DOCUMENT RESUME

ED 473 652 SE 067 311

AUTHOR	Klemm, E. Barbara; Plourde, Lee A.
TITLE	Examining the Multi-Sensory Characteristics of Hands-On Science Activities.
PUB DATE	2003-01-00
NOTE	10p.; Paper presented at the Annual Meeting of the Association for the Education of Teachers of Science (St. Louis, MO, January 29-February 2, 2003).
PUB TYPE	Reports - Research (143)
EDRS PRICE	EDRS Price MF01/PC01 Plus Postage.
DESCRIPTORS	*Hands on Science; Active Learning; *Cognitive Structures; Elementary Secondary Education; Science Instruction; *Science Laboratories; *Teacher Education; *Teaching Methods; Visualization

ABSTRACT

Research in science education demonstrates the importance and effectiveness of the hands-on approach in student learning. Activity-oriented instruction offers multi-modal opportunities for learning science. However, there is very little research on the sensory nature of hands-on science learning. How do science educators describe lab activities in terms of visual, kinesthetic, auditory, and motor characteristics? This paper describes a study investigating (n=10) inservice teachers' perceptions of hands-on science, the purpose of the activities, and instructional materials they use. (Contains 19 references.) (Author/YDS)

Examining the Multi-Sensory Characteristics of Hands-on Science Activities

E. Barbara Klemm
University of Hawaii
1776 University Avenue (WA 2-222)
Honolulu, HI 96822
808-956-3823
klemm@hawaii.edu

Lee A. Plourde
Central Washington University
(509) 665-2600
(509) 665-2601 FAX
plourdel@cwu.edu

Abstract

Activities-oriented instruction offers multi modal opportunities for learning science. How do science educators describe lab activities in terms of visual, kinesthetic, auditory and motor characteristics?

Theoretical Background

Ingrained notions in science education are that science is for all learners and that science is preferred when it uses constructivist approaches that provide hands-on, concrete, experiential learning opportunities. The national science education standards call for "science for all" (Rutherford & Alghren, 1990; American Association for Advancement of Science, 1993; National Research Council, 1996). Research on the human brain and cognition supports the research in science education on the effectiveness of such instructional approaches as the Learning Cycle. Further research demonstrates the effectiveness of using hands-on science learning approaches for students with disabilities (Atwood & Oldham, 1985,; Hadary & Cohen, 1978, Mastropieri & Scruggs, 1992; Mastropieri & Scruggs, 1994; Patton, 1993, Patton, 1995; Scruggs & Mastropieri, 1993, Mastropieri, Scruggs, Magnusen, 1999).

An underlying assertion made by researchers is that hands-on, concrete, experiential science instruction inherently involves multi-sensory learning (multi-modal experiences, including sight, sound, touch and taste), which provide multiple opportunities for differentiated instruction. Although research clearly demonstrates the efficacy of hands-on experiential approaches, to our surprise, little research has been reported which systematically characterizes the sensory nature of hands-on science learning, or which links the sensory characteristics of hands-on activities to opportunities for differentiating instruction. As science teacher educators, our work is based on the belief that information about the sensory characteristics of hands-on science activities is needed to better prepare teachers to make science learning accessible to all learners.

Relation to Other Efforts

We began this line of study several years ago when searching for science activities suitable for the very diverse needs of adolescent learners in a science camp for youth with moderate to severe disabilities (Klemm, Skouge, Radtke & Laszlo, 2000). Although we found general suggestions in science methods and resource books for ways to accommodate learners with disabilities, sometimes together with suggestions for adapting activities to make the activities more accessible, we found no systematic approach to aid us in locating and selecting activities for the science camp.

We thus devised the Levels of Accessibility Matrix (LAM) system as a way to evaluate the sensory and motor/manipulative accessibility of hands on activities (Klemm & Laszlo, 2001). LAM consists of a matrix with sensory inputs arrayed horizontally and types of disability impairments, vertically. We proposed a rating scale of 0 (completely inaccessible) to 4 (completely accessible) as a means of characterizing hands-on activities.

