On Defining and Assessing Engagement, Interest, Curiosity, and Motivation in Informal Science Learning

K. Ann Renninger, Swarthmore College

> Participants might evidence delight at having the car they built roll down a ramp, but might not ask questions about how to make its descent more rapid by changing the car, the surface, or the slope of the ramp; they might not really do any thinking about momentum at all and they may never reengage this type of activity again even if they have the opportunity to do so. What would their "delight" indicate?

This background paper is intended to support consideration of assessments "in improving program quality and student learning outcomes in the field of informal science education." There are three questions the NRC has asked me to address: (a) What definitions of engagement, interest, curiosity, and motivation might be used in evaluations of informal and after-school science learning programs and activities? (b) Given the diversity of learning experiences, what are the prospects for developing common definitions of engagement, interest, curiosity, and motivation? And, (c) Given the diversity of types of informal and after-school learning experiences, what are the prospects for developing common assessments of engagement, interest, curiosity, and motivation?

Working Definitions

The terms engagement, interest, curiosity, and motivation all reflect distinct bodies of research. Importantly, however, they cannot be conceptualized independently: you cannot remove engagement from interest, interest from motivation, and so forth. To address the questions as posed, then, the following are offered as working definitions. The variables refer to different ways in which participants may connect to settings. Briefly:

- Engagement refers to connecting for some period of time to any of a variety of tasks or activities.

- Interest refers to both the state of being engaged with and also the predisposition to return to engagement with particular content (e.g. science).
- Curiosity describes a disposition to explore and question.
- Motivation in its most general usage refers to the will to engage. Motivation, in this sense, is considered to describe reflective behavior: a participant chooses to engage or not, calculates the expectancy-value of participation (Wigfield, Eccles, Schiefele, Roeser, & Davis-Kean, 2006), and may or may not hold a perspective that he or she is intelligent and able to learn (e.g. Dweck, 2006). This is different and yet related to the cognitive, affective, and behavioral characteristics of engagement, the nature of the triggers for interest that catch and possibly hold participant attention for science, or whether a person seriously engages with content (e.g. by questioning) when it is called to his or her attention.

Table 1 depicts the general case regarding the characteristics of these variables in terms of assumptions that often are made about whether the variable:

- supports participants to make needed connections to disciplinary content
- assumes that the participant is aware of his or her behaviors and able to provide a description of them on a survey, for example
- is static in the sense that it is presumed to exist or not, rather than changing or developing over time
- targets one or another disciplinary content when tracked over time
- exists in the interaction of the participant and the setting—and is expected to change in relation to the quality of the interaction, rather than being located in the person or in the setting
- develops in relation to increases in principled knowledge and skills (although it should be noted that the presence of knowledge and skills should not be equated with developed interest, for example)

Prospects for Common Definitions

Common definitions of these variables are possible; however they should reflect developments in the research literature. When research on motivation has not informed an analysis, it can be the case that variables are studied as they are used in everyday conversation and do not reflect developments in the research on that variable. For example, positive feelings (e.g., liking, enjoyment, delight) are often used to assess interest, but research from neuroscience and interest research suggests that measuring interest solely on the basis of positive feelings may not be appropriate (Berridge et al., 2009; Ernst & Spear, 2009; Harackiewicz, Barron, Tauer, & Elliot, 2002; Turner & Silvia, 2006). Negative affect can be associated with the experience of interest especially in earlier phases of interest development (Ainley, 2007; Bergin, 1999; Hidi & Harackiewicz, 2000) and, in later phases of interest development, the presence of negative affect is overcome by the perseverance that accompanies well-developed individual interest (Kim, Lee, & Bong, 2009; Renninger, 2000).

One complication of assessing informal science settings is that they are use-informed (Stokes, 1997); the variables to be addressed are likely to reflect a number of different literatures and require a somewhat different procedure for anchoring the research methods and practices than that characterizing basic research. For example, a person conducting a study of an exhibit (software, an afterschool club) might want to know if it piqued its participants' curiosity. On one hand, the research is not on curiosity, per se. However, if curiosity is being studied, then once prior study of exhibits of this type has been reviewed, research on curiosity in other informal science contexts should be reviewed, as should the research that focuses specifically on curiosity as a variable.

Prospects for Common Assessments

Common indicators of engagement, interest, curiosity, and motivation do exist, suggesting that although data sources and methods may vary by setting and age of participant group, indicators of these variables should not differ across settings. It should also be noted that many studies have been conducted in which one or more of the listed variables is an item in the assessment of another of these variables because the concepts

are overlap conceptually, and/or as a way to extend the assessment to encompass and study potentially relevant dimensions. For example, the instance of the participant generating “curiosity questions” or demonstrating what neuroscience would term “seeking behaviors” (Panksepp, 1998) is one of the defining characteristics of more developed phases of interest (Renninger, 2000). Thus assessing the presence of curiosity questions in assessment of interest is appropriate. Connell’s (1990) assessment of variables such as belonging, autonomy, and sociability, in addition to assessing time on task and participation, provides an example of the way in which study of engagement was extended to consider variables from Self-Determination Theory.

Common Indicators

Engagement

Study of engagement focuses on the way in which participants work with tasks or activities (or school or the learning setting, more generally). It can vary in grain size from the microsecond as in a task to a larger time frame such the weeks or months in the duration of a project; more developed considerations of engagement sometimes reference a particular domain and the development of identity with that domain at which point there is clear overlap with the research on interest. Time on task and participation are two key indicators of engagement (Brophy, 1993; Natriello, 1984; see Fredricks et al., 2011 for a review of instruments).

