Activity-Based Science Learning Style Preferences

Xiaoqing Kong[1]

John T. Almarode[2]

Adam V. Maltese[3]

Robert H. Tai[1]

[1] Curry School of Education, University of Virginia, Charlottesville, VA, USA

[2] College of Education, James Madison University, Harrisonburg, VA, USA

[3] School of Education, Indiana University, Bloomington, IN, USA

Paper presented at the annual conference of National Association for Research in Science Teaching

March-April, 2014, Pittsburgh, Pennsylvania

Abstract

Many existing measurements of students' interest in and attitudes towards science mainly concentrate on assessing students' general views and perceptions about science and science learning. This study validated a newly developed survey instrument measuring students' seven activity-based science learning style preferences—collaborating, competing, making, discovering, presenting, caretaking, and teaching; and investigated whether and how these factors were significantly associated with students' career interest in science and engineering. Participants were 7,382 students in Grades 3 through 12 from 25 schools. We conducted confirmatory factor analysis to validate the typology of students' activity-based science learning style preferences, and logistic regression analysis to examine their relationships with whether students reported a career interest in science and engineering. Results indicated that our survey instrument for measuring seven factors was validated. In addition, students who reported a career interest in science and engineering had higher levels of preferences for making and discovering in science focused activities. Future researchers and administrators are suggested to develop science focused activities with emphasis on the aspects of making and discovering.

Activity-Based Science Learning Style Preferences

Problem

This study was to validate the typology of students' activity-based science learning style preferences, and to examine their relationships with students' career interest in science and engineering. Science focused activities are an important element of science teaching and learning process in both formal and informal education that can help increase students' science interest (National Academy of Sciences, 2007). Students' interest in science, attitudes towards science, and career expectation in science related fields are considered essential indicators of their continuous pursuit in the pipeline of science, technology, engineering, and mathematics (STEM). Therefore, with a good understanding of what particular aspects of science focused activities may spark students' interest in science, educators, policy makers, and researchers can develop and improve science activities that purposefully involve customized aspects to attract an increasing number of individuals in the STEM pipeline, and can also best match individuals' education selections with career options in STEM workforce (Carnevale, Smith, & Strohl, 2010).

Students' interest in science and their attitudes towards science are two dominant affective factors that have long been investigated (Koballa, Jr. & Glynn, 2007; Simpson, Koballa, Jr., Oliver, & Crawley, 1994). Interest can be defined as "a content-specific motivational characteristic composed of intrinsic feeling-related and value-related valences" (Schiefele, 1991, p. 299). According to Kind, Jones, and Barmby (2007), an attitude towards science refers to cognitive and emotional beliefs and views about science. Previous studies have suggested a positive relationship between various science focused activities and students' levels of interest in and attitudes towards science (Fields, 2009; Welchm, 2010).

So far, researchers have developed various measurements for students' interest in and attitudes towards science learning. The *Modified Attitude Towards Science Inventory* (mATSI; Weinburgh & Steele, 2000) examines interest in science, attitude towards social significance of science, and uneasiness about learning science. The *Relevance of Science Education* (ROSE; Talisayon et al., 2004) measures interest in specific science related topics, science experiences, and social significance of science and technology. The *Scientific Attitude Inventory* (SAI II; Moore & Foy, 1997) assesses interest in science, perception of scientists, and contribution of science to the society. The *Survey Items of Situational Interest* (Hulleman & Harackiewicz, 2009) investigates whether activities increase students' motivation in learning science, and asks for students' perceptions of expectancies for success, interest in science, and utility value of science.

