The Importance of Interest Theory across STEM Learning Environments

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For Submission to AECT July 2019 Journal Symposium, Bloomington, IN

Introduction

How is interest utilized, nurtured, and promoted in the classroom and during educational activities? How is interest related to learning outcomes? (Krapp, 2005). Renninger & Hidi (2016) established that new interests are possible at any time during any stage of a person's life, but the flipside of that is students can also lose interests at any time. This paper will explore the nature of interest, how interest can potentially promote and prevent learning, especially in the STEM (Science, Technology, Engineering, Mathematics) classroom, and offer recommendations to educators and instructional designers about pedagogical approaches based on viewing learning through the lens of interest development.

What Is Interest?

Interest drives our vocations and avocations. It influences what we do and enjoy at home, at school, at work, at play, at love and at war. Renninger & Hidi (2016) define interest as the state in which, when people interact with an activity, they “. . . voluntarily engage in thinking about it, happily prioritize the problems that arise . . . and are willing to persevere to address them” (p. 1). People are hardwired for interest, and that tendency does not change throughout their lives (Renninger & Hidi, 2016). Interest has two components. The first refers to a person’s psychological state while he or she is engaging with content, while the second is connected to a more longstanding affective and cognitive desire to reengage with the same content over time (Krapp, Hidi, & Renninger, 1992; Renninger & Hidi, 2016). The first type of interest originates
from outside of the individual and is called *extrinsic* or *situational interest*, while the second type, *intrinsic* or *individual interest*, originates within the individual. Person X has recently become engaged with zines because he thinks they are cool (*situational interest*, triggered by context-rich zines and/or sharing and encouragement from friends), while Person Y is an avid collector who spends much of her free time reading and trading zines (*individual interest*, triggered by her frequent previous engagement and long-standing, context-rich relationship with zines and their communities)—both people are interested in zines, but Person Y expresses a deeper, richer, and longer-lasting level of interest than Person X. Those levels are further defined in Renninger & Hidi’s (2016) *Four Phases of Interest Development* (see Appendix).

The somewhat limited-in-number empirical research studies done on interest triggers have mainly consisted of experiments using specific novelties or challenges (Renninger & Bachrach, 2015). In the early stages of interest, perhaps for Person X, learners may not even know that their interest has been triggered; the power of interest is manifested when behavior changes based on the interest (Renninger & Bachrach, 2015). However, triggered situational interest can also be fleeting (Renninger & Riley, 2012; Renninger & Hidi, 2016); a volcano eruption, author visit, or worm dissection can be exciting today but forgotten tomorrow (Crouch, et al, 2018). Additionally, seductive details, distracting information and/or events that deter learning (Garner, et al, 1992; Wade, 1992; Wang & Adesope, 2016), are ready to steal learners’ attention with misreadings, ancillary facts, too much focus on graphics in a text or documentary, or even changeable weather. In deeper interest levels, learners provide their own triggers (Renninger & Bachrach, 2015); they persevere with the task and even see themselves performing the task as part of their career (Renninger & Riley, 2012). However, at lower levels of situational interest, engagement and involvement, hence interest, may be fleeting without personal
connection and perceived value, often manifested as “interestingness” (Hidi & Anderson, 1992; Patall, 2013). Although people tend to have 4 or 5 well-developed interests, there is always room for shifting and changing; focus on interest changes regularly (Renninger & Bachrach, 2015; Renninger & Hidi, 2016; Renninger & Riley, 2012). Engagement is an element of interest, but they are not interchangeable. One can be engaged but not interested, but one cannot be interested without being engaged (Renninger & Bachrach, 2015).

