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# What Happens to Chemistry with the Reforms Advocated with STEM?

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**Abstract:** Few have questioned the appearance of chemistry as a high school course or its place among science offerings in most colleges. The emergence of Nanotechnology and the new focus on STEM research and teaching affect the status of chemistry as a discipline in educational settings. This short "Musing" illustrates the changes and current efforts related to chemistry offerings.

**Key Words:** Learning structures, centrality of questions, amalgamating science.

## MUSINGS

There seems to be hype and dollars supporting education with reference to STEM as a revolutionary change in science education. Funding for STEM reforms is important and exciting! But, what does it really mean? How does it affect chemistry, as typically taught in colleges? And what does it do to chemistry in high schools? Of course, it is easy to interpret STEM as an acronym for educational reform related to Science, Technology, Engineering, and Mathematics. But, is that enough??

Chemistry has long held a special place in the high school curriculum, along with physics. They are commonly 11th and 12th grade offerings labeled "college preparatory." Some now worry that chemistry will disappear with STEM efforts as a focus for education K-16 and for all students.

Physics was first labeled as a course required for entrance to Harvard University in 1896! Ten years later Harvard decided to require chemistry too. Most other universities were quick to follow Harvard! Such "entrance" requirements have identified Chemistry to be but "college preparation" required by universities — now for over a hundred years. It is offered to satisfy college entrance requirements with little concern for why. It is typically taught in high schools similar to the ways it is taught for college undergraduates. The problems will change and intensify if STEM efforts for K-12 curricula succeed. It could well ignore specific reference to the separate science disciplines!

Many chemists were concerned when the 1996 National Science Standards combined physics and chemistry into "physical science," along with biology and earth/space science. Now, STEM also includes Engineering and Technology and reduces Science in general (as the first letter of STEM). The advancement with STEM efforts has made it more difficult to relate school science to terms that designate the separate science disciplines. Physics and chemistry remain unchanged with the actions of the statements contained in the National Science Education Standards (NSES). Is it noteworthy that many chemists were the ones slightly upset because the term "physical science" seemed to emphasize physics more than chemistry?

Chemistry as a high school course has even been controversial with the reforms in science for schools in the early 50s and early 60s. Many linked chemistry to a new focus on the Chemical Bond Approach, marking it as a major reform and change from the typical 11th grade chemistry course defined as "topics" generally used in textbooks. A focus on "Bonding" represented a major change in Chemistry when publicized as an example of reform instruction.

As some curricula are defined as moving toward more student/learner centeredness, the importance of the typical science disciplines classified as school "science"

become even more of a problem to attain the reforms envisioned. Some actions are being taken to reform college science courses generally, but results with typical standardized testing create more problems, especially in the varying discipline content which STEM no longer uses. With the focus on developing exciting STEM programs, K-12 schools open the question again about specific science discipline content and skills required, similar to the discipline bound departments at most universities.

The excitement in using new learning theories, encouraging more research, and more focus on students personally "doing" science all may decrease interest in Chemistry, per se. Many continue to argue about what information should (must) be included in the reform of high school science courses. The concerns arise again resulting from the negative student attitudes; no focus on individual connections to life as well as no concern for science (chemistry) information or skills for personal use. Most negative student attitudes come from too little focus on the NSES goals which emphasize preparation of students for special citizenship participation and the work to solve 20th century problems. These new contexts are not common for typical Chemistry teaching — at least in any major ways. These changes need to produce more than gaining: 1) college entry; and 2) getting A's by remembering information and skills which are taught and emphasized by Chemistry professors. All these are negative outcomes of typical chemistry teaching which may also suggest failures for current STEM education — unless real changes occur in the teaching and new plans for college curricula!