The measurements discussed above mainly focus on students' general science interest and attitudes, instead of specific aspects of students' interest especially in science activities. Students may possibly lose their interest in science in the future if the activities they attend do not involve their preferred aspects or styles. In order to explore specific aspects of students' interest in science activities, based on existing related measurements, we developed a survey instrument to assess students' seven activity-based science learning style preferences in a typical science focused activity: collaborating, competing, making, discovering, presenting, caretaking, and teaching (Figure 1). It is also necessary to further explore the connections between each activity-based learning style preference and students' career interest in science and engineering, which is considered an important indicator of persistence in STEM pipeline (Bhattacharyya & Mead, 2011; Brown, 2002). The research questions in this study are: (1) To validate the survey instrument for the seven activity-based science learning style preferences. (2) To what extent were the seven activity-based learning style preferences associated with students' career interest in science and engineering?

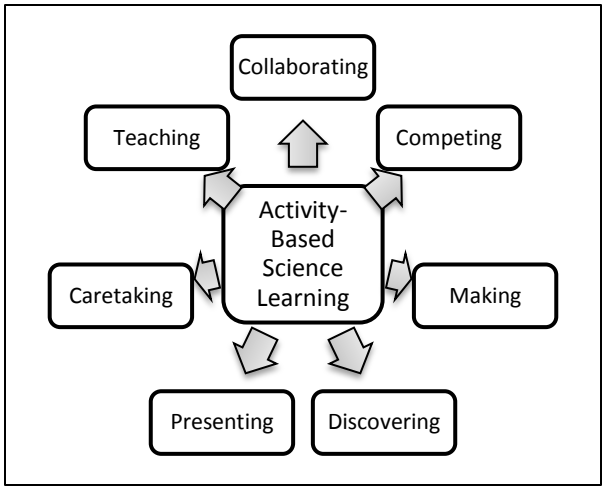

Figure 1. Framework for activity-based science learning style preferences.

Design

The source of the data was a survey asking for students' career expectations and opinions about statements indicating their specific activity-based science learning style preferences. Participants of the study were 7,382 students (in Grades 3 through 12) from 25 schools in four school districts located in urban, suburban, and rural areas. Tables 1 and 2 present the demographic information for the participants.

Confirmatory factor analysis (CFA) was conducted to validate the survey instrument for measuring activity-based science learning style preferences. For each of the seven preferences (treated as latent factors), we developed three to five statements with scale of five (from "strongly disagree" to "strongly agree") in the survey (Table 3). Each statement was treated as an observed variable with values ranging from 1 to 5. We analyzed one preference at a time (totally seven factor analyses). Likelihood ratio test was used for model selection. *Logistic regression analyses* were conducted to examine the relationships between each of the seven preferences and students' career interest. The predictors were students' reported scores on each preference, while the outcome was whether students indicated a career interest in science and engineering.

Table 1. Gender and grade level information

	Percentage
Male	48.9%
Female	50.6%
Elementary	33.7%
Middle	33.9%
High	29.4%

Note. The total number of subsamples is smaller than the sample size due to missing data.

Table 2. Ethnicity information

	Percentage
White	54.6%
Black	22.1%
Hispanic	20.0%
Asian and Pacific Islander	3.3%
American Indian and Alaska Native	3.3%
Multiracial	6.8%

Note. The sum of the percentages exceeds 100% since some participants selected more than one option.

Analyses and Findings

Through CFA for each activity-based science learning style preference, we compared full models (models with corresponding observed variables sharing a common factor) against independent models (models with observed variables only), and then selected a model that could better represent the data. The likelihood ratio tests (Table 4) indicated that the full models performed significantly better than the independent models in representing the data, and thus the full models with a common factor shared by corresponding observed variables were preferred for all the seven learning preferences. After CFA, we tested whether there was more than one latent factor in each preferred model. We conducted principal component analysis (PCA) and found that a second factor for each preference was not necessary. Meanwhile, our results for the correlations among all the 28 observed variables confirmed that the correlations between observed variables across different factors were overall mostly lower than the correlations

between observed variables within corresponding factors. As a result, the instrument for measuring seven activity-based science learning style preferences was validated.

