

# Probation Report Outline

Joseph Corneli

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## Abstract

This is an “outline” of my probation report (due in September). It introduces the concept of dynamic maps, and gives some background on explaining why we would think about these things in the process of building a personal learning environment for mathematics.

“Outline” is in quotes because this document more represents the ideas I plan to put into some more standard outline format coming from the research school. If it lacks detail in places, that is because it will be expanded into a  $\approx 20$  page report!

## 1 INTRODUCTION

Mathematics, like many academic subjects, but more explicitly than most, is presented as a sequence of modules. Mastery, at any level, is evidenced by the solution of problems (cf. [3], page 157, referenced in [4]).

Behind this sequential presentation there is an implicit nonlinear arrangement of dependencies and cross-references. The idea of tracing this network has come up at various times in the history of mathematics. Matters of both *content* (definitions, theorems, proofs) and *process* (exposition, theory-creation, proof) have been taken up in these projects. For example, Leibniz’s *characteristica* was focused on process; contemporary visions of a world digital mathematics library are focused on content.

With various elements of both types of projects now being realized on computers, the possibility of *dynamically mapping the relationships between mathematical process and mathematical content* is opened up. For example, we can realistically imagine charting how much mathematics a student knows at any given point in time by looking at a graphical overlay on top of a map of mathematical knowledge as a whole. (Also cf. Galois on relations.)

This vision is still just a technological possibility, not a *fait accompli*. Indeed, although various implementation steps pursuant to these goals seem clear (see Section 3), the practices adequate to achieve the most exciting results are rather less clear. In short, the traction between ideas and implementation in a dynamic context is not well understood.

In order to deal with this issue, I propose a multi-pronged approach, corresponding to the many-layered Deleuzian view described in DeLanda’s “A New Philosophy of Society” [1]. The right maps and connections within and between various levels need to be traced and set into motion or brought to life – anything but dreaming about utopias.

This is why the “sensemaking steps” taken by this project (such as *Simplification*, *Interconnection*, *Mastery*, *Praxis*, *Linearization*, and *Experiment* – or *SIMPLE* for short) need to be “real”, not just “mental”.<sup>1</sup> In particular, a research project on dynamic maps should really be an applied project. (Discuss Popper’s “Conjectures and Refutations” here.) Sensemaking is not so much positivistic science as an embodied view on ingenuity.

Our development goal is the production of a self-directed course of study in mathematics, extensible, editable, and self-documenting in the style of Emacs (or free software more generally), and no more difficult to learn.

Attendant to such a development goal are some more “social” objectives, including motivating sufficiently broad participation. (Cf. Emacs on MOTIVATION.) Of course, another one is: are users learning mathematics?

On this note and with reference to mathematics as a domain of study: even though we are talking about an applied social/software engineering project, the “meta-mathematical” mapping processes we will develop (outlined in the next section) in a certain sense have no aim of their own except for tracing the aims and behaviours surrounding mathematical practice. It is in this sense that this work is “anthropological”.

Indeed, to summarize the foregoing comments and points into one unified research question:

*Can various collaborating stakeholders, with nexuses at KMi, KWARC, and PlanetMath, guided by an anthropological method rooted in sense-making, develop, over the next few years, a self-directed course of study in mathematics, built using free software principles, with a significant and documented social importance?*

## 2 BACKGROUND

Actions going according to plan and plans suited to the desired actions. Too good to be true? Certainly a lot of questions come to mind.

How do we manage a large-scale project, given that its “success” depends on diverse contributions, skills, and motivations? What actually happens is often determined by purely formal thinking (“if you build it they will come”) and other similar illusions!

How much coordination is even desirable? Perhaps we want a very loose sort of coordination, like a common language that constrains what everyone can speak, but which permits the formation of an infinite number of sentences.

Mapping the possible as well as effectuated activities becomes a sort of linguistic trace. The key thing is that as actions change, the language changes too. Out of this comes the idea of a dynamic map. (Cf. Korzybski.)

Such maps can be applied to development projects (language change) or to learning projects (language acquisition). The map can even be applied to itself. Thinking about things this way, it appears that a great many human artifacts and behaviors already “count” as dynamic maps. This research project is thus less a description of a new technology, and more a tracing of the shape of many existing technologies.

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<sup>1</sup>Originally *Simplification*, *Interconnection*, *Control*, *Praxis*, *Motivation*, and *Experiment*, but *SICPME* isn’t a very cool acronym. In any case, the ideas,  $-$ ,  $+$ ,  $/$ ,  $*$ ,  $\partial$ , and  $\int$ , are the same. Note that whatever the acronym, it would be useful to compare Pólya’s problem-solving stages.

Still, we must ask some questions that are not yet thoroughly understood. How does embodied communication work relative to text? (Cf. “Language and gesture”.) How does it sometimes fail to work? What criticisms of communication or “communicationist” thinking are most appropriate? (Cf. Nishida [5].) What can we *do*, as critics or engineers of e.g. learning and teaching practices and processes? (Cf. Foucault [3].) Does the very specific idea of “knowledge management with sensemaking” provide a critical apparatus that will give us some mileage in applications? (Cf. Deleuze [2].)

