INTEGRATING THE NATIONAL SCIENCE EDUCATION STANDARDS INTO CLASSROOM PRACTICE pdf

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Subject Catalog. Humanities & Social Sciences. Anthropology; Art; Communication, Film & Theatre Catalog. Mass Communication / Public Relations / Film; Speech Communication.

The fourth standard addresses the characteristics of quality professional development programs at all levels. Professional Development Standard A Professional development for teachers of science requires learning essential science content through the perspectives and methods of inquiry. Science learning experiences for teachers must Involve teachers in actively investigating phenomena that can be studied scientifically, interpreting results, and making sense of findings consistent with currently accepted scientific understanding. Address issues, events, problems, or topics significant in science and of interest to participants. Introduce teachers to scientific literature, media, and technological resources that expand their science knowledge and their ability to access further knowledge. Incorporate ongoing reflection on the process and outcomes of understanding science through inquiry. Encourage and support teachers in efforts to collaborate. Knowledge and Understanding of Science One of the most serious questions in science education is what science a teacher needs to know. What does it mean to know a lot or a little, have a sound foundation, and have in-depth understanding? The criteria of credit hours that states, professional organizations, and higher education institutions use to prescribe content requirements are inadequate indicators of what is learned in a course. Therefore, the following discussion focuses on the nature of the opportunities to learn science needed by teachers, rather than on credit hours. It is assumed that teachers of science will continue to learn science throughout their careers. Understand the fundamental facts and concepts in major science disciplines. Be able to make conceptual connections within and across science disciplines, as well as to mathematics, technology, and other school subjects. Use scientific understanding and ability when dealing with personal and societal issues. Beyond the firm foundation provided by the content standards in Chapter 6 , how much more science a teacher needs to know for a given level of schooling is an issue of breadth versus depth to be debated and decided locally while respecting the intent of the Standards. Breadth implies a focus on the basic ideas of science and is central to teaching science at all grade levels. Depth refers to knowing and understanding not only the basic ideas within a science discipline, but also some of the supporting experimental and theoretical knowledge. National Science Education Standards. The National Academies Press. The depth of understanding of science content required varies according to the grade level of teaching responsibility. Teachers of grades K-4 usually are generalists who teach most, if not all, school subjects. A primary task for these teachers is to lay the experiential, conceptual, and attitudinal foundation for future learning in science by guiding students through a range of inquiry activities. To achieve this, elementary teachers of science need to have the opportunity to develop a broad knowledge of science content in addition to some in-depth experiences in at least one science subject. Such in-depth experiences will allow teachers to develop an understanding of inquiry and the structure and production Prospective and practicing teachers must take science courses in which they learn science through inquiry, having the same opportunities as their students will have to develop understanding. Science curricula are organized in many different ways in the middle grades. Science experiences go into greater depth, are more quantitative, require more sophisticated reasoning skills, and use more sophisticated apparatus and technology. These requirements of the science courses change the character of the conceptual background required of middle level teachers of science. While maintaining a breadth of science knowledge, they need to develop greater depth of understanding than their colleagues teaching grades K An intensive, thorough study of at least one scientific discipline will help them meet the demands of their teaching and gain appreciation for how scientific knowledge is produced and how disciplines are structured. At the secondary level, effective teachers of science possess broad knowledge of all disciplines and a deep understanding of the scientific disciplines they teach. This implies being familiar enough with a science discipline to take part in research activities within that discipline. Learning Science Prospective and practicing teachers of science acquire much of their formal science knowledge through coursework in colleges and universities. For all teachers, undergraduate science courses are a major factor in defining what science content is learned. Those courses also provide models for how science should be taught. Because of the crucial role of such courses, reform in the content and teaching of undergraduate science is imperative. The courses for practicing teachersâ€”those taught at universities as part of graduate programs as well as those typically included in school-based, inservice programsâ€”also require redesign. If that image is to reflect the nature of science as presented in these standards, prospective and practicing teachers must take science courses in which they learn science through inquiry, having the same opportunities as their students will have to develop understanding. College science faculty therefore must design courses that are heavily based on investigations, where current and future teachers have direct contact with phenomena, gather and interpret data using appropriate technology, and are involved in groups working on real, open-ended problems. Those science courses must allow teachers to develop a deep understanding of accepted