Evangelizing beyond early adopters: Developing materials to train teachers in the use of GeoGebra

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Abstract: The author has presented more than 20 workshops on GeoGebra to high school and college teachers using a variety of formats, from an hour session to a weeklong program. One indication of the successfulness of the workshops is the significant percentage of participants, as high as 50% for some workshops, who have subsequently made presentations of their own at professional meetings, or have trained colleagues to use GeoGebra. Since GeoGebra is open source, without a marketing department or professional trainers, its progress depends on users learning how to train their colleagues. This paper explores working principles that should inform preparation of training material and gives an outline of material that is already available and what still remains to be developed.

1. PREMISES FOR STRUCTURING A GEOGEBRA WORKSHOP

In developing material for training sessions on GeoGebra it is worthwhile to consider the assumptions of typical professional development programs and how they need to be modified for GeoGebra training. Typical professional development is either done by professional trainers or by people working with the marketing department of some product. Sessions tend to be organized by the administration, which has decided on curricular materials to be used. In contrast, since GeoGebra is open source without a company selling it, the trainers are typically be fellow teachers, often the teachers who are the early adopters of any new technology in the school. This means sessions should be organized for teachers who are trying to decide if GeoGebra is a worthwhile investment to help them in the task of teaching mathematics. This shifts the task of the trainer, from that of simply imparting expertise, to one that also involves introduction to a community and giving guidance to teachers searching for resources that fit into a syllabus that has already been determined. Importantly, it means running a training session in GeoGebra also includes advocacy to teachers not yet convinced that GeoGebra will work in their situation. This has implications both for the structure of any workshop and for collections of material that should be available as reference material for participants to use after the workshops.

As an early adopter, it is worthwhile to be explicit about assumptions I make about teachers who are trying to bring new methods into there classrooms. I assume they have good will, but are generally overworked and constrained by significant structures of inertia. In particular, almost all teachers are working with an overfull curriculum that they are not at liberty to trim. They will have their students evaluated by criteria designed without assuming the use of dynamic software or much technology. They teach within a sequence of courses, with someone else teaching the prerequisite and following courses. They understand that any new methods will, at least initially, mean more work for them.

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2. WORKSHOP GOALS

Giving these structures of inertia, it is unreasonable to expect many teachers to embrace a fundamental and thorough shift in pedagogy or teaching style at the outset. Thus, while GeoGebra allows a more dynamic and student centered pedagogy, the first goal of teacher development and evangelization for GeoGebra becomes to describe modest changes that a teacher can implement with a minimal amount of effort. This needs to be done within the pedagogical model currently embraced by the teacher. A second goal is to develop an imagination in the teachers that could see further development where more profound change is possible. In talking with teachers, I refer to the approach as the “shiny toy" theory of pedagogical reform. Faced with structures of inertia, I want to present teachers with a collection of shiny toys, with the intended reaction being that they see two or three toys that will make their lives easier, teaching in fundamentally the same manner that they currently teach. I then want to convince them that if those toys work well, there are others they may want to use in the future. Only after the teachers are regularly playing with a dozen or so toys, will they be ready to discuss systematic changes in teaching style and methodology. A consequence for this theory is that initial training material needs to explicitly address that GeoGebra can be

used in a variety of teaching styles.

This set of premises translates into a set of goals for a training workshop:

- Convince the teachers that GeoGebra is easy enough for them to use it.
- Have each teacher leave the workshop with an activity that they plan to use in their classroom during the next semester.
- Have each teacher envision at least a second activity that they will want to use, when they get time.
- Build a structure where the workshop is the beginning of a path of learning to use GeoGebra as a tool in teaching.

In terms of the shiny toy theory, each teacher should leave with a packaged toy that they plan to use right away. This will be an applet, or a GeoGebra file that can be plugged into a lesson for a specific day in the coming semester's curriculum. Each teacher should also have the sense that they can build an activity on their own, along with the experience of having done that. They should be thinking about a specific way of making a new activity. Finally, each teacher should have an answer to the question of where they go for help when they reach the next stage.

3. WORKSHOP OUTLINE

These considerations lead to my basic outline for a training workshop:

- Either find GeoGebra on your machine, or download it, and turn it on.
- Create a simple activity to demonstrate a standard theorem from geometry. (Geometry is chosen because it is simple and visual. My favorite activity is cutting a triangle in half three times and showing the lines all meet in a single point.)
- Save the activity developed above as an applet.
- Having used a number of tools, show the handout with all the tool menus together.
- Add some bells and whistles to first activity (e.g., colors, styles, text, and checkboxes).
- Do an algebraic activity connect geometry and algebra, such as the family of functions applet.
- Point out online resources, wikis, and collections of applets.
- Talk about process of incorporating technology like GeoGebra into teaching a class.
- As there is time, repeat the cycle of thinking about a concept that can be demonstrated/clarified with GeoGebra, and creating an applet or demonstration. If possible, create teams that will build pedagogical units and work together outside of workshop.
- Discuss reasonable expectations in pedagogical shift.