Developed interest costs time and money, two luxuries many students and parents do not have, creating a potential elitist rift in education (Aschbacher, Ing, & Tsai, 2014; Falk & Dierking, 2016). Interest development has been linked in past work to digital literacy and STEM educational pathways; e.g. in the work of Reynolds’ exploration in a 2-year-long after school computer club (Reynolds, 2008); the work of Zhang & Callahan (2014) using Science Fiction Prototyping, through which students can create a relevant and authentic STEM-based item, real or imagined; and Ito’s (2010) research that resulted in the connected learning and HOMAGO models. However, digital inequality, whether it is derived from socio-economic, gender-based, or racial policies or beliefs, is a reality that must be addressed and corrected (Cooke, 2017; Riegle-Crumb, Moore, & Ramos-Wada, 2011)

**Interest, Self-Determination, and Achievement Goal Theories**

People are motivated to pursue and engage in certain activities based on two primary factors: desire for accuracy and desire for a particular conclusion (Kunda, 1990). Students will develop interest in ideas and activities because they think it is the right thing to do and/or because it is the desirable thing to do; the latter is more likely to lead to prolonged interest (Renninger & Hidi, 2016). However, prolonged interest needs access to feed it. An important part of this process is the feelings of **autonomy**, **competence**, and **relatedness** connected with task
satisfaction and dissatisfaction described well by Self-Determination Theory (SDT) (Ryan & Deci, 2017).

Autonomy is the state in which one feels volitional, congruent, integrated, and self-endorsed, in tune with one’s authentic interests and values. The opposite is controlled, required to perform tasks and activities of less intrinsic interest (Ryan & Deci, 2017). Autonomy is much like well-developed individual interest (Renninger & Hidi, 2016), the highest level of their Four Phases of Interest Development model (see Appendix), in which students willingly and eagerly engage with material because they have chosen it (or assisted in the choice) and deem it useful and value-laden. The opposite of autonomy, controlled activity, is more like mandatory performance goal achievement, performed by necessity and inciting potential performance-avoidance tendencies (Senko, 2016). Autonomy is based on intrinsic motivation like personal interests and exciting activities, while control is based on extrinsic motivation like success in corporate-style assessments and receiving praise or rewards for performing tasks in specific, pre-determined ways with little or no personal input. Competence is the basic need to feel mastery; operating in harmony, effectively within one’s environment (Ryan & Deci, 2017). It is readily thwarted with difficult challenges, pervasive negative feedback, and personal criticism and social comparison. Amotivation can be a symptom of a lack of perceived competence, either because a person feels unfit and unable to perform the task, the person is simply unmotivated and uninterested in performing the task, or the person is defiant or resistant to the activity, usually as a result of lack of autonomy. Relatedness is socially connectedness, belonging, homonymy (Ryan & Deci, 2017). According to SDT, people naturally tend to internalize the values and goals of those people, groups, entities, with which they want to be associated. The more a student
attempts to act and think like a student, the more studiousness will define that person’s motivations and goals (Ryan & Deci, 2017).

Achievement Goal Theory (AGT) is also another useful tool that sheds light on interest development by contrasting mastery and performance goals (Senko, 2016). According to this approach, students encounter triggers and interest with one of two strategies: performance-approach (trying to outperform and show competence) or performance-avoidance (striving to keep up with the class and not appear incompetent) (Dweck, et al, 1986; Elliot, Church, & Geen, 1997). Mastery in this model operates much like individual interest in that the desire for success exceeds simple assessment and includes satisfaction, mastery, value, relevance, etc., while performance operates more like situational interest in that it is based upon environmental factors (triggers, interestingness) more than upon previous contexts and engagements. There is no logical avoidance component to mastery, since mastery accompanies self-generated interest and self-efficacy based upon that interest, two elements antithetical to avoidance. It is easy therefore to conclude that individual interest is “better” than situational interest, but the issue is far more complex than that, especially since students can have only a few individual interests at any given time; managing interest and choosing moments for triggers and engagement is a more balanced approach.

