The first motivation of this phd is a general question about of the nature of mathematical knowledge and the possibility to acquire it.

About mathematics we seem to have strong intuitions very early but still mathematical concepts can sometimes be very difficult to learn. Notably because these very intuitions are not sufficient to aquire general knowledge in mathematics. In this respect Mathematics seem to be a typical domain requiring conceptual change.

Beyond mathematics, there are general features of conceptual change which could help us understanding this process. Learning is known in general to be inductive and proceeds by accumulation of information.

There are also more distinctive effects of conceptual change. Some large scale effects: spacing periods of work with large scale intervals of time. Smaller scales effects: interleaving different periods of work about different concepts instead of working continuously on the same concept, and configuration which is a particular case of spacing, separating two periods of work by an interval of rest or distraction.

There are also specific subjective features of conceptual change : learners and problem solvers often experienced discontinuous and strong resolution feelings. We have here three different types of cues for assuming it: insight reports in history of mathematics, literature on problem solving showing that people cannot predict their proximity to a result until they have reach it, and an argument from Gilhooly who explains the benefit of incubation with unconscious processing.

This leads to the main problem of my phd which concerns the objective feature of conceptual change in mathematics and their relation with metacognition.

Study A, which is completed now, is dedicated to this question. B and C ongoing studies are dedicated to more specific aspects of this question. Study D, which is currently running relates to geometric intuitions as the exploration of the concept we used for studying conceptual change in A,B,C.

Study A is now completed. We had four goals before conceiving it.

Our learning situation is the notion of geodesic which is the generalization of straight line on all surfaces, notably on curved surfaces. We noticed that people identify correctly the first and the second one as respectively non straight and straight, even if the notion of straightness on spheres is rather counter intuitive. But they often fail to identify that the third case is not straight. And we think that they fail because this pattern is a plane intersection. As it is so error prone, geodesic is then a good candidate for a conceptual change situation.