The IDC Theory: Interest and the Interest Loop

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Abstract: Numerous studies have shown that learning is enhanced when students show interests in the subject matter. However, educators continue to grapple with the challenges, or simply do not recognize their potential roles, in the development of students' academic interest. This conceptual paper is written under the auspices of the Interest-Driven Creator (IDC) initiative, a theoretical synthesis effort carried out by a group of educational researchers in Asia. The intention is to co-construct a holistic developmental/design framework to guide the students in fostering their learning interests, capabilities in creation, and learning habits – the three anchored concepts of the IDC theory. This paper focuses on delineating a three-component "interest loop" to guide the design of a coherent learning process that encompasses a series of learning tasks. The three components are: *triggering interest*, *immersing interest*, and *extending interest*. Underpinned by the rich literature on interest development, we will propose suitable design strategies for each of the three components, namely, *curiosity*, *flow* and *meaningfulness*, respectively. We will then explicate their respective design considerations/principles to maximize the intended effects.

Keywords: Conceptual paper, Interest-Driven Creator (IDC) Theory, interest development, curiosity, flow, meaningfulness

1. Introduction

Interest has been recognized as a key condition in (effective) learning. Indeed, according to Schiefele's (1996) meta-review on studies that have quantified influences of interest on learning, about 10% of the variability in learning can be accounted for by factors related to interest. Thus, learning could improve by promoting student interest in the subject matters to be learned. In other words, when the affective domain prevails, students may learn more effectively and efficiently by paying greater attention and exerting greater efforts, surpassing the expectations on cognitive outcomes required in school.

Notwithstanding, educators continue to grapple with the challenges, or simply do not recognize their potential roles, in the development of students' academic interest (Lipstein & Renninger, 2007) within the formal schooling system. In particular, the mainstream examination-driven education and the assessment modes in Asia that emphasize duplication of knowledge over 21st century competencies favor teachers' classroom instructions and students' self-learning strategies which can be characterized as "working hard" and "working smartly" (as posited by Wong, Jan, Toh, and Chai (2012) based on their study on Singapore students' conceptions of learning). "Working hard" means behaviorist drill and practice of pre-packaged knowledge acquired through transmissionist means. "Working smartly" means evaluation of the system requirement (such as guessing the examination questions or figuring out tactics to score high, typically without the need to internalize the knowledge or skills to be assessed) to outcompete ones' peers. Such instructions or learning strategies are typically boring to the students, particularly to the young generation who are born and raised in a fast-moving, technology-based lifestyle, where they are accustomed to searching for, evaluating, remixing and producing timely and relevant multimodal information (Clapper, 2014) at their own discretion.

The Merriam–Webster Dictionary defines "interest" as "a feeling of wanting to learn more about something or to be involved in something," and the Oxford Dictionary adds that interest is "a quality of exciting curiosity or holding the attention" or "an activity or subject which one enjoys doing

or studying." The "feeling" referred to in the first definition is the emotional state of a person; the "quality" mentioned in the second definition is a cognitive state, which engages the person; and the "activity or subject," such as singing, sports, science, or philosophy, indicated in the third definition, is the person's interest if the person enjoys the activity or studying about the subject.

In the contemporary educational psychology field, interest is defined as an interaction between a person and an object (i.e., a particular content to learn) within the environment (Boekaerts & Boscolo, 2002; Hidi & Baird, 1986; Renninger & Wozniak, 1985). The potential for interest is in the person but the object and the environment define the direction of interest and contribute to its development (Hidi & Renninger, 2006). In his person-object theory of interest, Krapp (2002) described interest as a relational construct that consists of an enduring relationship between a person and an object. This relationship is reified by specific activities, which may comprise concrete or hands-on-actions and abstract mental operations.

