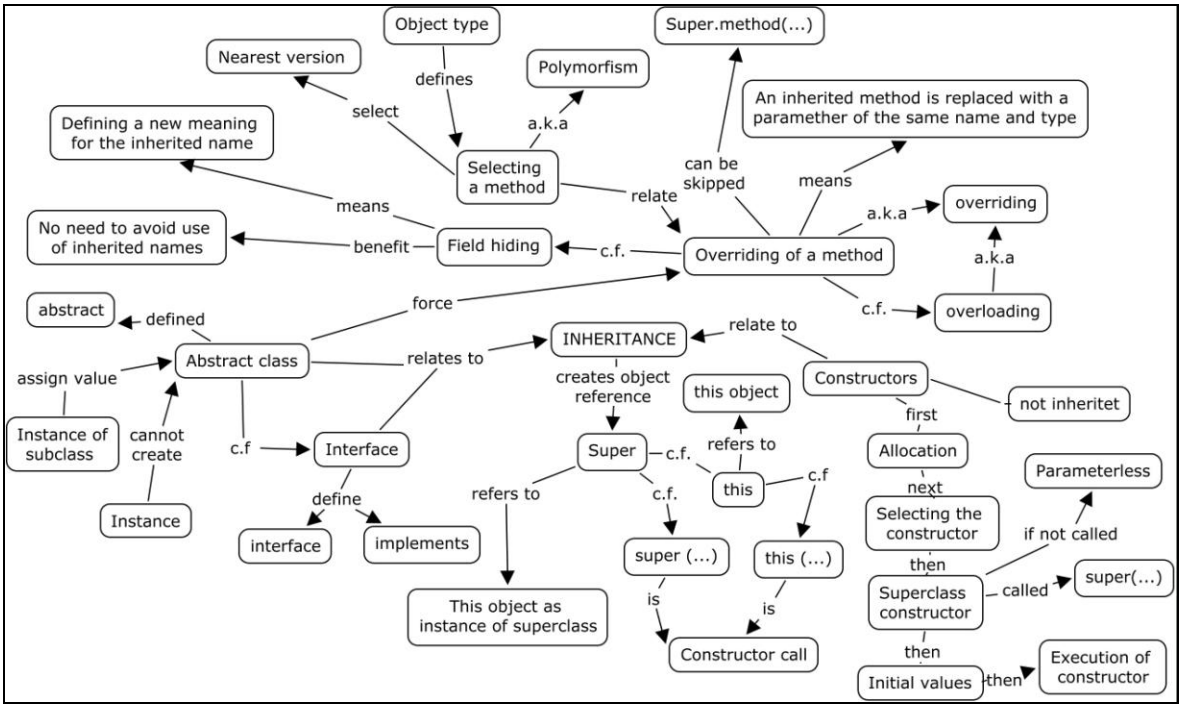
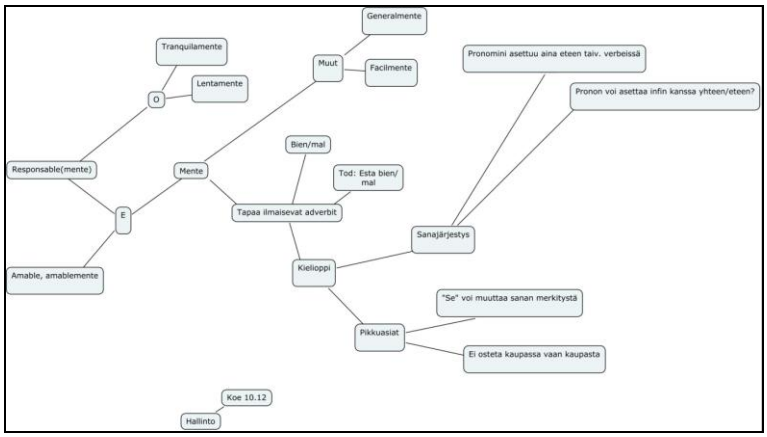




**Figure 1**. The student's concept map is about programming. The key concept 'inheritance' is placed in the middle of the map. The links are valid and accompanied by arrows and active, relevant verbs. The map indicates that the student has an excellent understanding of the topic and is familiar with the basics of concept mapping. He used Finnish and English in the labels.

Usually, each concept was written only once in one place, but the links occasionally had arrows. The links were labeled with active verbs irregularly, but they were used purposefully. More often than not, many concepts were used and the appearance of the map was somewhat confused.

As was pointed out by Kinchin, Hay and Adams (2000, 46) the usual emphasis on valid links with active words and arrows seems to fail to recognize the significance of the students' perspective (Figure 2). The invalid links in a map drawn by a student may reveal interesting processes of thinking along a particular path of understanding.