Interest

While studies of interest could focus on emotion, task features/experience, value, or vocational interest, if program goals include change in interest, a developmental approach to the study of interest should be employed (in other words, an approach that allows specification of change). A developmental approach would acknowledge that interest included the psychological state of being engaged as well as the likelihood of reengaging the content over time. Indicators include assessment of participant feelings, stored knowledge, and stored value with respect to particular disciplinary content, such as science (see Hidi & Renninger, 2006; Renninger & Hidi, 2011).

Curiosity

The curious participant is one who is more open to exploring and learning than others, may be filling in gaps in knowledge in this process, or may be responding to what Berlyne (1971) described as collative variables: uncertainty, novelty, surprise, challenge, or complexity (for a review see Silvia, 2012). Thus, indicators of curiosity include: participants' responses to uncertainty, novelty, surprise, challenge, or complexity and the likelihood that they will engage in exploration.

Motivation

Motivation to learn usually refers to the energy behind conscious decisions to act: to set goals, self-regulate, and exert effort toward achieving goals (see Eccles et al., 1998; Murphy & Alexander, 2000; Wigfield et al., 2006). Students are likely to set goals, and are likely to be classified according to the source of their motivation (more intrinsic, more extrinsic, see Hidi & Harackiewicz, 2000) and/or by the types of goals they adopt (e.g., more task or more learning, more mastery or more performance goals; see Harackiewicz, Durik, Barron, Linnenbrink, & Tauer, 2008). They make these decisions by (implicitly) calculating the worth of their effort, or the "expectancy-value," based on previous success (among other factors). Key indicators of motivation include goals, self-regulation, effort, success, cost, and utility.

References

Ainley, M. (2007). Being and feeling interested: Transient state, mood, and disposition. In P. Schutz (Ed.), *Emotion in education* (pp. 141- 157).

Berlyne, D.E. (1960). *Conflict, arousal, and curiosity*. New York: McGraw-Hill.

Berridge, K.C., Robinson, T.E., & Aldridge, J.W. (2009). Dissecting components of reward: "liking", "wanting", and learning. *Current opinion in pharmacology, 9 (1),* 65-73.

Dweck, C. S. (2006). *Mindset: The new psychology of success*. New York: Random House.

Eccles, J. S., Wigfield, A., & Schiefele, U. (1998). Motivation to succeed. In W. Damon (Series Ed.) & N. Eisenberg (Vol. Ed.), *Handbook of child psychology (5th ed., Vol. 3, pp. 1017-1095).* New York: Wiley.

Fredricks, J., McColskey, W., Meli, J., Montrosse, B., Mordica, J. & Mooney, K. (2011). *Measuring student engagement in upper elementary through high school: A description of 21 instruments.* REL 2011- No. 098. Greensboro, NC: IES National Center for Education Evaluation and Regional Assistance.

Harackiewicz, J. M., Barron, K. E., Tauer, J. M., & Elliot, A. J. (2002) Predicting success in college: A longitudinal study of achievement goals and ability measures as predictors of interest and performance from freshman year through graduation. *Journal of Educational Psychology, 94(3),* 562-575.

Harackiewicz, J. M., Durik, A. M., Barron, K.E., Linnenbrink, L. & Tauer, J.M. (2008). The role of achievement goals in the development of interest: Reciprocal relations between achievement goals, interest, and performance. *Journal of Educational Psychology, 100*(1), 105-122.

Hidi, S., & Harackiewicz, J. (2000). Motivating the academically unmotivated: A critical issue for the 21st century. *Review of Educational Research, 70,* 151–179.

Hidi, S. & Renninger, K. A. (2006). The four-phase model of interest Development. *Educational Psychologist, 41(2),* 111-127.

Kim, S., Lee, M.J., & Bong, M. (2009, April). *fMRI study on the effects of task interest and perceived competence during negative feedback processing.* Paper presented at the Meetings of the American Educational Research Association, San Diego, CA.

Murphy, P.K., & Alexander, P.A. (2000). A motivated exploration of motivation terminology. *Contemporary Educational Psychology, 25,* 3-53.

Natriello, G. (1984). Problems in the evaluation of students and student disengagement for secondary schools. *Journal of Research and Development in Education, 17,* 14-24.

Panksepp, J. (1998). *Affective neuroscience: The foundations of human and animal emotion.* New York: Oxford University Press.

Renninger, K. A. (2000). Individual interest and its implications for understanding intrinsic motivation. In C. Sansone and J. M. Harackiewicz (Eds.), *Intrinsic motivation: Controversies and new directions* (pp. 373-404). San Diego, CA: Academic Press.

Silvia, P. J. (2012). Curiosity and motivation. In R. M. Ryan (Ed.) *The Oxford Handbook of Human Motivation (pp. 157-166).* New York: Oxford.

Stokes, D. E. (1997). *Pasteur's Quadrant: Basic science and technological innovation*. Washington D.C.: Brookings Institute Press.

Turner Jr., S. A., & Silvia, P. J. (2006). Must things be pleasant? A test of competing appraisal structures. *Emotion, 6* (4), 670-674.

Wigfield, A., Eccles, J., Schiefele, U., Roeser, R., & Davis-Kean, P. (2006). Development of achievement motivation. In R. Lerner & W. Damon (Series Eds.) and N. Eisenberg (Vol. Ed.), *Handbook of child psychology: Vol. 3. Social, emotional, and personality development (6th ed., pp. 933-1002)*. New York: Wiley.

Table 1

The General Case Regarding Variable Characteristics

Characteristics	Engagement	Interest	Curiosity	Motivation
Supports connections to content	X	X	X	X
Assumes reflective awareness				X
Static			X	
Focuses on particular disciplinary content		X		
Conceptualized as existing in interaction		X		
Develops in relation to knowledge		X		