Research on interest dates back to the 1800s. James (1890) pointed out that interest plays an important role in directing attention and behavior; and Dewey (1913) asserted that interest boosts learning and elicits effort. However, interest research has flourished only in the last few decades, demonstrating that interest increases knowledge (Alexander, Jetton, & Kulikowich, 1995; Kintsch, 1980; Schraw, Flowerday, & Lehman, 2001), generates positive feelings (reference), and reduce the cognitive load within learning situations (Hidi, 1995; Schnotz, Fries, & Horz, 2009). In addition, interested learners proactively raise curiosity questions (Renninger, 2009), anticipate subsequent steps when processing work (Renninger & Hidi, 2002), develop more types and deeper levels of strategies (Schiefele, 1991), are resourceful when a question cannot be immediately answered (Renninger & Shumar, 2002), persist in constructive and creative endeavors (Izard & Ackerman, 2000), promote self-regulation (Sansone, Thoman, & Smith, 2000), increase self-efficacy (Hidi, Berndorff, & Ainley, 2002; Zimmerman & Kitsantas, 1997), and value the opportunity to reengage in the task or a similar task (Flowerday & Schraw, 2003), among others. How can we make school subjects such as reading, writing, mathematics, science, and history as students' interests?

This conceptual paper is written under the auspices of the Interest-Driven Creator (IDC) initiative, a theoretical synthesis effort carried out by a group of educational researchers in Asia. The intention is to co-construct a holistic developmental/design framework to guide the students in fostering their learning *interests*, capabilities in *creation*, and learning *habits* – the three anchored concepts of IDC theory. This paper focuses on delineating a three-component "interest loop" to guide the design of a coherent learning process that encompasses a series of learning tasks. The three components are: *triggering interest*, *immersing interest*, and *extending interest* (Figure 1). Underpinned by the rich literature on interest development, we will propose suitable design strategies for each of the three components and explicate their respective design considerations or dstil design principles to optimize the intended effects. We will then discuss about how such an "interest loop" can be integrated into the school schedule with the ultimate aim of nurturing lifelong learners.

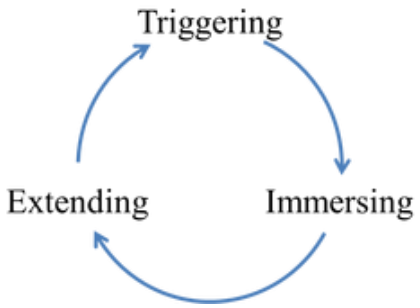

Figure 1: The interest loop

2. Development of Interest

The meaning of interest may range from a single, situation-specific person-object relation (e.g., reading a stimulating text) towards the enthusiasm with respect to a particular domains (e.g., interest in physics) (Schiefele, 2009). Accordingly, two major notions of interest have been identified, namely, situational interest and individual interest (e.g., Hidi, 2000; Krapp, 1999; Silvia, 2006). A developmental view of interest sees that interest can be cultivated, being initially aroused, maintained, and then further deepened and broadened – as a transformative trajectory from situational interest to individual interest. Hidi and Renninger (2006) characterized four phases of interest development: triggered situational interest, maintained situational interest, emerging individual interest, and well-developed individual interest. Situational interest is an affective reaction (e.g., the eagerness to know more) involving focused attention triggered by environment stimuli. Situational interest may not persist over time, and thus it must be maintained to develop a more stable interest. Individual interest refers to an enduring predisposition for reengaging with particular activities or subjects. Thus, individual interest, similar to what people generally know about the term interest, will sustain over time. After triggering and maintaining situational interest with environmental stimuli, individual interest emerges and could be further developed.

3. The Interest Loop in Interest-Driven Creator (IDC) Theory

In this section, we will propose suitable learning strategies for the three components of the interest loop. The three strategies can be characterized by three keywords respectively: "curiosity" for triggering interest, "flow" for immersing interest, and "meaningfulness" for extending interest. While this proposed trajectory can be loosely mapped to the first two or first three phases of Hidi and Renninger's (2006) interest development model (i.e., triggered situational interest, maintained situational interest, and emerged individual interest), our intention is to explicate the design guidelines for initial interest development that will eventually be harmoniously integrated into the full learning journey of IDC (i.e., to connect the interest development process with the "creation loop" and "habit loop" of IDC). Put it another way, within the context of IDC Theory, the "interest loop" begins with triggering of the students' situational interest, with the aim of nurturing emergent individual interest as the end; the "habit loop" would then take over from here to assist the students in the final step of establishing well-developed interest. The respective design considerations of the three components and their theoretical underpins will be explicated next.