These issues help contextualize the research question proposed above, and show how it connects to broader issues in project management, communication, and critical philosophy. In the two following sections, I sketch a design and implementation project that aims to answer the question (in the affirmative, or else say in a reasonable way why no affirmative answer was possible.) Throughout, my approach will be based on an iterative application, reevaluation, and extension of my proposed framework for sensemaking.

### 3 PROPOSED WORK 1: A PLE FOR MATHEMATICS

The first phase of the implementation-for-mathematics project can be sketched easily enough. We want: a (1) personalized, (2) semantically adaptive, (3) social platform, (4) for learning, (5) and doing mathematics:

- (1) We can use and existing registration and login features of PlanetMath, and extend them with more personalizable services.
- (2) We can connect PlanetMath to the OMDoc/TNTBase/sTeX/JOBAD toolset developed at KWARC.
- (3) We can improve PlanetMath’s forums, add blogging and blog-aggregation features, and play well with things like GNU Social.
- (4) We can add STACK and/or EduTeX for interactive problem solving.
- (5) and we can integrate wherever possible with the ArXiv, e.g. by adding links in both directions.

Since this is just a matter of polishing up and integrating existing tools, it shouldn’t be too hard. What’s interesting about this is to ask how close these somewhat obvious steps bring us to the dynamic mapping ideas. Certainly they do not get us all the way there: the question then becomes, what’s next?

Answering that question will be related to solving motivation and incentive problems. (Cf. TopCoder<sup>2</sup>, calc101.com<sup>3</sup>.) This means listening to any complaints or noting any obvious gaps, doing sensemaking and subsequent implementation work around these things.

Any data or stats we can get out of the system will be helpful. (E.g. to sketch coverage, or coverage versus usage, etc.) Indeed, to implement the “PLE idea”, we will often want to make such data available to learners, so that they can use it to design and self-regulate their own learning practices. This, in turn, should create a crowdsourcing component.

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<sup>2</sup><http://www.topcoder.com/>

<sup>3</sup><http://calc101.com/>

The question about contribution of exercises and high-quality semantic mathematics will be challenging. Redesigning PlanetMath’s scoring mechanism to take this sort of “quality” into account may help. Working to get various faculty-level contributors appropriate forms of “credit” for their participation will also help. (I have at least one collaboration of this nature in mind.)

## 4 PROPOSED WORK 2: DEVELOPING THE DYNAMIC MAP CONCEPT

This part of the project is more exploratory, but some high-level points can be made.

- Lots of tools exist for project management and dynamic mapping thereof. (E.g. Trac, github issues, etc.) Some background research on how these tools are used/useful will be in order.
- PlanetMath itself implements a basic “issue tracker” in the form of *corrections*. In what ways is this useful or not useful, working or not working? What other workflows exist for dealing with crowdsourcing and/or education that we could try out? (E.g. editorial boards work in an “academic” context, but do they work for education? How might things like Peer 2 Peer University<sup>4</sup> or ideas from various Popular Education programmes work here?)
- PlanetMath has historically had a slow response time when it comes to feature requests. Why is that, and what can we do about it?
- The SWOT/SECI/SIMPLE models are supposed to work for project management – but can they be retuned to work for much, much, bigger things like managing an entire academic discipline – or something like “science”? Getting some sense of the flows involved certainly wouldn’t hurt as “background research” (e.g. getting info about the number of STEM graduates, the demand for them, and other stuff like that).
- Looking at this the other way, although PlanetMath and its immediate context is useful as a “main example”, other *small* examples will make for a much better research project. Luckily there are many free software and content projects out there (and the author is already involved with a few of these, including Etherpad<sup>5</sup>). This will be useful for purposes of comparison.

In short, to make this work well, there should be both an “HCI” component and a more general social-anthropological component.

## 5 CONCLUSION

I have sketched a Ph. D. project about supporting the learning and practice of mathematics in a contemporary online context. The challenges faced by any such project are both social and technical, and in a large-scale project, particularly complex. In order to deal with this complexity I have introduced a set of SIMPLE and widely applicable sensemaking steps, which, combined with the idea of dynamically mapping

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<sup>4</sup><http://p2pu.org/>

<sup>5</sup><http://github.com/ether/pad>

various forms of social engagement, forms the basis of an anthropological method suited to working with this kind of complexity.

This work connects to the way project management, communication, and critical philosophy tackle the issues of learning and development.

The key outcomes of my proposed work are (1) a semantically adaptive, socially networked, personalized learning environment for mathematics, and (2) a strategy for effectively managing “crowdsourced” development projects.

## **Bibliography**

- [1] Manuel DeLanda. *A New Philosophy of Society: Assemblage Theory and Social Complexity*. Continuum, 2006.
- [2] Gilles Deleuze. *The Logic of Sense*. Columbia University Press, 1990. Edited by Constantin V. Boundas.
- [3] Michel Foucault. *Discipline and Punish: The Birth of the Prison*. Penguin, 1970.
- [4] Nick Lee and Steven D. Brown. The disposal of fear: Childhood, trauma, and complexity. In *Complexities: Social Studies of Knowledge Practices*, 2002.
- [5] Kitaro Nishida. *Hataraku mono kara miru mono e*. Tokyo: Iwanami Shoten, 1927. Known in English as “From Acting to Seeing” or “From That Which Acts to That Which Sees”.