Table 3. Descriptions of 28 variables in factor analysis

Factor	Variable	Description
Collaborating	feelgrp	I like an activity that involves "Being in a group".
	wrkothrs	Working with others is more fun than working alone.
	partteam	I like being part of a team.
	lrnothrs	I learn better when I am working with others.
Competing	feelcmpt	I like an activity that involves "Being in a competition".
	exctcmpt	I get excited when I hear there will be a competition.
	cmptothr	I enjoy competing against other people.
	focusown	I like to focus on my own goals, rather than competing with others.
Making	feelmkbd	I like an activity that involves “Making or building things”.
	likemake	I like doing projects where I make things.
	resrcful	Whenever I can, I make the things I need.
	likebld	I like building things.
Discovering	feeldisc	I like an activity that involves "Discovering and learning new things ".
	figrhow	I like figuring out how things work.
	tkapart	I like taking things apart to see what is inside.
	figrdiff	I like trying different ways to figure things out.
	probsolv	I like solving problems.
Presenting	feelpres	I like an activity that involves "Presenting in front of lots of people".
	perform	Performing in front of other people is fun.
	presppl	I like telling people about my work.
	presclas	I like presenting my work to my class.
Caretaking	feelanml	I like an activity that involves "Taking care of animals".
	havepet	Having a pet is a big responsibility, but something I like to do.
	plntaqua	I like to take care of things like plants and aquariums.
Teaching	feeltutr	I like an activity that involves "Helping people learn things".
	hlpothrs	Helping others to learn things is fun for me.
	tchothrs	I like teaching things to others.
	dpendme	I feel good when people depend on me.

Table 4. CFA Likelihood Ratio Test results for each factor

	Full model		Independent model		*p* Value
	-2LL	NEP	-2LL	NEP	
Collaborating	82195.8	11	93137.8	8	<0.001
Competing	88433.3	11	102154.9	8	<0.001
Making	83885.8	11	94341.4	8	<0.001
Discovering	111093.7	14	117556.2	10	<0.001
Presenting	92528.4	11	104186.2	8	<0.001
Caretaking	64426.4	8	70272.3	6	<0.001
Teaching	84799.8	11	95207.8	8	<0.001

Note. -2LL = negative two log-likelihood; NEP = number of estimated parameters.

Table 5 presents two sets of logistic regression results. In the first set of regression analyses, all the participants were included. Students with one point higher preferences for discovering had 1.591 times greater odds in reporting a career interest in science and engineering than students with one point lower preferences for discovering. Additionally, students with one point higher preferences for making had 1.317 times greater odds in reporting a career interest in science and engineering than students with one point lower preferences. However, students with higher levels of preference for collaborating were significantly less likely to indicate a career interest in science and engineering than students with lower levels of interest in collaborating. In the second set of regression analyses, the associations were examined by different grade levels. Results showed that preferences for making and discovering were consistently and positively associated with students' career interest in science and engineering, while collaborating had a consistently negative relationship with students' science and engineering career interest.

Table 5. *Odds Ratios from Logistic Regression Analyses*

Preference Factor	All	Grade Level		
		Elementary	Middle	High
Collaborating	0.778***	0.771***	0.772***	0.785***
Competing	0.977	0.923	1.044	0.938
Making	1.317***	1.261*	1.600***	1.342***
Discovering	1.591***	1.353**	1.931***	1.727***
Presenting	1.047	1.094	1.153*	0.938
Caretaking	0.978	1.017	1.058	1.043
Teaching	0.960	0.945	1.009	1.053
Gender	Included	Included	Included	Included
Race/Ethnicity	Included	Included	Included	Included

*$p < .05$. **$p < .01$. ***$p < .001$.

Contribution

This study validated a newly developed instrument measuring students' activity-based science learning style preferences. We found that students did have separate preferences for specific aspects of science focused activities. Researchers have previously developed surveys mainly to measure students' general interest in and attitudes towards science (e.g., Talisayon et al., 2004). This study further broke down general science interest and explored the specific aspects within science focused activities.