3.1 Triggering Interest – "Curiosity"

"Triggering interest," the first component in the interest loop, concerns designing an activity that induces initial interest in learning a particular object. Providing incongruous and surprising information, for example, can intrigue students. Neuroscientists found that a specific area in the brain can be stimulated to evoke sniffing in rats, what is known as "seeking" behaviors that are present when the animal is searching, or investigating. Panksepp (1998) argued that the types of feelings that characterize the arousal of this system in humans would be described as intense interest, engaged curiosity, and eager participation. Such a behavior in humans has been found to produce feelings of invigoration, as if something very interesting and exciting is going on (Heath, 1963; Panksepp, 1998). In turn, minimal cognitive processing is likely to trigger situational interest, especially in early phases of interest development (Hidi & Renninger, 2006). Thus, we see arousing curiosity as the general design strategy for triggering interest.

Berlyne (1954, 1960, 1966) categorized different types of curiosity into two dimensions: one dimension ranging between perceptual and epistemic curiosity and the other dimension ranging between specific and diversive curiosity. Perceptual curiosity, aroused in animals and humans by visual, auditory, or tactile stimulation, increases the perception of stimuli. Epistemic curiosity, mainly evoked in humans by conceptual puzzles and gaps in knowledge, is a desire to know. Specific curiosity enables investigating the details of a particular piece of information or exploring in-depth the experience with a particular activity. Diversive curiosity, motivated by feelings of boredom or longing for stimulus variation, leads people to seek new stimuli or opportunities regardless of source or content.

Arousing specific epistemic curiosity is closely related to triggering interest because curiosity is not only for obtaining information that dispels uncertainties at the moment, but also for acquiring knowledge (Berlyne, 1966). According to the knowledge-deprivation hypothesis (Berlyne, 1954; Loewenstein, 1994), the emergence of epistemic curiosity (or situational interest in general) is the consequence of a knowledge gap between what a person knows and what (s)he desires to know. If we regard what a person desires to know in a particular domain as a knowledge "reference point", and when this reference point exceeds the person's level of knowledge, then curiosity, the drive for acquiring new knowledge, arises to remove the discrepancy. In addition, as satisfying curiosity is a pleasant experience (Csikszentmihâlyi, 1990; Izard, 1977), people voluntarily expose themselves to curiosity-inducing situations. To students, posing questions that foreground the students' knowledge deficit, presenting riddles or puzzles, exposing to a sequence of events with an anticipated but unknown outcome, violating expectation that motivates a search for explanation, etc., arouse their curiosity.

Curiosity, particularly epistemic curiosity (which is often connected to triggering situational interest), is a well-studied topic within the educational psychology field. Distilled from literature, a list of design principles for triggering interest by generating curiosity is given below,

(1) *Awareness of knowledge deficit*: According to the research findings of Rotgans and Schmidt (2014), students have to be *consciously* aware that a knowledge gap to understand the problem-at-hand has to exist, in order to provoke situational interest. Being confronted with only captivating learning materials is not sufficient for the stated purpose. Nevertheless, Rotgans and Schmidt (2014) also cautioned that in the everyday reality of classroom practice, students are typically confronted with far less intriguing problems. For example, a student who simply has no interest in mathematics may perceive a complicated math formula as knowledge deficit, but the topic may still fail to arouse situational interest. This leads to design principle (2) as posited below.

(2) *Novelty and complexity*: The context or problematization of the designed activity should be something new, complex, surprising, unexpected, or otherwise not understood (Litman & Jimerson, 2004; Silvia, 2005, 2006). Yet it should be concrete and vivid. However, both too low and too high levels of complexity may reduce interest. Too low levels of complexity may be deemed as a lack of challenging element to intrigue the students. Too high levels of complexity may result in cognitive overload. This leads to the specification of design principle (3) as below.