We realized that the LAM system could help others too as a means of selecting science activities, and that it could serve as a heuristic device to facilitate preservice teachers' thinking about selecting and modifying activities to accommodate learner needs. Accommodation of the needs of learners with disabilities is not an option, as it is mandated under federal special education legislation. We further reasoned that preservice (and inservice science teachers) as well as special educators who work with science teachers might benefit using a system like LAM. Thus, we tested the LAM system using a series of activities related to hands-on exploration of sound in elementary science methods classes (Klemm, Plourde & Laszlo, 2002). We reported that our findings demonstrated the effectiveness of the LAM system in focusing preservice teachers' thinking on the kinds of sensory experiences related to the activity. Specifically, LAM focused thinking in terms of what the learner does; the learner's abilities to see, hear, or feel; what sensory experiences are related to the activity; and what modifications could be made so that the activity is more accessible to students with disability.

Since 2002, we further tested the LAM system, this time with inservice teachers engaged in a series of hands-on activities related to magnetism. We found that they too reported that the LAM approach stimulated their thinking about the nature of the activities as well as potential accommodations for diverse learners. Here we do not provide detailed analysis of the results using the magnetism activity, except to note that the inservice teachers also found that the LAM system prompted them to think about the sensory characteristics of hands-on activities in ways that they had not done before. This experience also demonstrated that LAM works with prompting thinking about magnets and magnetic force, so that we knew at that point that LAM works with at least two topics in physics.

The inservice teachers who did the magnet activities suggested that we separate out the two dimensions of the LAM matrix. That is, they suggested that we focus first on the characteristics of the hands-on lab activities, then as a second step consider the accessibility of specific activities to learners with sensory or motor disabilities. Reflecting our experiences thus far, we reasoned that, in general, we ought to be able to obtain agreement among participants as to the sensory characteristics of a given hands-on activity.

The Present Study

Therefore, we decided to find out how a different group of inservice teachers would describe the sensory characteristics of yet another hands-on science learning activity. This time, ten inservice teachers were asked to characterize the hands-on activities they had just done related to Newton's Laws of Motion. We asked them what they expected their students to see, hear, touch (feel) or manipulate. Of note here is that in this workshop the teachers constructed mini-ramps and devised pulleys using an assortment of recycled materials, not standard purchased lab supplies. In other words, these teachers had to think through the purpose of the activity and how the materials were used to make observations and collect data. We had not prompted them to think through the sensory characteristics of the activity beforehand, but rather, waited until after they had carried out the activity, predicted results, and collected and interpreted data.

With this group we did not present the LAM table as a way to think about the activities or their accessibility. Instead, we focused separately on each aspect of LAM. First, we asked the teachers to characterize the sensory nature of the activities they had just completed. Specifically, we asked

> How would you characterize these lab activities? What are your students expected to see, hear, touch (feel) and/or manipulate in order to do this activity? Please focus on the properties of the lab activities and not on your instructional strategies or how you would group the students (e.g., individuals, pairs or cooperative groups), or what individual accommodations you might make. Circle the best phrase for each characteristic.

Teachers' responses are shown in Table 1. All (100%) agreed that the activities were highly visual in nature. Responses were the most divided on the auditory characteristics of the activities, and somewhat divided on tactile characteristics. We did not ask, and therefore do not know their reasoning behind their responses, something we will tend to in future studies. We had expected greater consistency among their responses, especially because the group was small, had actively engaged in discussing the activities among themselves, and because all were experienced teachers. One possibility that might explain differences in responses is lack of definitional clarity in the terms we used. Another is that such ratings are subjective and may well reflect the sensory capabilities of these teachers as much as the sensory characteristics of the labs they experienced.

Second, we asked the teachers to rate the accessibility of the activities to students with disabilities in terms of the visual, tactile, auditory and motor requirements of the labs. See Table 2. Teachers were asked to consider four categorical types of learners:

those with profound hearing impairment/deaf, visual impairment/blind, motor impairment, and speech/language impairment. We used the same 0 = not accessible to 4 = full accessible scale that we had used in prior LAM studies. As we did with prior studies, we acknowledged that in classroom practice teachers develop individual education plans tailored to individual learners with special needs. As we present our findings in Table 2, we note that we asked the teachers to focus on one category of disability at a time, disregarding the possibility of learners with multiple disabilities. We note also that we did not specifically ask the teachers what they would do to modify the lab activities or to provide personal assistance.

