Integrated STEM Education

Current Status, Opportunities and Considerations for Science Centers

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Study Status

- The study committee met five times to review research data and hear from integrated STEM pioneers and practitioners in the field.
- Draft report has been independently reviewed.
- Academy staff now incorporating reviewer's comments and finalizing report.
- Anticipated report release date – Late 2013 or Early 2014.

NAE/NRC Committee on Integrated STEM Charge

1. Identify and characterize existing approaches to integrated STEM education, both in formal and after/out-of-school settings.
2. Review the evidence for impact of integrated approaches on various student outcomes.
3. Determine a set of priority research questions to advance understanding of integrated STEM education.

DHA Research Components

- Literature Review
  - 550 citations identified and initially reviewed
  - 30 formal reviews; 54 informal reviews; 68 cognitive science reviews
- Program & Materials Review
  - 158 programs identified and initially reviewed
  - 28 selected for full review
- Stakeholder Interviews
  - 25 interviews conducted, 45 minutes in length
  - Policy makers, business/industry funders, formal and informal educators, university faculty, scientists and engineers, discipline-specific professional organizations, curriculum and materials developers, educational researchers and evaluators

Key Questions Guiding DHA's Work

What is the current status of integrated STEM education?

What are the main issues related to integrated STEM teaching and learning?

What are the potential advantages/disadvantages of integrated STEM education and to what extent have they been documented?

What new information may benefit the field in terms of improving the quality and effectiveness of integrated STEM education?

Samples From Both Formal & Informal

- **Formal Education** – included classroom activities, modules, and curricula; school-wide programs; teacher preparation and professional development programs

- **Informal Education** – included ancillary curricula; professional development; after-school; camps; community events; competitions; exhibits; mentoring and internships; and multi-media (TV, radio, web)

Program/Materials Selection Criteria

- Representative sample from the range of programs/materials available on the landscape
- Representative sample from a range of pedagogical approaches – problem-based, project-based, theme-based, inquiry-based, etc.
- Representative sample for a particular target audience – open enrollment, underrepresented, girls, etc.
- Integrated approach to STEM teaching and learning
- Defined goals and objectives
- Research and/or evaluation documentation, preferably with evidence of learner outcomes
- Evidence of sustainability based on proven longevity or continuing support
- Willingness to be included in the review

Literature & Program Review Findings

- Multiple definitions for STEM and integrated STEM exist
- Increasing number of programs are including “T” and “E” in the integration, and some include disciplines outside of STEM
- Development of STEM and integrated STEM programs is proliferating
- Many STEM programs claim to be “integrated” but upon further analysis appear to be “multidisciplinary”, or at best, “interdisciplinary”
- Most reviewed programs provide some form of teacher professional development and/or support
- Informal programs are more free to integrate across disciplines than formal programs where discipline-based standards, curricula, and teacher skills and experience guide instruction

Literature & Program Review Findings (con't)

- Research and evaluation of STEM education is limited, even more so for integrated STEM
- Currently most integrated STEM programs are characterized by the following attributes:
  - Focus on relevant, "real-world" problems and project-based learning
  - Incorporation of 21st Century skills and/or engineering design processes
  - Use of STEM professionals as resources, mentors and role models
  - Belief that integration will motivate learning in STEM and increase interest in further STEM studies and careers
- Additional research and evaluation is needed to determine efficacy and value of these attributes and programs

Potential Advantages of Integrated STEM Education

From the program/materials review:

- Most programs mention "real-life" context as the driver for integration
- Program evaluations consistently report positive changes in student interest and motivation
  - Increased student interest, excitement, collaboration
  - Increased and sustained engagement of underserved audiences—particularly informal programs
  - Increased student self-efficacy and confidence—developing a STEM "identity" for themselves
  - Evidence of students intrinsically seeking out science and math knowledge in order to solve problems
- Many programs emphasize 21st Century skill development
- Many programs also emphasize STEM career awareness and mentoring from STEM professionals

Potential Advantages of Integrated STEM Education

From the literature review:

- Integrated approaches provide context, reflect the "real world", and can facilitate and enhance student learning of STEM concepts and practices
- Integrated approaches are particularly conducive to incorporating and developing 21st Century skills
- Cognitive science studies show a small positive learning benefit from integrated STEM approaches to teaching and learning
- Incorporating design-based and/or problem-based activities into science and math instruction can increase student interest in and enthusiasm for future STEM studies and careers, including for traditionally underserved students

Stakeholder Priorities for Integrated STEM Education

Priority	% Listing as Priority	Stakeholder Categories
Teacher Preparation or Professional Development	60%	Eight of the nine categories (all but Policy Makers)
Changes in Policy or Systemic Changes	33%	Scientists, Educators, Policy Makers, Informal Educators, Materials Developers
Clarity of Definition and Goals	29%	Scientists, Educators, Professional Organizations
Equity/Diversity	24%	Researchers/Evaluators and Materials Developers
Adhering to Standards	24%	Educators and Funders
Integrated STEM Education	24%	Educators, Professional Organizations, & Funders
Appropriate Curricula	14%	Educators and Materials Developers
Appropriate Assessments	14%	Educators and Funders
Workforce Development	10%	Scientists and Professional Organizations
Ramping up K-5	10%	Educators
Informal STEM Education	10%	Informal Science Educators
Motivate Students	10%	Scientists and Researchers/Evaluators

Additional DHA Insights & Considerations

- Next Generation Science Standards will likely accelerate development of integrated STEM programming
- Any definition/taxonomy of integrated STEM needs to take into account its complex and multifaceted nature
- To what extent will a definition/taxonomy foster or inhibit future innovations in integrated STEM education?
- The proliferation of integrated STEM programs presents both opportunities and challenges—especially in the arenas of policy, practice, assessment, and performance
- The number of pre-service and professional development programs designed to increase teachers' integrated STEM knowledge and skills is increasing

Additional DHA Insights & Considerations (con't)

- There are valid concerns about the quality of current research and evaluation methodologies used to study the impacts of integrated STEM education
- Tension exists between disciplinary, interdisciplinary, and integrated approaches to STEM education
- Discipline-centered curriculum and instruction remains the norm in STEM education, hindering integrated approaches
- Implementing integrated STEM on a large scale will require significant changes and investments in teacher training, curriculum development, school and classroom management and infrastructure

Additional DHA Insights & Considerations (con't)

- How can early integrated STEM pioneers and practitioners be actively engaged in further developing the field?
- Can students learn foundational math and science concepts through an integrated STEM approach?
- Relatively few teachers are prepared to teach in a truly integrated fashion
- How can the informal education community contribute to integrated STEM education, and where might they lead?

Opportunities for Science Centers

- Modeling true integrated STEM programming for schools and communities
- Actively engaging STEM professionals
- Teacher preparation and professional development
- Exhibits, experiences reflecting integrated STEM
- Facilitating and convening integrated STEM stakeholders in your community/state
- Contribute to advancing research and evaluation around integrated STEM education

Session slides will be posted at:

www.davidheil.com

"News"

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