(3) *Perceptions of competence*: Design activity that the students feel competent in their ability in resolving the curiosity stimulus (Arnone, Small, Chauncey, & McKenna, 2011; Millis, 2001; Silvia, 2005), both in terms of (a) their competency in dealing with the complexity of the problem and (b) the skills required to carry out the task.

(4) *Cautious use of seductive details*: Teachers often spice up their instruction by adding enjoyable, emotional, but unimportant information/element (e.g., dazzling multimedia presentations, fun games, etc.) to make the process fun (Harp & Mayer, 1997; Wade & Moje, 2000). Garner, Gillingham, and White (1989) referred to such sources of seemingly motivating but unrelated to the content to be learned as 'seductive details'. Such design elements could render cognitive overload in students; thus distracting them from important information and impede knowledge construction (Meyer, Rose, & Chall, 1998; Schank, 1979; Shen, McCaughtry, Martin, & Dillion, 2006). For this reason, teachers are advised to design "interest triggering" activities with the core consideration in promoting the construction of the targeted knowledge, while treating seductive details as peripheral.

(5) *Creation of positive and psychologically safe learning environments*: In enacting the activity, encourage students to tinker with their ideas, 'good' or 'bad'. Teachers should not intimidate students by making them feel that they risk being embarrassed by the teacher or by their peers for giving 'bad' or 'wrong' answers or even opinions (Brookfield, 1995; Clapper, 2014).

(6) *Arrangement for student presentations of findings:* Depending on the nature of the designed activity or the knowledge to be learned/constructed (particularly for those open-ended curiosity questions without standard answers), students may be required to present their findings to the class toward the end of the interest triggering activity. Based on the findings of Rotgans and

Schmidt's (2011) study, such a synthesizing activity as the "highlight of the day" would further uplift the students' situational interest, perhaps due to the "sense of audience" and the elevated sense of achievement.

Nonetheless, it is important to note that such interest triggering activities are not necessarily effective in holding interest over a longer period of time (Magner, Schwonke, Aleven, Popescu, & Renkl, 2014; Mitchell, 1993). As noticed by Rotgans and Schmidt's (2011, 2014) series of studies, students' situational interest triggered by curiosity would be decreasing with the increase of knowledge. This seems to be counterintuitive with the common argument made by general educational psychologists that the relationship between interest and knowledge is a positive linear one (e.g., Alexander, 2003; Schraw & Lehman, 2001; Silvia, 2005). The main reason is that such past accounts typically refer to interest development as a whole, i.e., from situational interest to individual interest, or did not always distinguish the two types of interest in their relevant studies. Rotgans and Schmidt's studies were however focusing on situational interest. Situational interest, particularly in the form of epistemic curiosity, is about "thirst for knowledge" (Lynch, 2006; Rotgans & Schmidt, 2014; Shernoff & Csikszentmihalyi, 2009), which can be satisfied by being "quenched" with knowledge. If the perceived gap is closed because of knowledge gains, there is no additional impetus for further knowledge to be acquired and, hence, situational interest would be reduced (Rotgans & Schmidt, 2014). Thus, in order to maintain the students' interest beyond the triggering activity, it is crucial to facilitate the students in advancing to "immersing interest".

3.2 Immersing Interest – "Flow"

"Immersing interest", the second component in the interest loop, pertains to designing learning activities that engage the full attention of the students. We contend that the main design strategy related to this component is enabling students to experience "flow" (Csikszentmihályi, 1990; Csikszentmihályi & Rathunde, 1993). Flow refers to an experience of intense emotional involvement, being completely engaged in the activity for its own sake, thus feeling a sense of control or mastery, fully enjoying tackling the task at hand, being unaware the passage of time, losing self-consciousness, and experiencing great gratification that the activity is intrinsically rewarding. Mihály Csikszentmihályi aptly described the phenomenon where "The ego falls away. Time flies." (quoted by: Geirland, 1996) When students experience flow, they seek out increasingly greater challenges while devoting more attention to stretch their skills to confronting such challenges, resulting in personal development as well as feelings of efficacy. When flow activities are collaborative, engaging in such tasks with immersing interest enables building positive social relations with others by caring for and benefiting others. Thus, as Pintrich and Schunk (2002) stated, "… the flow experience requires skill, expertise, concentration, and perseverance, not just hanging out and feeling good." (p.284)