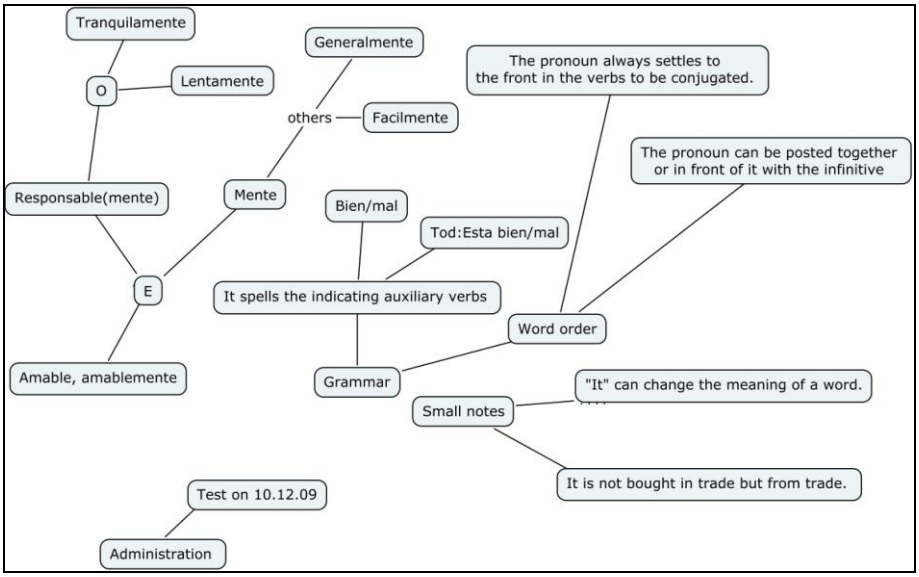
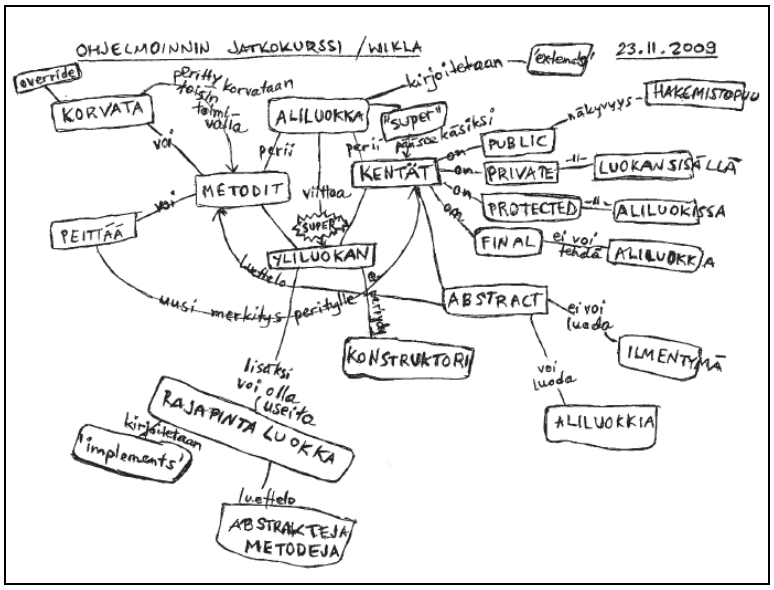




**Figure 2**. The student took notes by hand during her Spanish lesson mixing Finnish and Spanish. She redrew the map afterwards by using CMapTools, but did not find it comfortable to name the links. Also the arrows are missing. The map indicates that the student did not pay a lot of attention to the task. However, she marked important and practical matters in her map. The two separated boxes in the left hand corner include a note on date and place of the course exam.

In our case, there were many hints of invalid links and misunderstandings among the students. Many of the findings in the written reports indicate that the students shared similar experiences and discussed them in peer groups:

> *During the introductory course for computer science I made notes in the form of the concept map. It is not a very functioning technique from the point of view of learning for me because I concentrate on the clear appearance of the figure too much. I had no time to concentrate on understanding the substance and I ended up only copying the concepts from the lecture transparencies into my map. Afterwards nothing can quite be learned from the figure because the copied concepts are not at all clear to me. Also otherwise it is difficult for me to perceive new, big thematic entities from the graphic notes in which matters and arrows are swarming crossways.*

The non-linear notes taken on programming in figure 3 are an example of a coherent concept map. While the map seems to be in order and consistent, there are many connections drawn without arrows and explaining verbs (Figure 3).



