VISUALIZATION OF ORTHONORMAL TRIADS IN CYLINDRICAL AND SPHERICAL COORDINATES.

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According with Committee on Programs for Advanced Study of Mathematics and Science in American High Schools (2002, p. 197), "the primary goal of advanced study in any discipline should be for students to achieve a deep conceptual understanding of the discipline's content and unifying concepts. Well-designed programs help students develop skills of inquiry, analysis, and problem solving so that they become superior learners."

If it is undoubted that abstraction is one of the skills that teachers wish to improve in their students, our first question is: Must teachers take advantage of technological resources such as CAS or DGS as a help in their classes in undergraduates courses and what kind of course could be the best for proving it really happen?

If we had to decide which courses can be a goal to use any kind of technological help, we will choose Geometry. Hilbert, D., and Cohn-Vossen, S. (1990, Preface, p. iii) said that Geometry has had a tendency to magnify some conceptual theories which make extensive use of abstract reasoning and symbolic calculation in the sense of algebra, but "with the aid of visual imagination we can illuminate the manifold facts and problems of geometry".

One concept, whose importance is both theoretical and practical, corresponds to the coordinate transformation, in particular orthogonal coordinate systems. We can use trigonometric constructions to find the transformation equations, i.e., the algorithm for passing of a Cartesian system, of two or three dimension, to other coordinate system, such as: polar, cylindrical or spherical coordinates. But if we add the knowledge and some techniques from Linear Algebra, for example following the reasoning of the book by Arfken & Weber (2005), we can introduce new mathematical properties, but we will increase considerably the abstract reasoning and symbolic calculation.

So, a second question arises: how we can increase the mathematical level and at the same time help students to understand this knowledge? We know that visualization helps intuitive understanding. Both of them play a major role in geometry. Therefore we propose using CAS and DGS to show how a triad, of basis vectors, is continuously changing of direction, keeping the norm vector without change, and we can match this visualization with the reasoning from theories of linear algebra.

References

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