scientific ideas and the manner in which they were formulated. They must also address problems, issues, events, and topics that are important to science, the community, and teachers. Learning science through inquiry should also provide opportunities for teachers to use scientific literature, media, and technology to broaden their knowledge beyond the scope of immediate inquiries. Courses in science should allow teachers to develop understanding of the logical reasoning that is demonstrated in research papers and how a specific piece of research adds to the accumulated knowledge of science. Those courses should also support teachers in using a variety of technological tools, such as computerized databases and specialized laboratory tools. In the vision described by the Standards, all prospective and practicing teachers who Teachers of science will be the representatives of the science community in their classrooms. Courses and other activities include ongoing opportunities for teachers to reflect on the process and the outcomes of their learning. Instructors help teachers understand the nature of learning science as they develop new concepts and skills. Those who teach science must be attentive to the scientific ideas that teachers bring with them, provide time for learning experiences to be shared, and be knowledgeable about strategies that promote and encourage reflection. Science faculty also need to design courses for prospective and practicing teachers that purposely engage them in the collaborative aspects of scientific inquiry. Some aspects of inquiry are individual efforts, but many are not, and teachers need to experience the value and benefits of cooperative work as well as the struggles and tensions that it can produce. Page 62 Share Cite Suggested Citation: Learning experiences for teachers of science must Connect and integrate all pertinent aspects of science and science education. Occur in a variety of places where effective science teaching can be illustrated and modeled, permitting teachers to struggle with real situations and expand their knowledge and skills in appropriate contexts. Use inquiry, reflection, interpretation of research, modeling, and guided practice to build understanding and skill in science teaching. Knowledge of Science Teaching Effective science teaching is more than knowing science content and some teaching strategies. Skilled teachers of science have special understandings and abilities that integrate their knowledge of science content, curriculum, learning, teaching, and students. Such knowledge allows teachers to tailor learning situations to the needs of individuals and groups. This special knowledge, called "pedagogical content knowledge," distinguishes the science knowledge of teachers from that of scientists. It is one element that defines a professional teacher of science. Learning is an active process by which students individually and collaboratively achieve understanding. Effective teaching requires that teachers know what students of certain ages are likely to know, understand, and be able to do; what they will learn quickly; and what will be a struggle. Teachers of science need to anticipate typical misunderstandings and to Skilled teachers of science have special understandings and abilities that integrate their knowledge of science content, curriculum, learning, teaching, and students. In addition, teachers of science must develop understanding of how students with different backgrounds, experiences, motivations, learning styles, abilities, and interests learn science. Teachers use all of that knowledge to make effective decisions about learning objectives, teaching strategies, assessment tasks, and curriculum materials. They are familiar with a wide range of curricula. They have the ability to examine critically and select activities to use with their students to promote the understanding of science. Page 63 Share Cite Suggested Citation: Teachers need continuous opportunities to do so. Through collaborations with colleagues, teachers should Teachers use their knowledge to make effective decisions about learning objectives, teaching strategies, assessment tasks, and curriculum materials. How should laboratory journals be structured? Is this experiment appropriate for the understanding and ability of the students? What type of research do students need to do to extend their understanding? Is this curriculum unit appropriate for this group of third-grade students? Does a particular study allow students sufficient opportunity to devise their own experiments? Are all students participating equally? Effective teachers are knowledgeable about the various educational purposes for assessment and know how to implement and interpret a variety of assessment strategies. Learning to Teach Science Developing pedagogical content knowledge of science requires that teachers of science have the opportunity to bring together the knowledge described above and develop an integrated view of what it means to teach and learn science. In the vision described by the Standards, teachers also develop concepts and language to engage in discourse with their peers about content, curriculum, teaching, learning, assessment, and students. The development of pedagogical content knowledge by teachers mirrors what we know about learning by students; it can be fully developed only through continuous experience. But experience is not sufficient. Teachers also must have opportunities to engage in analysis of the individual components of pedagogical content knowledgeâ€”science, learning, and pedagogyâ€”and make connections between them. For example, higher education science and education faculty must learn to work together: An instructor in a university science course might invite a member of the science education faculty to participate in regular discussion time designed to help students reflect on how they came to learn science concepts. Not only must the departments in higher education institutions work together, but schools and higher education institutions must