4. GOAL ONE – CONVINCE PARTICIPANTS THEY CAN EFFECTIVELY USE GEOGEBRA

It is worthwhile to connect the workshop outline to the workshop goals. Specifically, the order of presentation is not the same as the order in which the goals were listed. As with any professional development workshop it is better to actively engage the teachers. Thus the workshop starts with no assumption of familiarity with GeoGebra. The first goal is to convince the teachers that they can make something useful on their own, thus we start with creation of a geometry activity, not because we thing it is the most common course, but because it can be constructed using only tools presented by icons. For a similar reason, we have the participant save an activity as an applet so that they can see how easy GeoGebra makes applet creation. This first cycle of applet creation is done step by step, with participants following the actions of the workshop leader. It is anticipated that participants will follow along, but will want instructions they can go back to at a later date. To ease concerns about remembering details, the leader should have materials that could be used independently, but will more typically be references for the instructions that are only partially remembered the next day (May, 2012a, Activity handouts i and ii cover the geometry activity and converting to an applet). Experience shows that lists of capabilities are more effective after a step by step construction rather than at the outset (May, 2012a, Technical handouts).

5. GOAL TWO – PROVIDE AN EASY AND USEFUL TAKEAWAY TOOL OR SKILL

The second goal is to see that the teachers each walk away with something that they can use in the coming semester in their classes. As mentioned above, I like doing a more algebraic construction, such as the Family of Functions applet, since such an applet is useful in a broad variety of courses (May, 2012b for applet, May, 2012a, Activity handouts iv for construction). Obviously, there are many choices of the material to be used for this activity. Ideally the workshop leader has a collection of applets on a web page so participants can make a suggestion and be shown applets that have already been developed. In a number of workshops, the ability to make nice graphs that can be exported for tests and worksheet has appealed to partici-

pants as a useful takeaway (May, 2012a, Activity handouts x.a).

6. GOALS THREE AND FOUR – BUILDING FOR THE FUTURE

The last two goals are intrinsically intertwined. Thinking about other uses of GeoGebra is connected with building structures that will support its use. As more time is available for repetition of the cycle of constructing activities and learning techniques, the focus can be adjusted for participant interest. It is important to have some time for discussion about pedagogy and how a GeoGebra activity or applet can be incorporated into a class structure. It is useful to emphasize how materials can be adapted to a variety of teaching styles and situations. I point out a variety of methods I have seen, including homework with applets and paper worksheets, in class demonstrations by the teacher, and having students create constructions in a lab setting. Ideally participants are organized into teams that will create an activity during the workshop, but more importantly will build more activities after the workshop is over. I caution the participants that planning on 2 or 3 new activities in a semester is actually quite ambitious at first. From past anecdotal experience, if a participant incorporates at least 3 GeoGebra activities in the classroom over the next academic year, they will continue to develop material and reshape their teaching.

Since the paradigm of open source material differs from that of proprietary products, it is important to introduce participants to community resources, both discussion groups and repositories of materials. It is also important to encourage the normal ethics of open source material, where users contribute material they produce back to a common pool.

7. BUILDING RESOURCE SETS

Along with the workshop there is a need to have developed materials for the participants and for their colleagues. The first block of material is needed immediately and as mentioned above is a collection of handouts or screencasts that cover activities substantially the same as was covered in the workshop. These materials allow the participants to focus on following along and making the constrictions, rather than taking notes. They also allow participants to independently review the material at a later date and fill in any gaps in their understanding. Such materials have been developed independently by a number of workshop leaders (Bautista, 2012; Christersson, 2012; May, 2012a; Phelps, 2012a; Renault, 2011a). While the materials have different styles, they all provide a reasonable repository of materials that can be viewed as discrete lessons, with enough detail to be used independently, over introductory material in learning to use GeoGebra.

It is also useful to have materials that extend the workshop. Once again it helps to think about the mindset of a typical workshop participant and to think of a reasonable list of questions a participant might ask:

- What can GeoGebra do for me as a teacher of a particular math course?
- What resources are available for me if I want to use GeoGebra when teaching a particular math course?
- How do I use a particular capability of GeoGebra?
- Where can I find a general library of activities and applets?
- Where can I find a more substantial introduction to GeoGebra?