Interest and Identity

Identity construction is crucial to engagement of interest. As students gather and process experiences, informal (non-school related) elements become increasingly important. Maybe students should be afforded more opportunities to visit science-related sites, in-person, online, or both, during school hours (Subramaniam, et al, 2013). As participants become more involved in an activity or organization such as a Coding Club or a Conservation Team, they move towards
the center of that activity and assume more ownership and responsibility in the organization and
the activity (Lave & Wenger, 1991). Educators may be partially responsible for not engaging
students enough with real-life experiences communicated in a style that both students and
educators can relate to (Pauw, et al, 2015). However, even if students build more content-related
context and experience, they still need impetus to make connections to previous funds of
knowledge which are not always activated. Many learners have the skills to make meaningful
connections but choose not to. Social media platforms are a bridge to such connections, and
online groups should be organized around learning to enhance the possibility of critical
connections (Mills, et al, 2018). Social media can help students further craft their identities as
future engaged citizens by discussing and sharing their experiences, affirming their choices with
their peers (Subramaniam, et al, 2012). Achieving these goals takes dedication by both students
and staff, and it helps if they both like the material, and equally importantly, if staff stay current

Internet Search and STEM

When students search for information, they engage in “forming new constructs and
altering those previously held” (Kuhlthau, 1989). As students realize the problem they face, the
information they lack to complete their assignment, they encounter a “. . . recognized anomalous
state of knowledge (ASK), which, further modified by linguistic and pragmatic considerations,
becomes a request put to the IR [Information Retrieval] system” (Belkin, 1980, p. 135). Thus, a
communication is established between the technology that retrieves the information and the user
who requests the information (Belkin, 1980). Students must learn to navigate difficult terrain in
the Google era (in which every answer is just a Google Answer Box away), acting and being
acted upon by forces both inside of their personal experience and from external, societal forces (Schutz & Luckmann, 1973).

As students encounter gaps in their “stock of knowledge” (Schutz & Luckmann, 1973, p. 100), learning and attempt to fill those gaps becomes the primary goal. However, there are limiting factors to the stock of knowledge such as situation, spatiality, temporality, and social arrangements (Schutz & Luckmann, 1973). Temporality suggests that time is a factor in information behavior concerning searches, and that the search and the searcher are interrelated (Beheshti, J., Cole, C., Abuhimed, D., & Lamoureux, I., 2015). Since searchers can only assimilate a certain, finite amount of information in a search session, they purposefully construct meaning by choosing those slices of information they know and connecting new information to them (Kuhlthau, 1991).

Kuhlthau’s (1991) model of information search (see appendix) can be useful when examining interest development. This is uncharted territory, so future work will focus on the ways in which the process of interest development, from initial, situational, extrinsic trigger, to well-developed individual interest, mirror the temporal, cognitive, and affective processes through which students search for information. Students perform many of the same tasks, e.g. search, documentation, vetting, sharing, in both learning situations, and there is much to be gleaned by this cross-pollination. Interest is inextricably linked to value (Ryan & Deci, 2017), and examining how that value is viewed by students from elementary to university levels (Wyss, 2013 is crucial to understanding how to teach with interest in mind.

**Improving Instruction through Interest**
Since interest plays such a significant role in learning, curricula and lessons containing interest-generating activities should be incorporated into learning environments to generate more authentic learning experiences. Teaching for conceptual understanding takes precedence over content-based or unauthentic activities (Fosnot, 1992). Furthermore, since learning extends over multiple years, educators can consider and re-consider how topics are presented at each grade level each year, building on prior understanding and supporting increasingly complex concepts (Next generation, 2013).

As much as educators may want to offer choices to their students and facilitate their journey through them, curricula, instructional strategies, and objectives are often imposed on students and staff from outside. However, this reductionist approach cheats students of an opportunity for self-efficacy and identity construction (Winn, 1992). The work of Piaget supports construction of identity and self-efficacy through interaction with the environment and growing, developing, and evolving within it, reinventing and reorganizing information and understanding along the way (Fosnot, 1992). As students progress through Piaget’s stages from concrete understandings, to symbolic representations of those understandings, to abstract models, they learn structure, order, and reflection, then through interactions with others at which time their understandings change again (Fosnot, 1992). This is the process through which students come to own their research and their skills, fostering a growing curiosity that serves students well and leads to engagement and interest (Kuhlthau, Caspari, & Maniotes, 2015). Interest development occurs on a parallel course with cognitive development.