enter into true collaboration. She also reads research regularly, reviews resources, and makes judgments about their value for her teaching. The students in her high-school class have opportunities to develop mental models, work with instructional technology, use multiple materials, teach one another, and consider the personal, social, and ethical aspects of science. She has the support of the school and district and has the resources she needs. She also relies on resources in the community. She taught the course before and read extensively about the difficulties students have with transmission genetics conceptually and as a means of developing problem-solving skills. She also has been learning about new approaches to teaching genetics. From her reading and from a workshop she attended for high-school teachers at the local university, she knows that many people have been experimenting with ways to improve genetics instruction. She also knows that several computer programs are available that simulate genetics events. She wants to provide the students with opportunities to understand the basic principles of transmission genetics. She also wants them to appreciate how using a mental model is useful to understanding. She wants her students to engage in and learn the processes of inquiry as they develop their mental models. Selecting an appropriate computer program is important, because simulation will be key to much of the first quarter of the course. Each simulation allows students to select parental phenotypes and make crosses. Offspring were produced quickly by all the programs; genotypes and phenotypes are distributed stochastically according to the inheritance pattern. With such programs, students will be able to simulate many generations of crosses in a single class period.

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In addition to offering clear descriptions of each of the six standards, Integrating the National Science Education Standards into Classroom Practice also: â€¢ Provides sample activities drawn from contemporary.

The standards now specifically address the concern for physical literacy across the nation by adding "The physically literate individual. Standard 1 The physically literate individual demonstrates competency in a variety of motor skills and movement patterns. Standard 2 The physically literate individual applies knowledge of concepts, principles, strategies and tactics related to movement and performance. Standard 3 The physically literate individual demonstrates the knowledge and skills to achieve and maintain a health-enhancing level of physical activity and fitness. Standard 4 The physically literate individual exhibits responsible personal and social behavior that respects self and others. Human Kinetics , The National Standards are broad statements that are to be used across K programs. The Grade-Level Outcomes outline these expectations for each physically literate student ending the elementary years: By the end of Grade 5, the learner will demonstrate competence in fundamental motor skills and selected combinations of skills; use basic movement concepts in dance, gymnastics, and small-sided practice tasks; identify basic health-related fitness concepts; exhibit acceptance of self and others in physical activities; and identify the benefits of a physically active lifestyle. The concept of integrating physical education into the academic curriculum may seem a daunting task for classroom teachers. However, it is necessary, especially given that many students are kinesthetic learners Hannaford, This chapter outlines these four steps for integrating physical education activities into the academic curriculum: These steps will help you move from brainstorming general ideas to creating a plan to teach the activity in class. With over lesson ideas, this section is a great place for classroom teachers to go for ready-made integrated lessons. Brainstorm Integration Ideas The first step in this approach is to brainstorm ideas for how physical education can be integrated into academic subjects. Your goal is to identify ways physical education could support the acquisition of mathematics skills expected of your students according to the standards. This might include outlining shapes with a rope or with the body, tossing balls or beanbags at specific geometric shapes, or traveling in a specific pathway. Elementary students need to be able to count in sequence, skip count, add, subtract, multiply, and divide. You can use several physical activities in a mathematics lesson to help students with these skills. For example, the student could move to the number of claps or beats, count the number of times a target is hit, or use movement to answer math flash cards. Older elementary students can measure time spent on a particular activity or tasks, construct graphs showing changes in heart rate during activity, or use pedometer data to show movement counts of different activities as ways to meet the standards for measuring, graphing, and so on. Integrating science and physical education in the elementary classroom is not hard to imagine. Physical activity addresses the systems of the body, and you can integrate the muscular and skeletal system easily through identifying muscles and bones used for activities. Involving other systems may require more setup. For example, you might do a physical demonstration of the cardiovascular system in which you use physical education equipment to create a course; students travel through the course like a drop of blood through the heart and lungs out to the body then back to the heart again. Another idea could be to illustrate the movement of the solar system by having the students physically moving like the planets would around the sun. Integrating physical education with social studies involves more creativity. Some examples include performing historical dances or reenacting historical events. Memorizing states or capitals may be easier for students in an activity setting e. The elementary English language arts curriculum offers an