The fourth and fifth of these questions are easy to answer. In contrast, the first three questions are only partially covered. The easiest question to answer is for the location of a more substantial introduction to GeoGebra. The original designer of GeoGebra, Markus Howenharter, and his wife have coauthored a book (2011) that has been updated to cover the newest version, and is available online. Steve Phelps has also produced a handout (2012b) that is at least the size of a small book. The GeoGebra Forum (2012) has over 70,000 posts, and will provide answers to almost all GeoGebra questions.

There are several good libraries of GeoGebra applets and activities. The preeminent library of GeoGebra files is GeoGebraTube (2012), which is also set up as an easy place to post files. Mentrard (2012) has an excellent library that in particular shows off how GeoGebra can be used for visually appealing activities. Kuhlmann (2012) has a site that has a lot of GebGebra files, essentially organized along the lines of a standard high school syllabus. May (2012c) has a collection of applets, each in a web page that gives mathematical background for the appropriate lesson.

One of the areas where resources is still lacking is collections of resources, organized by the standard syllabus of a course, with information concerning how to use the applets or activities in a classroom setting. The best example I have seen is the collection of applets by Renault (2012b) set up to cover the topics in a standard course in single variable calculus. Collections like this are very useful for instructors who are open to using technology like GeoGebra, but are not early adopters. I hope that collections like this appear for more courses.

Another question where the resources do not seem to be fully developed is question 1, the area of listing GeoGebra capabilities, with the organization once again being done

by course, using a fairly standard syllabus. May (2012a, Activity handouts, v.a, v.d, and vi.) has produced documents that outline GeoGebra capabilities for single variable calculus and introductory statistics. It would be nice to have comparable documents for other standard courses.

The final question to be considered is a collection of documents that are organized not by mathematical content, but by the technical capabilities of GeoGebra. These resources would be aimed at more advanced participants who are ready to make their own materials. Material of this kind can be found in the tutorial sections listed above.

8. CONCLUSIONS

Since GeoGebra is free rather than sold, evangelization falls to teachers rather than to sales reps. To effectively change the culture where GeoGebra usage is widespread rather than restricted to the usual early adopters of any technology, the training, often done by in-service teachers, needs to be done in a way that allows for gradual increases in usage and the building of a community of users who will develop and share materials.

REFERENCES

Bautista, G. (2010). Mathematics and Multimedia GeoGebra Tutorial Series. Retrieved from http://www.alistapart.com/articles/writeliving

Christersson, M. (2012). GeoGebra Tutorial. Retrieved from http://www.malinc.se/math/geogebra/mainen.php

GeoGebra Forum (2012). Available online at http://www.geogebra.org/forum

GeoGebraTube (2012). Available online at http://www.geogebratube.org/

Howenharter, J. & Howenharter M. (2011). An introduction to GeoGebra 4. Downloaded from http://www.geogebra.org/book/inro-en.pdf

Kuhlmann, D. (2012). Geogebra Activity Site. Retrieved from http://dougkuhlmann.webs.com/

May, M. (2012a). Professional Enhancement Programs of the MAA. A list of handouts located at https://prep11geogebra.pbworks.com/w/page/30980465/FrontPage

May, M. (2012b). Family of Functions. Applet located at http://www.slu.edu/classes/maymk/GeoGebra/FamilyOfFunctions.html

May, M. (2012c). SLU GeoGebra Applets. Located at http://www.slu.edu/classes/maymk/GeoGebra/

Mentrard, D. (2011). Les Mathematiques. Accessed at http://dmentrard.free.fr/GEOGEBRA/Maths/accueilmath.htm

An Introduction to GeoGebra Screencasts. (n.d.). Retrieved June 5, 2012 from the GIOHIO Workshop Wiki: http://giohio.wikispaces.com/An+Introduction+to+GeoGebra+Screencasts

An Introduction to GeoGebra Workshop Handout. (n.d.). Retrieved June 5, 2012 from the GIOHIO Workshop Wiki: http://giohio.wikispaces.com/An+Introduction+to+GeoGebra+Screencasts

Renault, M. (2012a). A GeoGebra Tutorial. Accessed at http://webspace.ship.edu/msrenault/tutorial/index.html

Renault, M. (2012b). Calculus Applets using GeoGebra. Accessed at http://webspace.ship.edu/msrenault/GeoGebraCalculus/GeoGebraCalculusApplets.html

Tutorial Page (n.d.). Retrieved from the GeoGebra Wiki: http://wiki.geogebra.org/en/Tutorial:Main_Page