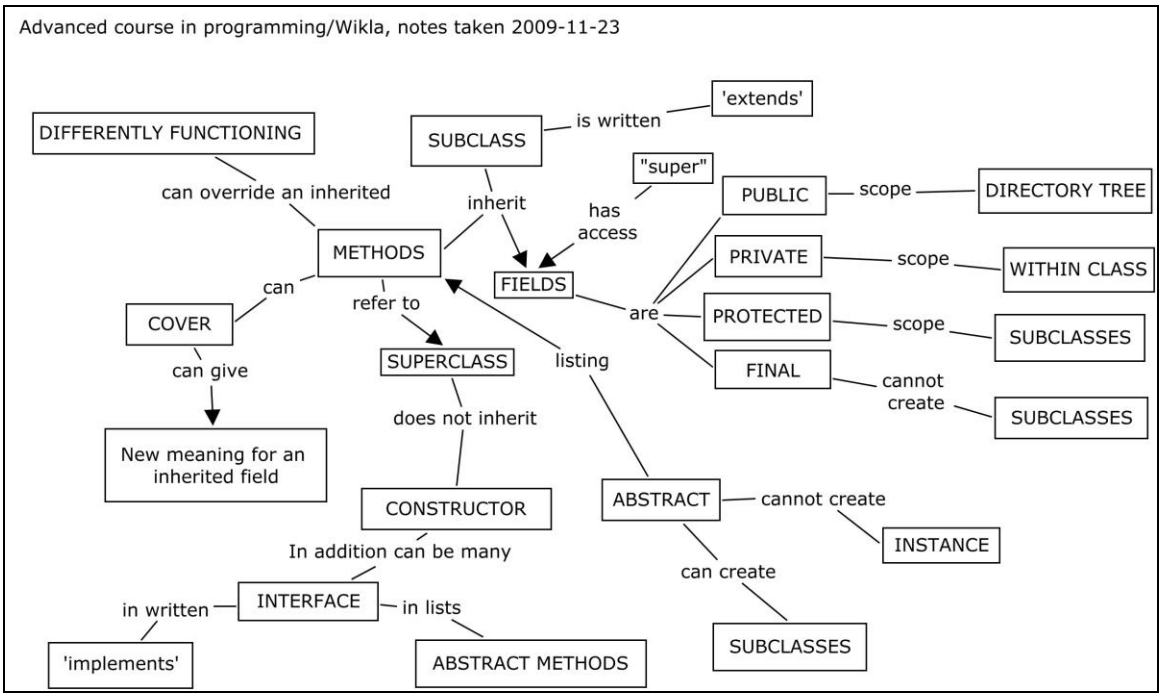




**Figure 3**. The student's concept map is about programming. He used English and Finnish in his hand drawn map. The links are valid and active verbs are used properly, but arrows are often missing. The map indicates that the student has a coherent understanding of the key concepts discussed during the attended lecture.

## 5 Conclusive Remarks

In our study it was not possible to evaluate, how successful the students using non-linear note-taking techniques were in their studies after this course. Research results in Makany's, Kemp's and Dror's study (2009, 633) indicated,

that non-linears achieved better performance results not by recording significantly more details of the presentation but instead by putting concepts and examples into a semantically more connected network of mental representations. This suggests that non-linear note taking is a cognitively more optimal knowledge-management system than 'traditional' linear note taking. It allows, however, the non-linear users to integrate the newly acquired pieces of information better into their existing network of mental representations.

In our case it was evident, that students found concept mapping challenging during the lectures. Mostly this was because the rhythm of the lecturing was too quick for non-linear note taking. It was difficult for the students to pay attention to what the lecturer says and at the same time interpret the meaning of and connections to the new concepts at same time. This finding was similar to Nordell's (2009, 41) study. She ran an Advanced Study Technique Workshop with students in higher education from several disciplines. According to the final assessment survey, only 6,6 % of the students (N= 68) responded that they would modify or add to their studies by making and using concept maps. Sadly enough, concept mapping was second to last on the list, while creating quizzes was the very last of the most implemented activities.

For further development of quality in learning for understanding, the instructions for the course should include a wider implementation process of non-linear note-taking techniques. For example, notes could be taken from the scientific papers already available as the material of the course. This process was depicted by Kinchin (2005, 74-75). In two of the figures by Kinchin there were annotations used in concept maps in order to raise questions among the students and in that way engage the students with the core substance of the article. Our results indicate that this annotation tool is worth adapting to facilitate the peer-to-peer co-operation and documenting in the study groups.

Additionally, however, we have to admit that there was a hidden agenda behind this note-taking assignment. The purpose was not only to introduce concept mapping and share the experiences in the study groups, but also to force the students to attend lectures more actively. We believe, in this we were quite successful and are going to further develop this learning activity as part of our Study Techniques Module.

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