Aha! Moments while learning mathematics with Geogebra

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Profile: Harita Raval and Sushant Pawar are part of the mathematics education research group and Deepa Chari is a reader at Homi Bhabha Centre for Science Education(HBCSE), TIFR. The work presented here is a part of a larger talent nurture programme called Vigyan Pratibha of the HBCSE, which is aimed at supporting high quality and well-rounded science and mathematics education to interested students.

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ABSTRACT: In recent years, we have witnessed a growing demand for computer technology inclusion in school education. But somehow , mathematics teaching in Indian classrooms still opts for traditional "chalk and board" style, leaving the technology part mostly for demonstration purposes by teachers, that too with a little exchange of ideas about these demonstrations collectively from students. Moreover, students rarely have opportunities to observe peers' work and comment, which eliminates the possibilities of discussing a wide range of students' drawings that an open-ended question may have generated in class occasionally. Overall, teaching mathematics offers a little opportunity for visualization and exploration to students, and silently pushes the agenda for re-envisioning technology use for constructive teaching and learning in mathematical classrooms. Foregrounding these reasons, we have developed a workshop to enhance the experience of learning mathematics and science "by doing". The workshop sessions allowed students to explore the basic mathematical processes, like finding examples, making conjectures, proving theorems, etc. The paper describes details of a particular session on the "Euler line" explored with the Geogebra platform. The session was conducted with 20 students, who have passed 9th std from central government schools.

  In Geogebra-like learning environments students can easily construct complex geometrical figures and perform a very wide range of transformations on figures. In our session, students began with exploring basic geometric constructions from their mathematics textbooks. Students were then asked to find the centroid, circumcenter, or orthocenter of a triangle they have constructed on Geogebra. The question then posed to the students was how are these centres related? Is there a ratio that can be obtained

as a distance between orthocenter and centroid and centroid and circumcenter? If yes, how can we find it? Describing the collinearity of the orthocentre, circumcentre and the centroid of a triangle, was first presented by Leonard Euler in the 18 [th] century. It is known as the Euler line and is regarded as one of the finest results in geometry. With the Geogebra platform, students could visualise this collinearity in seconds, their first "Aha" moment! Not only that, Geogebra could also allow students to explore more examples easily which lead them to come up with more informed conjectures from observations, many "Aha" moments for individual students. Like in another instance from the classroom, students were asked about the location of all the centres and the ratio, in the case of equilateral triangle. Due to the dynamic nature of Geogebra, they could easily construct such triangles and observe that all centres coincide when we have equilateral triangles. Also, with the help of an algebra window, it was very easy for them to justify that the ratio which is 2:3 will not be true in this triangle!! Just to list, such an environment also eliminates the limitation of human error in construction which in a classroom is hardly possible.

These Aha! moments encourage students to learn mathematics. We believe the potential of enabling students to explore mathematics through technology will give them a rich and motivating environment to explore mathematical ideas. In our workshop, we could observe how GeoGebra empowered these students by giving them access to higher-level concepts while exploring geometrical problems and also created many "Aha" moments for them to enjoy mathematics.

KEYWORDS: Mathematics Education, Geogebra, Euler line

Additional Resources:
- https://vigyanpratibha.in/
- https://mathedu.hbcse.tifr.res.in/

Recording of presentation: (from 4:50 to 5:07)
https://www.youtube.com/watch?v=xim5-GhuX9Q