Schools should be places of social justice and opportunity; employees may only see the building’s students, but they serve the entire community and should work to transform both students and communities (Cooke, 2017). Interests provide a window into students’ values (Voss
and priorities, and are hence powerful tools for change. Two media through which young people can empower themselves and demand a voice in the STEM world are zines and fanfiction. Zines, online and/or print topical documents created outside of the traditional publishing world, “represent the oppressed narratives that dominant informational sources sometimes willfully ignore” (Stahura, 2017, p. 177). Although some of them may represent hate and bigotry, the platform they provide for all people considered “the other” is palpable. Fanfiction heightens the narrative experience, often with attractive multimedia tools (Gretter, Yadav, & Gleason, 2017). It enables an additional level of context that fans of any particular universe, such as The Hunger Games (Collins, 2008) or Sherlock Holmes mysteries, can share, debate, and enjoy. Fanfiction adds an additional layer to alternate universes. Is Buffy the Vampire Slayer (Stuller, 2013) gay? Is Mr. Darcy (Austen & Rogers, 2006) a secret, anonymous abolitionist? How do Wookies use the bathroom? Like uchronic literature, the what-ifs of history (e.g. The Man in the High Castle (Dick, 1962), in which the world is shifted into an alternate reality in which the Allies lose World War II), fanfiction gets to explore the forbidden, unexplorable, secret nooks and private desires of already existing characters. Sometimes, fictional constructs matter more than orthodox interpretation (Gretter, Yadav, & Gleason, 2017). Unfortunately, although students generally enjoy working with them more than traditional research sources, faculty are hesitant to allow the use of zines and fanfiction due to their lack of formal vetting (Stahura, 2017). They are another Wikipedia to be feared by the old guard as the end of legitimate research, not authentic, vital, urgent information sources that can stimulate interest among middle schoolers. A sad irony is that Wikipedia has the same STEM gender gap as other media (Eckert, Metzer-Rifkin, & Nurmis, 2018). Instructors are wise to consider that Internet databases or trusted websites do not comprise the sum of valid student research
opportunities; this is the same reductionist approach that prevents authenticity in research projects and encourages students to “get projects over with” instead of engaging in them and making them relevant and value-laden.

**Conclusion**

Many underserved populations did not and still do not have the chance to go to science museums, collect fossils, learn about surgical procedures, attend space camp or coding camp, go to field sites to develop scientific literacy, or use the Internet outside of school to go on virtual tours and watch STEM-related videos (Falk & Dierking, 2016; St. Jean, et al, 2015). This can occur due to socioeconomic and personal factors such as single-parent families, lack of transportation, and lack of STEM-related career models in their lives (Falk & Dierking, 2016); many disadvantaged youths do not have access to some of the bridging activities between school and the outside world necessary to build scientific literacy and are therefore greatly in need of STEM subjects and experiences (Ahn, et al, 2018). At-risk groups like girls of color and youth in lower-income families are “. . . far less likely than their more affluent peers to have access to, or to participate in, out-of-school science enrichment offerings, placing them at an educational and long-term economic disadvantage” (Brown & Rubinson, 2017, p. 6-7). It is society’s responsibility (that falls upon STEM teachers) to ensure that all students have the opportunity to like STEM. Understanding how and why students become interested in STEM subjects can generate improved strategies for creating more students prepared for, and self-interested in, pursuing STEM careers, which is not only necessary (Aschbacher, Ing, & Tsai, 2014; Falk & Dierking, 2016), but also just and fair to all students and citizens.
Works Cited