Previous studies suggested a significant relationship between students' career interest in science-related fields and their positive interest and attitudes towards science (Archer et al., 2010; Becker, 2010). In this study, by categorizing the science interest into specific preferences, we found that students who reported a career interest in science and engineering tended to have significantly higher levels of preferences for making and discovering than students who did not across all grade levels. It is suggested to emphasize the making and discovering aspects in science focused activities in the future, potentially to maintain students in the STEM pipeline. Therefore, it is important to evaluate specific aspects separately, since they may have uniquely different relationships with students' future career interest.

In summary, we successfully developed an instrument measuring students' seven activity-based science learning style preferences, which can be considered a complement of previous studies on students' general science interest and attitudes. In addition, researchers, administrators, and policy makers are suggested to give more focus on the making and

discovering aspects in science related activities so as to potentially engage students in the STEM pipeline, as students' preferences for these factors are positively related to their science and engineering career interest. Future research is needed to further explore the relationships among those seven factors, and their connections with other affective indicators in science education.

References

Archer, L., DeWitt, J., Osborne, J., Dillon, J., Willis, B., & Wong, B. (2010). "Doing" science versus "being" a scientist: Examining 10/11-year-old schoolchildren's constructions of science through the lens of identity. *Science Education, 94*(4), 617-639.

Becker, F. S. (2010). Why don't young people want to become engineers? Rational reasons for disappointing decisions. *European Journal of Engineering Education, 35*(4), 349-366.

Bhattacharyya, S., & Mead, T. P. (2011). The influence of science summer camp on African-American high school students' career choices. *School Science & Mathematics, 111*(7), 345-353.

Brown, D. (2002). *Career choice and development*. San Francisco, CA: John Wiley & Sons, Inc.

Carnevale, A. P., Smith, N., & Strohl, J. (2010). *Help wanted: Projections of jobs and education requirements through 2018*. Washington DC: Georgetown University, Center on Education and the Workforce.

Fields, D. (2009). What do students gain from a week at science camp? Youth perceptions and the design of an immersive, research-oriented astronomy camp. *International Journal of Science Education, 31*(2), 151-171.

Hulleman, C. S. & Harackiewicz, J. M. (2009). Promoting interest and performance in high school science classes. *Science, 326*, 1410-1412.

Kind, P. M., Jones, K., & Barmby, P. (2007). Developing attitudes toward science measures. *International Journal of Science Education, 29*(7), 871–893.

Koballa, Jr., T. R., & Glynn, S. M. (2007). Attitudinal and motivational constructs in science learning. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education* (pp. 75–102). London: Lawrence Erlbaum Associates.

Moore, R. W., & Foy, R. (1997). The scientific attitude inventory: A revision (SAI II). *Journal of Research in Science Teaching, 34*(4), 327-36.

National Academy of Sciences. (2007). *Rising above the gathering storm: Energizing and employing America for a brighter future.* Washington, DC: The National Academies Press.

Schiefele, U. (1991). Interest, learning, and motivation. *Educational Psychologist, 26*(3&4), 299–323.

Simpson, R. D., Koballa, Jr., T. R., Oliver, J. S., Crawley, F. E. (1994). Research on the affective dimension of science learning. In D. Gabel (Ed.) *Handbook of research on science teaching and learning* (pp. 211–234). New York: Macmillan.

Talisayon, V. M., Mulemwa, J., Corrigan, D., Mehta, J., Jenkins, E., Koulaidis, V., Goel, V., Aikenhead, G., & Ogawa, M. (2004). Relevance of Science Education. Retrieved from http://www.ils.uio.no/english/rose/about/rose-brief.html

Weinburgh, M. H., & Steele, D. (2000). The modified attitudes toward science inventory: Developing an instrument to be used with fifth grade urban students. *Journal of Women and Minorities in Science and Engineering, 6*, 87-98.

Welch, A. G. (2010). Using the TOSRA to assess high school students' attitudes toward science after competing in the FIRST robotics competition: An exploratory study. *Eurasia Journal of Mathematics, Science & Technology Education, 6*(3), 187-197.