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Empowering Elementary and Middle Level Science Educators: Keeping Pace with Instructional Trends in Science Education for the 21st Century

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The need exists for elementary and middle science educators to keep pace with 21st Century instruction by using current methods and techniques. Empowering Elementary and Middle Science Educators is critical for enabling them to keep pace with instructional trends in science education for the 21st Century. Providing teachers with the knowledge and understanding of how to use technology in the classroom, encouraging critical thinking and discourse, and practicing skills for effective collaboration and teamwork is essential. Current trends and issues need to continue to be discussed among the science education community to allow for students to be able to grow and solve problems independently. Additionally, teachers need to consider the following issues for planning quality science lessons for their elementary and middle science students.

Engaging Young Learners

Technology continues to be a great motivator for young minds. Using iPads for showing interesting websites, engaging students with web quests, whiteboard activities, and even fun science songs can engage and motivate students. Administrators should support funding for science programs when possible.

Teachers can also engage young learners by showing confidence with the content they teach by preparing and delivering quality science lessons. Professional development focusing on technology tools and instructional methods such as using the 5E Instructional Model (Bybee, 2019) is an integral part of this goal. The 5E format supports the constructivist learning model, with students building on their previous ideas as they create new ones. A 5-E lesson has five parts that begin with the letter "E"; Engage,

Explore, Explain, Elaborate, and Evaluate. The Engage is an activity that focuses student's attention, stimulates their thinking, and accesses their prior knowledge. The Explore provides students with time to think/investigate/test/make decisions/problem solve, and collect information. During the Explain stage, the students' understanding is clarified and modified. First, students will operationally define (stated in their own words) what they learned during the explore activity. This is done by engaging students in completing a reflective activity, such as creating a concept map or writing a story. The explain activity provides students with an opportunity to analyze their results. Then, the teacher will help students connect what they learned to the science content and terminology. The Elaborate activity expands and solidifies student thinking and/or applies it to a real-world situation. During the Evaluation activity, the teacher assesses student performance and/or understandings of concepts, skills, processes, and applications.

Additionally, science teachers should be passionate about teaching young students science. Elementary school teachers should share a passion for learning science and try to instill a similar love for science with their students. In other words, teachers need to have the ability to access quality science curriculum and to stay up with the latest research trends. Teachers need to be life-long learners.

Managing "Talking Classrooms"

Lev Vygotsky (1962) supported ideas involving social constructivism. When students are given experiences in the science classroom to talk about newly acquired science content and are given time to verbalize their observations with their peers or a more knowledgeable adult, they can begin to make sense of the new material.

Teachers can use strategies such as “Think-Pair-Share” and “Table-Talk-Time” to encourage classroom discourse. “Think-Pair-Share” is a classroom technique where students are given a question by their teacher to think about, pair with a partner to discuss, and share ideas with the group (Lyman, 1981). A similar technique, “Table - Talk - Time” can also be applied when students are given a purposeful question by their teacher to discuss with a partner or small group for 2-3 minutes. Then one group member is asked to report out or share with the class (Plankis, et al., 2011).

Working Cooperatively in the Science Classroom

Cooperative learning is an instructional method in which students work in small groups to accomplish a common goal with the teacher’s guidance. A team approach can effectively encourage young learners to think critically, solve problems, and work on Science, Technology, Engineering, and Mathematics (STEM) skills together in class. This is 21st century learning.

Students need to be given opportunities by their teacher to work with peers in science through cooperative learning groups, field trips, and engaging hands-on classroom activities. Teamwork helps children learn to work cooperatively with one another. Cooperative learning fosters problem-solving skills and helps students develop communication skills (Woods et al., 2016). When students work together in “person-centered” classrooms, they learn to communicate more effectively, work cooperatively in class and online, and engage in needed peer-to-peer discourse (Freiberg & Lamb, 2009).

Students need to be given an opportunity in the classroom to take pride and ownership of their learning experience. Elementary science educators should consider a balanced approach to classroom management. Person-centered instruction is classroom

management that is not entirely student-centered and is not entirely teacher-centered. In other words, leadership is shared in a balanced classroom. Person-centered instruction is an excellent approach to classroom management and works well in elementary science classrooms when hands-on experiences are provided for young science students. In person-centered classrooms, responsibilities are shared (one-minute manager positions/student jobs), and students can take pride in their chosen responsibilities. Person-centered learning environments encourage balanced classrooms where both the teacher as facilitator and the students share responsibilities and learn to communicate effectively with one another (Freiberg & Lamb, 2009).

Content Matters

The Next Generation Science Standards support classroom opportunities for elementary and middle level science students to build strong content knowledge. Strong content knowledge is critical for subject mastery (NGSS, 2013). Likewise, teachers are responsible for ensuring that proper pacing occurs and that standards are taught in a sequence that makes sense so content knowledge can develop throughout the year.

Misconceptions in understanding should be continually addressed as learning occurs. This can be accomplished when teachers assess prior knowledge and understanding before beginning science labs or activities.