array of areas that can be integrated with physical education. Reading ideas include performing the instructions written on station cards, reading about famous athletes or favorite sports, reading and assessing partners using a checklist of cue words for skill performance, and acting out the content of a book while reading it. Integrating writing could include writing reflections or journals about physical activity experiences. Also, students could write reports about how to make healthy choices in nutrition and physical activities. For the speaking and listening part of the curriculum, students could give oral reports on various sport-related topics. Class discussions could include students sharing experiences with others in groups or in front of the class. You can integrate language skills into physical education through activities involving spelling words, sounding out syllables while dribbling a basketball, and acting out verbs. Link Physical Education Standards With Academic Standards When the brainstorming activities are completed, teachers will then move to more specific integration by using the National Standards for K Physical Education. This second step will connect a physical education standard with an academic standard that the students are expected to meet. One way to get started is to brainstorm ideas of how an academic subject area could integrate with the National Standards. For example, National Standard 1 states that a physically literate individual will demonstrate competency in a variety of motor skills and movement patterns. A language arts lesson could have the student spell words using large movements of the arms. A student in social studies could discuss the history and importance of fitness levels of men and women serving in the armed forces, demonstrating the knowledge and skills needed to achieve and maintain a health-enhancing level of physical activity and fitness, as required by Standard 3. For states not using Common Core State Standards or for other academic standards, you can find state standards and courses of study by searching state websites for education standards. Develop Grade-Specific Interdisciplinary Activities Now that you have developed a lot of ideas about connecting the academic standards to the National Standards for K Physical Education, it is time to address the Grade-Level Outcomes. The third step includes working on grade-specific interdisciplinary activities. When developing interdisciplinary activities, each activity should be detailed enough that anyone reading the activity can see clearly the integration of both the physical education standard and the academic standard. In other words, the activity should detail what the students will be asked to do in order to meet the outcome. Here is an example of how an interdisciplinary activity can integrate a kindergarten math standard and a specific physical education grade-level outcome: Kindergartners need to be able to know number names and the count sequence to meet Common Core math standards for that grade level. A kindergartner also needs to be able to hop, gallop, run, slide, and skip while maintaining balance to meet the standard for locomotor skills. What sort of interdisciplinary activity can a teacher develop to help the young student meet both expectations? One idea could be to have the student count the number of hops it took to get from one spot to another. Another activity could be to draw the numbers from 1 to 10 on the floor and have the student say the number names as students skip over them. Another way to find state physical education standards is at www. From there, you can search for academic standards for the state. Develop an Integrated Activity Plan The final step in this integration process moves the activity idea to a lesson activity. Choose one activity listed in the charts, and plan how to use the activity in a lesson. See the example of a kindergarten activity suggestion in the following chart. The integrated lesson activity form is used for planning the activity. The activity form is similar to a class lesson plan, but it is shorter in duration because it only addresses one integrated activity that the classroom teacher can use to reinforce an academic lesson plan or to provide a specific brain break activity to help classroom performance. This lesson activity can take place in the classroom, or the teacher can take the students to an open space area outside the classroom. Teachers need to create a name for the activity, then list the objective and standards that are addressed in the activity. For the kindergarten example, the physical education grade-level outcome addressed is related to locomotor skills, and the math standard is counting and cardinality. The specific lesson objectives are to practice locomotor skills while counting in a sequence and to practice locomotor skills on the letters of the names of numbers drawn on the floor. The name of the activity might be Locomotion Numbers. The teacher will need chalk or tape for numbers, and everyone will need to be aware of personal space so that students can move safely without running into each other. Finally, the teacher will plan how to explain the activity and organize the students and the event. The following sample activity provides a model format for developing the activity plan that reflects this minute lesson. Also, practice locomotor skills on the letters of the names of numbers drawn on the floor. Content Standards Applied Chalk or tape for numbers Safety Concerns Awareness of personal space so that students do not run into other students See lab 9. The above excerpt is from:

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3: Integrating Science Practices Into Assessment Tasks : StemTeachingTools

Integrating the national science education standards into classroom practice. [Kenneth P King] -- "This brief volume helps bridge the gap between theory and practice. It offers readers a tool to understand not only what the National Science Education Standards (NSES) are, but also how they can.