Recall that our original purpose was to devise a simple way to characterize hands-on science labs. By calculating the overall mean rating of the teachers, and using our rating scale, the accessibility of the labs on Newton's Laws may be characterized as follows:

Speech/Language impairment:	3.7
Profound hearing impairment/ Deaf	3.0
Motor impairment	2.4
Visual impairment/Blind	1.9

Descriptively, these numbers tell us that the activities are almost fully accessible for learners with speech/language disability (3.7); accessible with lab modifications but no personal assistance for learners with profound hearing impairment (3.0); in the range of accessible with lab modifications and some personal assistance for learners with motor impairment (2.4); and closer to the range of might be accessible with lab modification and personal assistance than not at all accessible for learners with profound visual impairment/blindness (1.9).

These means however, do not reflect the spread in ratings, which with a larger sample size would be examined in terms of standard deviations. Clearly, larger samples are needed to ascertain whether the notion of numerical rating of the accessibility of hands-on science labs is feasible. For example, the spreads in teacher ratings might be affected by prior experiences in working with learners with disabilities or with more or less familiarity with working with the activities. In an earlier study (Klemm, Laszlo & Plourde, 2002), we observed differences in responses between preservice teachers with and without a prior course in special education. We began this study thinking that we needed to examine two factors, the sensory characteristics of the a hands-on lab and the accessibility of the labs to categorized groups of students with disability. From the results of this study, we now realize that teachers' own perceptual abilities and their prior teaching experiences may be factors too.

Relevance of Work to Teacher Education

Our present work focuses on characterizing the sensory nature of well-known hands-on, inquiry science learning activities. This study builds on our earlier work, which began out of need to find appropriate science learning activities for youth with moderate to severe disabilities, including sensory and motor disabilities. Subsequently, as teacher educators, we realized that we also needed to find ways to engage preservice teachers in thinking about the accessibility of hands-on science activities to learners with a wide, diverse range of needs.

According to Stefanich, "Multi-modality instruction is especially critical in helping students with disabilities gain a familiarity with the content material" (Stefanich, 2001). Clearly, better understanding of the sensory characteristics of science inquiry learning has relevance for instruction of learners with profound sensory or motor impairment. Statistically, physical and orthopedic impairments are low incident disabilities, comprising less than 5% of those learners classified as disabled (U. S. Dept. Education, 1998). However, activity-oriented science is advocated for all learners, including those who are English language learners (ESOL). Central to reasons for advocating hands-on approaches to science learning is that the concrete and multi-sensory nature of hands-on science provides multiple ways for students to learn. The science education community largely accepts this today, so information is needed to elucidate the multi-sensory, multi-modal nature of that which is advocated.

We prepare teachers today, advocating that they adopt constructivist instructional approaches and assume the role of facilitator of learning, so it is reasonable to ask what we know about facilitating learning that is multi-sensory in nature. Our approach to science education is founded on the notion that science as a body of knowledge is founded upon the use of one or more science process skills. Often the first listed among the science process skills is observing, which Abruscato (2000, p. 3) explains as "using the senses to obtain information, or data, about objects and events." We note here that Abruscato, like other authors of science methods texts, then exemplifies "observing" with suggested activities that engage learners in use of visual senses.

Furthermore, we know from instructional approaches like the Learning Cycle or the 5E Instructional approach, that as a first step we expect learners to engage in exploring and observing phenomena. We often ask learners to "observe" or to "make observations." How often, though, do we ask them to "use all of their senses" or to "use as many of your senses as you can"? As we move further towards student-centered, problem-based learning, where students devise their own procedures, how have we prepared them for observational encounters with phenomena? At the least, common sense, bolstered by safety concerns, has shown us that we do indeed need to teach learners how to use their senses to safely detect smells, handle extremely cold or hot objects, and mitigate very loud noise.