Inquiry Based Learning

It is important for teachers to maximize the “Aha” moments of learning. When learners are engaged in classroom activities on a cognitive level, they acquire the conceptual understandings expected (Gallenstein, 2005; Turner & Patrick, 2008). Science educators should continue to provide hands-on, minds-on learning experiences for their

students to encourage learning and keep motivation high. Hands-on activities motivate students to learn and participate.

The National Science Education Standards (NSES p. 23) define inquiry as the diverse ways scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry is also referred to as the activities through which students develop knowledge and understanding of different scientific ideas as well as an understanding of how scientists study the natural world.

Teachers need to provide students with opportunities to practice inquiry in the science classroom. Inquiry is an active learning process in which students answer research questions through data analysis (Bell, et al., 2005, p. 35). In the classroom, children can progress through many levels of inquiry as they move toward scientific thinking.

The Many Levels of Inquiry

- Confirmation – Students are given the questions, procedures, and the results are known in advance
- Structured – Students are given the questions and procedures but come up with their own explanations
- Guided – Teacher provides a testable question, and the students come up with their own procedures and explanations.
- Open – Students come up with their questions, procedures, and explanations.

(Bell, et al., 2005) (Banchi & Bell, 2008)

The ultimate goal for elementary students is to be able to conduct open inquiry investigations by coming up with their own questions, procedures, and explanations.

Science educators need to continue to organize and facilitate experiences, so students are able to inquire and ask questions.

STEM, STEAM and STREAM

Elementary science programs should encourage students to become problem solvers in a scientific and technological world. In other words, STEM, Science, Technology, Engineering, Arts, and Mathematics (STEAM), and Science, Technology, Reading, Arts, and Mathematics (STREAM) are big. Science programs need to integrate the other disciplines and should provide numerous hands-on experiences for young learners. Science educators should look for opportunities to take students on field trips (virtual or other), use technology when applicable, and motivate students with hands-on activities by providing chances for solving problems. Students need to have opportunities to inquire and ask questions about the world around them!

Technology Integration

Teachers need to remember that motivating students matters. Science educators want to see their students motivated in the classroom and to inspire a love for learning! Students must be motivated and interested before learning will take place (Turner & Patrick, 2008). Besides providing empowering lessons, teachers need to understand how learners are spending time with digital technologies. Teachers should use this knowledge to reflect and think about instructional methods and student learning. Technology helps with lesson building (Koch, 2016).

Consider the following ideas for technology integration in the elementary science classroom:

- iPads in the classroom for writing science stories – example: Story Jumper. Also, have the students share their stories verbally with one another.
- Interactive whiteboards – can be used for activities like classification (living and nonliving things) or even charting the weather.
- Chrome Books – can be used for journaling using One Note– example: life cycle of a mealworm

Differentiation Matters

Differentiation is a way of thinking about teaching and learning that addresses differences in students' learning needs (Tomlinson & Imbeau, 2010). Research shows students learn best when their individual learning needs are met. To meet their needs, teachers can differentiate the content, process, and/or product of the curriculum (Tomlinson, 2017, 2005).

Content is the curriculum, materials, and approaches used for student learning. To differentiate content, a teacher might use texts or novels at more than one reading level. They could do a pre-assessment to determine where students need to begin, then match them with the appropriate activity. A teacher might re-teach students who need further demonstration of the content; or have advanced students work on special in-depth projects (Tomlinson, 2017, 2005).

Process refers to the instructional activities or the approaches used to help students learn the curriculum. The way teachers can differentiate the process is by including various activities based on students' different learning preferences. This can be accomplished by using Gardner's Multiple Intelligences to frame activities (Tomlinson, 2017, 2005).

Products are the means through which students express their learning. Good products cause students to use their critical thinking skills to apply and extend what they have learned. Differentiating products involves giving students a choice to express learning. For example, students might be provided with the option to create a poem, write a story, or draw and label a diagram (Tomlinson, 2017, 2005).

The ultimate goal of differentiating our teaching and students' learning is to enable all students to learn.

Conclusion

Tomlinson and Imbeau recommend that teachers should consider five aspects of classroom systems and how they relate to student learning:

- Learning Environment
    - "Students should feel safe, respected, involved, challenged, and supported" (Tomlinson & Imbeau, 2010, p. 20).
- Curriculum
    - The curriculum should be challenging and engage learners
- Assessment
    - Assessments should be purposeful and inform the teacher of students' readiness, interests, or learning profiles and help the teacher determine how to move forward with future instruction.
- Classroom Management
    - Classroom practices and procedures need to be in place for students to be able to focus on learning.

    - Set high expectations for all learners: “Teachers must create an environment where differentiation is understood and accepted by students from the beginning of the year” (Tomlinson & Imbeau, 2010)

- Instruction
    - Instruction should align with the lesson goals and offer depth with learning by understanding student differences.

Healthy discussion over topics such as the classroom environment, curriculum, assessment, classroom management, and inquiry-based science instruction are trends that have held up over time and still serving as an area of focus today. They are “tried & true”! Researchers such as Tomlinson & Imbeau recommend this as well to empower teachers to reflect on their current instructional methods and classroom delivery techniques.

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