Brown Two years ago, propelled by National Board expectations, I found myself up to my hip waders in unfamiliar watersâ€"the integration of math and science. I have a literacy background, so I understood how to integrate reading and writing, but math and science? The idea was intriguing. I got online, plunged into the National Science Education Standards for my 5th grade students, and got started. I found that there are big ideasâ€"huge ideasâ€"about how our world operates. Of Big Ideas and Mud My first foray into integration involved extending my geology curriculum, which was a kit providing inquiry-based lessons and all necessary materials. Students studied topographical maps, built mountains out of precut Styrofoam, and conducted controlled experiments with water and sand erosion. Math was implied but not explicit. These lessons focused on models Aha! I wanted students to practice their research skills by finding information about real landforms. In creating their own models, students would learn to identify, explain, and demonstrate the infinitely slower processes in the world around them. I also wanted them to recognize that these processes were quantifiable and measurable and to see how collecting and analyzing this data would help them understand what they had observed. The kids plunged in with glee. Mud, clay, and water swamped the classroom as students tore apart their creations and put them back together again. The custodian refused to vacuum my room any longer, but I bought him coffee and plied him with homemade cookies until he relented. I recalled, with some longing, my abandoned kitâ€"so neat, so controlled, with worksheets so easy to assess. Then one day we had a torrential rainstorm. Water cascaded over the basketball court and across the playfield. You have to come! There are landforms everywhere! My students showed me flood plains, undercuts, meanders, rapids, and a lake. My students saw, with wide-open eyes, how the world was formed. Adding Accountability The following year, our district piloted a high-stakes state science test at my grade level. Now I had curriculum requirements, state expectations, and my commitment to inquiry-based instruction to juggle. We had used an inquiry-based approach, but I had concentrated so much on integrating these standards that my teaching of scientific process had been erratic. I needed to do a better job with the math piece. To better pull the pieces together, I created a new, integrated curriculum unit called Things That Fly. Students would practice their research skills by looking for information about the principles of flight. They would then use this knowledge to build something that flew, create repeatable experiments, and use the research and their experiment data to explain their findings to the class. It looked good on paper, but implementation was not quite so smooth. I stood on the playground watching paper airplanes loop past, bottle corks whiz by, and homemade kites bounce and cartwheel across the sand. I had emphasized keeping notes and charts. Students learned about data collection, measurement, and rate and ratio. But in the excitement of creating flying machines, they forgot to use these skills. Only about half of the students kept marginal notes. Many of them muddled their variables and switched their ideas. Hardly any projects worked. Still, the students were ready to discuss their work, as required, with the class. Feeling a little desperate, I pressed them to explain the science and math that guided their experimentation. Why did you do it? How do you know it made a difference? They held up a chart showing data of distance trials from different mixtures of chemicals. Real evidence of student learning! Annie, Madison, and Andrea presented next. They had tried to build a parachute with no success, and then moved on to a kite. It never flew more than five feet and crumpled on impact. Still, they had kept painstaking notes of every change including color, ribbon length, and straw stabilizers and every unsuccessful trial. As far as I could see, that was it. The three girls did not seem to have absorbed much scientific awareness. This unit had not gone as I had envisioned. The students had produced almost no tangible product or success. As we debriefed, I asked students if they thought they would have learned more if I had taught them a lesson on the principles of flight, rather than letting them research the basics. Would they have preferred for me to demonstrate, for instance, how to make a kite and then let them build a more elaborate model, one that would actually fly? Their response was immediate and indignant. The questions I ask myself and them are, What are you observing? What does it mean? What does this tell you about how the world works? How can you demonstrate to me and anyone else that this is accurate and repeatable? If they understand the big ideas and have used charts, measurements, ratio, tables, graphs, and data, they can answer each of these questions. Far too often I am uncertain of what my next step is. Susan Brown sbrown foxinternet. Brown Requesting Permission For photocopy, electronic and online access, and republication requests, go to the Copyright Clearance Center. Enter the periodical title within the "Get Permission" search field. To translate this article, contact permissions ascd. Learn more about our permissions policy and submit your request online.