As researchers, we plan to continue our work for the purpose of better preparing teachers to differentiate instruction for diverse learners, including examining the role of sensory learning in working with students who are learning disabled or English language learners. In seeking to better understand the sensory characteristics of science learning activities, our work has taken on a broader series of questions, several of which we pose here. Aside from safety concerns, does it really matter whether or not we as teachers understand the sensory characteristics of science activities, or whether our students engage a range of senses in making observations? When exploring real world situations on their own, what sensory observation skills and knowledge might they need? As technology and multimedia tools are increasingly making simulations and virtual reality viable in classroom learning environments, what senses will students be using as they learn science, and what experienced based learning is gained or lost in this technological shift?

References

Abruscato, J. (2001). Teaching children science. *Discovery methods for the elementary and middle grades.* Boston: Allyn and Bacon.

American Association for the Advancement of Science. (1993). *Benchmarks for science literacy.* New York: Oxford University Press : Author.

Atwood, R. K., & Oldham, B. R. (1985). Teachers' perceptions of mainstreaming in an inquiry oriented elementary science program. *Science Education, 69*, 619-624.

Cawley, J. F. (1994). Science for students with disabilities. *Remedial and Special Education*, 15, 67-71.

Daniels, S. M. (1990). The meaning of disabilities: Evolving concepts. *Assistive Technology Quarterly (1)*3. Arlington, VA. Available: http://www.resna.org/tap/atq/paradigm.htm.

Enders, A. (1999) *Technology for the next millenium: Building a framework for collaboration.* Missoula, MT: Rural Institute on Disabilities. Available: http://ruralinstitute.umt.edu/rtcrural/advocacy/technology.htm.

Klemm, E. B. & Laszlo, J. (2001, January). The levels of accessibility matrix system for determining the appropriateness of hands-on science activities for students with disabilities. *Proceedings of the 2001 Association for the Education of Teachers of Science Annual International Meeting*. Costa Mesa, CA

Klemm, E. B., Plourde, L. A., & Laszlo, J. (2002, January). Using the levels of accessibility matrix system to promote preservice science students' thinking about inclusionary teaching. *Proceedings of the 2001 Association for the Education of Teachers of Science Annual International Meeting*. Charlotte, NC.

Klemm, E. B., Skouge, Radtke, R. L. & Laszlo, J. (2000, *Winter*). Ocean of potentiality: Fully accessible science camps. *The Journal of Science Education for Students with Disabilities (8)*, 22-29.

Meyen, Edward L. and Thomas M. Skirtc, eds. 1994. *Special education and student disability.* Denver: Love Publishing Company.

National Institute on Disability and Rehabilitation Research. (1998). Notice of proposed long-range plan for fiscal years 1999-2004. *Federal Register 63* (206) 57189-57219. Available: http:// www.wais.access.gpo.gov.

National Research Council. (1996). *National science education standards.* Washington, DC: National Academy Press.

Norman, K., & Caseau, D. (1995). The learning cycle: Teaching to the strengths of students with learning disabilities in science classrooms. *Journal of Science for Persons with Disabilies, 3* (1), 18-25.

Patton, J. R. (1993). Individualizing for science and social studies. In J. W. Wood (Ed.), *Mainstreaming: A practical approach for teachers*, (2nd ed. ed., pp. 366-413). New York: Macmillan.

Patton, J. R. (1995). Teaching Science to Students with Special Needs. *Teaching Exceptional Children, 27* (4), 4-6.

Rutherford, F. J. & Alghren, A. (1990). *Science for all Americans*. New York: Oxford University Press.

Seelman, K. D. (1998). *Change and Challenge: The integration of the new paradigm of disability into research and practice.* Paper presented at the National Council on Rehabilitation Conference. Vancouver, WA. Available: http://www.ncddr.

Stefanich, G. (2001, January). Inclusive science education – Model lessons. Paper presented at the *2001 Association for the Education of Teachers of Science Annual International Meeting*. Costa Mesa, CA.

U. S. Department of Education. (1998). 20th *Annual Report to Congress on the implementation of Individuals with Disabilities Education Act*. Washington, D. C.: Author.

