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Science and Mathematics Education in the GCC Countries

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Abstract: All six countries in the Gulf Cooperation Council (GCC) have developed science and mathematics curriculum standards that focus on the content essential for preparing students to be engaged and productive citizens. A careful review of the well-developed standards in all six countries reveals a strong emphasis on the fundamental elements of critical thinking, enquiry and reasoning in all grades to ensure that students develop the ability to work creatively, think analytically and solve problems.

Keywords: Science and Mathematics Education, Curriculum Standards, Education Reform in GCC

1. Introduction

The educational systems in the Gulf Cooperation Council (GCC) countries were based on religious scholarship covering teaching reading, writing, and religious scriptures. It was not until the middle of the 20th century that the education systems began to take on a more modern and organized form. Nonetheless, teaching was teacher-centered and dependent on rigid rote-memorization, with little attention to the analytical thinking, research and communication skills that are indispensable in the ever-changing labor market. In recent years, education in GCC countries became an issue of national concern and discussion and comprehensive reforms were attempted. Each GCC country instituted roadmaps for K-12 education, including standards for science and mathematics education.

Statement of Problem

There are claims that the K-12 education systems in GCC countries are not preparing students adequately for post-secondary education or for work. Officials in the education sectors blame outdated and rigid curriculum along with educational systems lack of vision and goals and poor training of teachers. Hence, lack of educational standards has been identified as a primary reason for the weakness of the system. This article examines challenges facing the implementation of the science and mathematics standards in the GCC counties.

2. Development of Education Standards in the GCC Countries

In general, the science standards in the GCC countries start with scientific enquiry, life science, materials, earth and space, physical processes and progress into advanced and specialized areas in biology, chemistry, and physics. The overall aims of the science standards are that students ought to create and sustain an interest for science and its applications and to be capable in utilizing a range of scientific methods and technique and in taking care of mechanical assembly. The standards additionally intend to create sound and efficient learning of vital scientific facts, ideas and principles, and abilities required in continually changing circumstances of personal, industrial and environmental contexts (Alfadala, 2015).

On the other hand, the mathematics standards in the GCC countries are mainly comprehensive with reasoning and problem solving, algebra, calculus, geometry, trigonometry, and statistics and probability. Students are expected to become problem solvers capable of solving familiar and unfamiliar problems in mathematical real-world settings. They are supposed to develop proficiency in mental and written calculations, algebraic manipulation and other techniques, including visualization and geometric imagery.

2.1. Vision of the Standards

The Standards present a vision of a scientifically literate populace. They lay out what students need to know, comprehend, and develop the capacity to be able to be scientifically literate at different grade levels. They depict an educational framework in which all students show high levels of performance, in which teachers are enabled to make the decisions essential for effective learning, in which interlocking communities of teachers and students are centered around learning science, and in which steady instructive projects and frameworks sustain accomplishment (NRC, 2015).

The Standards are intended to apply to all students, regardless of age, gender, social or ethnic background, handicaps, desires, or interest and inspiration in science or mathematics. One must believe that students have different abilities and will achieve understanding in various ways and will accomplish diverse degrees of profundity and broadness of comprehension relying upon interest, ability, and context. Yet, all students can build up the learning and aptitudes depicted in the Standards, even as a few students go well past these levels. By underscoring both excellent and equity, the Standards likewise highlight the need to give students the chance to learn science and mathematics. Students can't accomplish anticipated levels of execution without access to gifted proficient teachers, sufficient classroom time, a rich exhibit of learning materials, obliging learning spaces, and the assets of the communities encompassing their schools. Responsibilities regarding giving this bolster fall on every one of those included with the education system in the public and private sectors.

2.2. Application of the Standards

It is clear that the Standards stress the importance for every citizen to become scientifically literate. A scientifically literate person is identified as one who is curious about the world and desires to ask questions and find answers to those questions (Chiapetta, Koballa, and Collette, 1994). These individuals can describe and explain natural phenomena as well as predict their behavior. They can also deal with science and societal issues by expressing them from an informed point of view, using their knowledge to evaluate the issues. Knowledge and understanding of science and mathematics are important guidelines for the realization of a scientifically literate society. Students must learn fundamental scientific facts, concepts, principles, laws, and models. These ideas must be integrated into students' cognitive structures so that they can be recalled and applied in their decision-making activities. Further, students must be able to use their understanding to distinguish between scientific information that is valid and that which is unsubstantiated. Inquiry is a theme that runs through the Standards. The Standards make it clear that there are many ways to inquire and to find out, from conducting firsthand investigations to reading about what others have found (Brandt, 1993).

The Standards serve as a guide for educators and policy makers in the respective countries in meeting their goal of producing scientifically literate citizens. They outline what students should know, understand, and be able to accomplish in the natural sciences and mathematics at different grade levels. The Standards provide significant impetus for reform as well as goals that should function as coordinators and regulators. They provide the qualitative criteria and framework for judging science and math programs (content, teaching, professional development, assessment, program, and systems) and the policies necessary to support them (Spillane and Callahan, 2000).

2.3. Teachers' Role

The Standards provide teachers as well as the entire educational system in a country with important guidelines that they can use to plan, organize, develop, implement, and evaluate science and mathematics programs which will make a difference in reforming education. There are many dimensions to teaching and they must he considered in the development of effective educational programs that will produce scientifically literate citizens (Chiapetta, Koballa, and Collette, 1994).