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4: Integrating Math and Science

Note: Citations are based on reference standards. However, formatting rules can vary widely between applications and fields of interest or study. The specific requirements or preferences of your reviewing publisher, classroom teacher, institution or organization should be applied.

Problems include how to use insulation to create an energy-efficient building by minimizing loss of thermal energy and how to design a boat engine based on understanding of energy transferred through pneumatic and hydraulic systems. Readings from first-person narratives by engineers and technicians provide background on how to apply engineering standards. Math and science concepts are brought in as prototypes are tested. Rubrics, or criteria, for evaluating paper-based entries e. Progress reports on integrated STEM concepts and practices can be entered into the notebooks and in a teacher class-level assessment record. While there is no universal measure of such knowledge, all indications are that a significant percentage of educators have inadequate STEM content knowledge in the individual STEM fields that they teach. One important indicator of content knowledge is an undergraduate degree in the subject being taught, but a significant proportion of elementary Page Share Cite Suggested Citation: Status, Prospects, and an Agenda for Research. The National Academies Press. These questions and problems could include text, graphics, photos and videos of sample designs, calculations, and prototype sketches. Some of the newly designed embedded assessment tasks and items could be automatically scored; some designs and drawings could be displayed for peer review and assessment. For the auto-scored tasks and items, the system could provide individualized feedback and scaffolding related to problematic concepts and practices, and generate progress reports. The summative assessment tools are print self-evaluations, concept maps, a and end-of-project tests that can be administered electronically, with automatic scoring and rubric-based ratings generated for student and teacher analysis. An alignment table could show the links between the intended learning targets and the different forms of evidence from the concept maps and end-of-project tests. The table would also document the extent to which learning targets for the distinct STEM disciplinary concepts and practices were at the same or different grade levels. A more ambitious summative assessment effort could develop brief simulation tasks for each unit to test whether students correctly apply the STEM concepts and practices to other integrated STEM design problems about energy concepts related to insulation and engines. According to the National Survey of Science and Math Education NSSME; Horizon Research , just 5 percent of elementary teachers had a degree in science or science education, and 4 percent had a mathematics or mathematics education degree. Among middle school science teachers, 41 percent reported having earned a degree in science or science education, and 35 percent of middle school mathematics teachers had a degree in mathematics or mathematics education. The comparable figures for high school teachers were 82 and 73 percent for science and mathematics, respectively. Some science and mathematics teachers without degrees obtain certification to teach those subjects, and this provides a proxy for content knowledge. For example, data from the â€” school year indicate that 12 and 16 percent of high school science and mathematics teachers, respectively, Page Share Cite Suggested Citation: Beyond majors and certifications, the professional associations representing Kâ€”12 science and mathematics teachers have proposed specific course-background standards for elementary and secondary educators. Among elementary teachers, 74 percent have taken courses in at least two of the three recommended areas, NSSME found, and 73 percent of middle school general science teachers had taken courses in at least three of the four NSTA-recommended areas: NSSME found that 10 percent of elementary teachers met this standard, 42 percent of mathematics teachers at the secondary level took coursework in at least three of the areas, and 49 percent of middle school mathematics teachers took courses in all or five of the six areas recommended by NCTM. Although they are in the majority by a wide margin, science and mathematics teachers are not the only teachers of Kâ€”12 STEM. Some 45 undergraduate programs in the United States prepare technology teachers CTETE , most of whom will be working in middle and high schools. A survey of technology teacher preparation programs McAlister found that most required between 2 and 8 credits of mathematics and 6 to 8 credits of science. The curriculum also includes coursework in specific areas of technologyâ€”such as communications, manufacturing, transportation, construction, and medicine and healthâ€”and on the relationship between technology and society. Courses such as engineering math and statistics include mathematics and science content; others address engineering design as well as more narrow subjects, such as thermodynamics and mechatronics. Self-efficacy, research shows, is a major determinant of teacher effectiveness e. Not surprisingly, educators who are or feel deficient in their content knowledge are less likely to believe they can teach the material effectively Peterson et al. The literature reports abundant data showing that many teachers are reluctant to teach science Wenner and to a lesser extent mathematics, especially in the elementary and middle grades. Several studies suggest that efficacy is a significant factor contributing to this reluctance Baker ; Riggs and Enochs ; Wenner Lack of confidence in mathematics and science knowledge