https://doi.org/10.1016/j.learninstruc.2005.07.007


## Appendix

### Table 1. Renninger & Hidi’s (2016) Four Phases of Interest Development.

<table>
<thead>
<tr>
<th>Definition</th>
<th>Less-Developed (Earlier)</th>
<th>More-Developed (Later)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phase 1:</strong> Triggered Situational Interest</td>
<td>Psychological state resulting from short-term changes in cognitive and affective processing associated with a particular class of content</td>
<td>Psychological state and the beginning of relatively enduring predisposition to seek reengagement with a particular class of content over time</td>
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<tr>
<td><strong>Phase 2:</strong> Maintained Situational Interest</td>
<td>Psychological state that involves focused attention to a particular class of content that reoccurs and/or persists over time</td>
<td>• Psychological state and a relatively enduring predisposition to reengage a particular class of content over time</td>
</tr>
<tr>
<td><strong>Phase 3:</strong> Emerging Individual Interest</td>
<td>• Attends to content, if only fleetingly</td>
<td>• Independently reengages content</td>
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<tr>
<td><strong>Phase 4:</strong> Well-Developed Individual Interest</td>
<td>• May or may not be reflectively aware of the experience</td>
<td>• Has stored knowledge and value</td>
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<td></td>
<td>• May need support to engage from others and through instructional design</td>
<td>• Is reflective about the content</td>
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<td></td>
<td>• May experience either positive or negative feelings</td>
<td>• Is likely to recognize others’ contributions to the discipline</td>
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<td></td>
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<td>• Self-regulates easily to reframe questions and seek answers</td>
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<td>• Appreciates and may actively seek feedback</td>
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<td></td>
<td></td>
<td>• Can persevere through frustration and challenge in order to meet goals</td>
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<td></td>
<td></td>
<td>• Has positive feelings</td>
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</table>
Chart 1. Kuhlthau’s (1991) 6-stage, 3-domain ISP Model

<table>
<thead>
<tr>
<th>Model of the Information Search Process</th>
<th>Initiation</th>
<th>Selection</th>
<th>Exploration</th>
<th>Formulation</th>
<th>Collection</th>
<th>Presentation</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feelings (Affective)</td>
<td>Uncertainty</td>
<td>Optimism</td>
<td>Confusion</td>
<td>Frustration</td>
<td>Doubt</td>
<td>Clarity</td>
<td>Sense of direction / Confidence</td>
</tr>
<tr>
<td>Thoughts (Cognitive)</td>
<td>vague</td>
<td>focused</td>
<td></td>
<td>increased</td>
<td>interest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actions (Physical)</td>
<td>seeking</td>
<td>Exploring</td>
<td>seeking</td>
<td>pertinent</td>
<td>information</td>
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</tbody>
</table>

Table 2. AASL Standards for the 21st Century Learner

<table>
<thead>
<tr>
<th>SHARED FOUNDATIONS AND KEY COMMITMENTS</th>
<th>I. INQUIRE</th>
<th>II. INCLUDE</th>
<th>III. COLLABORATE</th>
<th>IV. CURATE</th>
<th>V. EXPLORE</th>
<th>VI. ENGAGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. THINK</td>
<td>Learn to display curiosity and abilities by:</td>
<td>1. Formulating questions about a personal or social concern.</td>
<td>Learn to contribute to the information sharing community by:</td>
<td>1. Identifying and selecting appropriate resources.</td>
<td>Learn to develop and satisfy personal curiosity by:</td>
<td>1. Seeking out and discovering multiple sources of information.</td>
</tr>
<tr>
<td>C. SHARE</td>
<td>Learn to share, critique, and use resources with others by:</td>
<td>1. Sharing resources with others while providing feedback and information.</td>
<td>Learn to take personal responsibility for learning by:</td>
<td>1. Identifying and selecting appropriate resources.</td>
<td>Learn to create and communicate information:</td>
<td>1. Identifying and selecting appropriate resources.</td>
</tr>
<tr>
<td>D. GROW</td>
<td>Learn to participate in ongoing inquiry with new information:</td>
<td>1. Continuously asking new questions.</td>
<td>Learn to take personal responsibility for learning by:</td>
<td>1. Identifying and selecting appropriate resources.</td>
<td>Learn to engage with information:</td>
<td>1. Identifying and selecting appropriate resources.</td>
</tr>
</tbody>
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