Scientific and technological proficiency is the principle purpose of science education in K-12. This is applied for all students, not only those individuals bound for vocations in science. Expanding the scientific and technological competency of students requires a few key changes in science and mathematics curricula. First, the content presented must be supplanted by key reasonable plans that students learn in some profundity. Second, the inflexible disciplinary limits of earth science, biology, chemistry, and physics ought to be softened and more noteworthy accentuation placed on connections among the sciences and among disciplines generally thought of as outside of school science, such as technology, mathematics, ethics, and social situations.

Accomplishing the objective of scientific and technological proficiency requires more than comprehension concepts and procedures of science and technology. In fact, the general public must comprehend science and technology as an integral part of the society. That is, science and technology as an enterprise that shapes human thought and social activities.

2.4. Education Reform

Reform of science and mathematics education must be viewed as part of the general reform of education. Approaching the improvement of science education by changing textbooks, buying new computers, or adding a new course simply will not work. The amount of time that elementary students spend studying science and mathematics increased slightly in recent years. More encouraging is the news that greater numbers of high school students are taking mathematics and science courses (Alfadala, 2015). Nevertheless, taking courses does not guarantee results

(Schmidt, McKnight, and Raizen, 1997).

Fortunately, widespread educational reforms and reviews in GCC countries are under way. Science and mathematics educators must view reform, holistically and systemically as the reconstruction for K-12 education and include all courses and students, staff development program, reform of teacher preparation, and support from school administrators. This comprehensive or systemic recommendation is based on the research on implementation and research literature on school change and restructuring (Eisner, 1993).

2.5. Reality Check

How will the Standards affect science and mathematics in the classroom? In part, the answer depends on how well we heed the invaluable guide of past experience. If standards are used in the descriptive way, they could provide useful direction to local school systems (Gonzalez, et al. 2008). However, if they are misused to impose unattainable goals and excessive governmental regulation, the standards could become yet another reform movement that merely frustrates and, in the end, fails to improve science and mathematics education (Hoffman and Stage, 1993).

National science and mathematics standards can supplement K-12 educational systems with a solid conceptual basis for reforming education. Local curriculum framework developers can use the Standards to describe the knowledge and skills they want their students to have. By aligning the framework with credible, nationally accepted guidelines, education leaders will be able to build support for their framework more rapidly. They will also be able to take advantage of implementation tools that are being developed to support these national guidelines.

Decisions about what to teach, how to teach, and how to evaluate what students have learned are among the most important choices educators make. While there are many reasonable criteria for making such decisions, only by carefully evaluating textbooks, teaching strategies or tests against specific science literacy goals (i.e. Standards) will we be able to help students achieve those goals.

2.6. Putting It All Together

Using Standards as the focus of teacher education and professional development programs can help define a base for teachers' content knowledge and for their understanding of standards-based reform and its implications for teaching and learning. Just as Standards can bring coherence to the K-12 curriculum, they can also encourage colleges, universities, and school districts to coordinate their teacher education and professional development efforts. Standards can also help GCC countries strengthen their teacher certification and placement requirements.

Setting high academic standards for *all* students contributes to greater equity in the educational system. A core curriculum based on the goal of science literacy for all students will help create a larger and more diverse pool of students who are likely to pursue further education in scientific fields. These same efforts will help *all* students gain the knowledge and skills they will need in a world that is increasingly shaped by science and technology (Bybee, 1996).

No matter how skillfully crafted, Standards alone cannot change science and mathematics education. Leaders in the educational systems in the countries have an unprecedented opportunity for reform, but much more will be needed. If Standards are all that they should be, then many schools will find themselves falling short. These schools will need financial, human, and curricular resources to meet the Standards. New teaching methods, materials, and assessment tools must be developed so that Standards can be implemented. All of this requires a commitment far beyond the adoption of Standards. Educators have to move beyond the analysis of the Standards and use them to improve curriculum, instruction, and assessment and to inform professional development (Bybee, 1996).

3. Conclusion

The Standards provide a powerful set of policies to guide the improvement of science and mathematics education programs and classroom practices. As important as the development of the Standards has been, it represents only one step in the progress of standards-based systemic reform of education. The Standards, rather, present outcomes, not the means to achieve the outcomes. By design, the Standards do not provide complete programs, practices, and assessments (Gonzalez, et al., 2008). Practitioners with technical expertise to read, interpret, and implement all dimensions of the Standards will have to implement the policies as school science programs and innovative instructional practices.

It is human nature to resist change, even when it is necessary. Therefore, adoption and implementation of the standards rely on people as agents and consumers of the Standards without being distracted with daily operation and bureaucracies. As change agents, education officials in GCC countries must concentrate on building a critical mass of motivated, interested, capable people supporting the Standards and working to make them a success. The critical mass extends beyond teachers and administrators to include parents and visionary leaders. As consumers, communication is key to keep the public informed about the Standards and their full implementation in the classrooms. Second, schools do not exist in vacuum, thus they must respond to workforce needs, projected quantity and quality of jobs, and aspirations for future generations. Consequently, evaluation of the Standards and their outcomes must be ongoing and in line with the ideals of the governments. It is important to realize this is a process, not a project with a due date on a calendar. This continuous project will transform the educational systems in the GCC countries into a culture of work to monitor and assess, to make changes when necessary, and to reflect on new directions.

The challenge of the science and mathematics education reform is large, significant, and achievable, and will require the combined and continued support of all. Education

researchers can contribute to meeting the challenge through policy as well as through research (Collins, 1998).

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