Diefes-Dux and Duncan and fear of engineering Cunningham have been tied to educator reluctance to engage in professional development related to engineering. The NSSME Horizon Research found that only 4 percent of elementary teachers 4 and only 6 and 7 percent of middle and high school science teachers, respectively, felt very well prepared to teach about engineering. By comparison, 39 percent and 77 percent of elementary teachers reported that they felt very well prepared to teach science and mathematics, respectively. For mathematics topics, 6 high confidence ranged from 48 to 88 percent for middle school teachers and from 30 to 90 percent of high school teachers. In a specific illustration of the problem, William Hunter of Illinois State University told the committee about the development and implementation of the iMaST Integrated Mathematics, Science, and Technology curriculum. Math teachers were especially hesitant because of their lack of confidence in teaching science. It is highly likely that educator self-efficacy will play a critical role in effective integrated STEM education e. As we note above, even in the individual STEM subjects, Kâ€”12 teacher expertise is often lower than what professional organizations in the field recommend. It is therefore important to determine ways to help Kâ€”12 educators develop substantive understanding of more than one STEM field. Although expertise related to the individual subjects is important for integrated STEM, content knowledge alone is not sufficient. Teachers also need to know about and become expert in pedagogical strategies that support students in integrated experiences. For example, as discussed in Chapters 3 and 4 , teachers need to know how to provide instructional supports that help students recognize connections between disciplines. The lowest level of confidence for both middle and high school teachers was in discrete mathematics. Page Share Cite Suggested Citation:

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5: Curriculum & Standards - McREL International

- Integrating the National Science Education Standards into Classroom Practice by Kenneth King ISBN Unknown; ^^ In Stock: We Ship At Once Fr. Il Usa;: Prentice Hall, September 19, ;.

Inclusion in the Science Classroom by Deborah H. Haskell Clemson University Often, when a school or district embraces a philosophical position and develops curriculum policies, the process involves only a few individuals such as administrators and curriculum coordinators. Teachers, who often do not have the opportunity to collaborate in the decision making process, feel as if changes are mandated or imposed upon them. As a result, they are less willing to implement the changes Idol, This has been the case with the inclusion of students with learning disabilities in the science classroom. Most of the discussion about inclusion practices is found in the special education and administrative literature. As a result, the practices being implemented in the general classroom usually originate from special educators and administrators. To make inclusion work, science teachers need to assume an active role in the planning process and advocate instructional practices which can be implemented in the large group setting of the science classroom as well as meet the diverse needs of individual students. A collaborative relationship between the science teacher and the special education teacher can link what was formerly two separate educational domains. Unlike plans which originate from administrators and special educators, the four step plan discussed in this article requires the science teacher to initiate a collaborative process with the special education teacher and develop instructional strategies which will work in the science classroom before legally binding decisions are made in the Individualized Education Plan IEP meeting. The gap between the two educational domains is not as wide as it first appears and through collaborative efforts the span can be bridged. This philosophy includes not only students differing in age, gender, and ethnicity, but also students who have disabilities. For the school year, 5,, children with disabilities were served under Part B state grants of the Individuals with Disabilities Education Act. Of those served, The passage of P. This education should take place in the least restrictive environment LRE. Instead of placing the student in the resource room or self-contained classroom, and going to the general education classroom when it was determined the student was "ready", the student now starts in the general education classroom. The student goes to the more restrictive environment of the resource room or self-contained classroom only if the specified goals are not attained in the general education classroom. The Council for Exceptional Children views inclusion as a part of a continuum of options Johnston, As a result, more students with learning disabilities are now included in science education classrooms. But placement in the science classroom does not always result in appropriate educational practices. Four Step Plan Step 1: Collaboration Between the Science and Special Education Teachers There are several teaching models which have been effectively used in inclusive classrooms. Of these, team teaching is thought to be the most desirable. Team teaching involves both the science education and special education teachers working together in the classroom and instructing the entire class. Because the team approach lowers the student to teacher ratio, the students get more individualized attention. The teachers benefit as working side by side with a colleague removes the sense of isolation many teachers experience. The science education teacher presents the science content component of the lesson and the special education teacher contributes learning