Appendix

Table 1. Teachers' sensory characterization of the Newton's Laws lab activities

Visual Characteristics	Highly visual 100% (N=10)	Somewhat visual 0%	Not visual 0%
Tactile Characteristics	Highly tactile 78% (N=7)	Somewhat tactile 22% (N=2)	Not tactile 0%
Auditory Characteristics	Highly auditory 22% (N=2)	Somewhat auditory 56 % (N=5)	Not auditory 22% (N=2)

Table 2. Accessibility of the activities on Newton's laws of motion arranged by sum of means.

Disability	Visual Input Accessibility	Tactile Input Accessibility	Auditory Input Accessibility	Motor Requirement Accessibility	Overall Mean Rating
Speech/Language Impairment	3.9	3.7	3.4	3.9	3.7
Profound hearing impairment/deaf	3.7	3.7	1.1	3.5	3.0
Motor Impairment	3.6	1.6	3.3	0.9	2.4
Visual impairment/blind	0.5	2.0	2.6	2.3	1.9

Scale for rating levels of disabilities:
0 = Not Accessible (even with lab modifications and personal assistance)
1 = Might be Accessible (with lab modifications and personal assistance)
2 = Accessible (with lab modifications and personal assistance)
3 = Accessible (with lab modifications, no personal assistance required)
4 = Fully Accessible (without lab modifications or personal assistance)

SE067311

ERIC

U.S. Department of Education
Office of Educational Research and Improvement (OERI)
Educational Resources Information Center (ERIC)

REPRODUCTION RELEASE

(Specific Document)

I. DOCUMENT IDENTIFICATION:

Title: Examining the Multi-Sensory Characteristics of Hands-on Science Activities	
Author(s): E. Barbara Klemm, University of Hawaii Lee A. Plourde, Central Washington University-Wenatchee	
Corporate Source:	Publication Date: January 2003 AETS Conference January 29-February 2, 2003 St. Louis, MO

II. REPRODUCTION RELEASE:

In order to disseminate as widely as possible timely and significant materials of interest to the educational community, documents announced in the monthly abstract journal of the ERIC system, *Resources in Education* (RIE), are usually made available to users in microfiche, reproduced paper copy, and electronic media, and sold through the ERIC Document Reproduction Service (EDRS). Credit is given to the source of each document, and, if reproduction release is granted, one of the following notices is affixed to the document.

If permission is granted to reproduce the identified document, please CHECK ONE of the following three options and sign at the bottom of the page.

The sample sticker shown below will be affixed to all Level 1 documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

1

Level 1

X

Check here for Level 1 release, permitting reproduction and dissemination in microfiche or other ERIC archival media (e.g., electronic) *and* paper copy.

The sample sticker shown below will be affixed to all Level 2A documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE, AND IN ELECTRONIC MEDIA FOR ERIC COLLECTION SUBSCRIBERS ONLY, HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2A

Level 2A

Check here for Level 2A release, permitting reproduction and dissemination in microfiche and in electronic media for ERIC archival collection subscribers only.

The sample sticker shown below will be affixed to all Level 2B documents

PERMISSION TO REPRODUCE AND DISSEMINATE THIS MATERIAL IN MICROFICHE ONLY HAS BEEN GRANTED BY

Sample

TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

2B

Level 2B

Check here for Level 2B release, permitting reproduction and dissemination in microfiche only.

Documents will be processed as indicated provided reproduction quality permits. If permission to reproduce is granted, but neither box is checked, documents will be processed at Level 1.

I hereby grant to the Educational Resources Information Center (ERIC) nonexclusive permission to reproduce this document as indicated above. Reproduction from the ERIC microfiche or electronic/optical media by persons other than ERIC employees and its system contractors requires permission from the copyright holder. Exception is made for non-profit reproduction by libraries and other service agencies to satisfy information needs of educators in response to discrete inquiries.

Sign here please

Signature:	Printed Name/Position/Title: Lee A. Plourde, Ph.D./Education Program Director	
Organization/Address: Central Washington University-Wenatchee 604 Ringold St. Wenatchee, WA 98801	Telephone: (509) 665-2600	FAX: (509) 665-2601
	E-Mail Address: plourdel@cwu.edu	Date: 2/21/03