strategies and other meta-cognitive skills. Unfortunately, very few schools have the financial and personnel resources to implement this model. According to the Fifteenth Annual Report to Congress given in , 8, teachers or 8. This is not a situation which makes co-teaching feasible for most schools. Aide services would bring a paraeducator into the science classroom to work under the science teacher. Rather than working as equals, as in the co-teaching model, the aide would receive instruction from the classroom teacher as to how to serve the students during each lesson. Once again, many schools do not have the financial resources to provide an aide for every classroom teacher. Limited pullout service returns to the more traditional form of special education practiced in schools. The student or a group of students leave the general classroom environment and go to the resource room. In the resource room, the student works on specific skills in an individualized or small group setting. The lessons learned in the resource room are often not transferred to the content area classroom. These are the very problems inclusion is striving to correct. This collaborative relationship between the science teacher and the special education teacher can bring about positive changes for the students. Each teacher has strengths to bring to the relationship. The science teacher is the content area specialist. The special education teacher knows how to plan for individualized learner goals, learning strategies, adapting instruction, and alternative assessment. If the co-teaching or aide service models are not in place, the science teacher preparing for an inclusive classroom must propose a collaborative relationship to the special education teacher. Once both parties agree to use the collaborative model, the collaborative team then proposes their request to the principal. Scheduling time to meet and plan is a major obstacle in collaborative efforts. In addition to scheduling joint planning time, professional development opportunities must be made available, not only in pedagogy, but also in skills related to collaboration Johnston, Once the collaborative team is established and has received administrative support, specific instructional strategies can be addressed. The Development of Effective Instructional Practices The science classroom can be set up as a successful environment for the student with learning disabilities. Yet many teachers still use a textbook-oriented teaching approach. Mastropieri and Scruggs , found that science textbooks contain enormous amounts of vocabulary and often the readability surpasses the skills of students with learning disabilities. By using activity oriented methods, the students use less vocabulary, are asked to do far less independent reading and paper and pencil work and spend more time interacting with actual examples of the concepts being studied. Effective activity oriented teaching strategies use constructivist models which allow the student to build the lesson from what she already knows. Many strategies have been found to be effective for both general education students and students with learning disabilities. Authentic assessment, rather than just paper and pencil tests, gives a more accurate measure of academic outcomes. After the passage of P. The benefits of cooperative learning are multiple. In addition to the opportunity to improve social skills, the learners are actively engaged, participate in discussions which increase their cognitive levels of thinking, and are given new perspectives to problems. Integrated units make the content relevant and applicable to real world situations. The lessons learned in science class can be more easily transferred to other applications. Textbooks compartmentalize content, making it difficult to use in ways other then how it is presented. This makes it difficult to transfer this knowledge to real life problems. This is true not only of students with learning disabilities, but all students who try to learn content by rote in an effort to get by in the American school system. This limits the development of the problem solving skills needed for success in the post secondary world. Graphic organizers such as charts and concept maps are effective for both students with learning disabilities and for general education students. By designing their own concept maps, students have to reflect on the content and organize it in a way that is meaningful to them Novak, Not only have students performed better on standardized tests, but by 7th grade fewer students required special education services, and by 12th grade, fewer of the students instructed with CWPT had dropped out of high school Greenwood, Additional studies have found variations of CWPT to be effective. Peer tutoring provides social and academic skills for students and is practical for the general education teacher to implement. Students learn most effectively when they have many opportunities to respond and receive immediate feedback regarding their performance. Peer tutoring should be used only after information has been introduced, discussed, and reviewed by the classroom teacher. Depending on the objective,the tutoring teams should be designed with either random pairings or with the more able students assisting students who need extra help. All students need to have the opportunity to be both tutor and tutee. An example of a middle school peer tutoring activity follows: This activity is designed for students who understand how to record experimental data and convert that data into a graph to tutor students who are still developing that skill. Using the activity of measuring worm pulse rates at different temperatures, the data recording and graphing skills are broken into smaller, observable steps Table 1.

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