To enable students to experience "flow", the key design consideration includes providing concrete goals, offering immediate and clear feedback, giving flexibility to exercise some choice and control (i.e., student autonomy), balancing skill levels and challenge (cf. Table 2 in Pintrich, 2003, p. 672), and both the skill and the challenge must be above a critical threshold (Hoffman & Novak, 1996). In particular, entering flow requires the establishment of an equilibrium between perceived action capacities and perceived action opportunities (cf. Massimini & Carli, 1988). If challenges posed by the "flow" activity begin to exceed skills, one first becomes vigilant and then anxious; if skills begin to exceed challenges, one first relaxes and then becomes bored (Nakamura, 2002). Considering individual differences within a class, teachers should advise and assist students who are experiencing anxiety or boredom during a "flow" activity to adjust their levels of skills and/or challenges in order to re-enter flow.

Notwithstanding, flow experience and instructional design (in traditional sense) bear major differences in orientation. Instructional design is typically concerned with learning and achievement (regardless of whether individual students have established their interest in the target domain), while flow essentially foregrounds emotion and attitude (regardless of the effectiveness in learning about the target domain) (see: Chan & Ahern, 1999). Still, we argue that it is possible to reconcile the two seemingly disconnected objectives in the design of flow activities, particularly if teachers manage to trigger students' situational interest pertaining to the target domain prior to engaging them in a flow state in tackling challenges on the same domain. With students' situational interest being maintained

through the "flow", they are perhaps one step away from developing individual interest on the target domain through "extending interest".

3.3 Extending Interest – "Meaningfulness"

"Extending interest", the final component in the interest loop, relates to designing an activity to extend student interest in the domain after immersion in the learning activity. Extending interest also predisposes students to re-engage in similar activities should the opportunities arise. This should be the latest point of time where meaningfulness and self-directed learning is injected to the interest loop-informed learning process. The intention is to assist the students in transforming their maintained situational interest into emergent individual interest. Meaningfulness, or personal value, refers to students' perception of target domain as being relevant to their daily lives (Schiefele, 2009). Studies (e.g., Dohn, Madsen, & Malte, 2009; Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000; Mitchell, 1993) showed that perceived meaningfulness of the learning tasks was a crucial factor in maintaining situational interest, and perhaps even triggering the development of individual interest. In addition, Hidi and Renninger (2006) argued that conditions that support interest development not only need to generate positive feelings but also entail a shift from more external support to more internal support. Thus, for example, unlike during the "triggering interest" state where curiosity questions were imposed by the teachers, students who are engaged in the "extending interest" state may begin to generate curiosity questions on their own. Such questions (or other self-set challenges) enable students to connect their present understanding of content to alternative perspectives that challenge them to reconsider what they do know and to seek additional information (Renninger, Sansone, & Smith, 2004). As a result, students may redefine and exceed task demands with an emerging individual interest (Lipstein & Renninger, 2007), as well as deepening and broadening their knowledge or skills about the target domain in the future. In addition, students would re-engage in such activities in the way that they intended, without feeling any pressure to produce a performance that meets some standard of excellence (Brophy, 1999).

In light of the above explication, Schiefele (2009) distilled several conditions for inducing individual interest, which can be treated as design principles of "extending interest" for the teachers, in the context of IDC framework. First, highlight the practical implications of subject content and its relation to students' everyday life (Mitchell, 1993); constructivist learning activities such as problem-based learning or authentic activities should help to increase students' interest (Cordova & Lepper, 1996; Hickey, 1997). Second, assist individual students to associate the content or the "extending interest" task with their already existing or natural individual interests (Assor, Kaplan, & Roth, 2002; Meece, 1991), e.g., encourage students who are football fans to apply statistics skills to the statistical analysis of the performances of their favorite football teams. Third, express the teachers' own interest in the subject being taught (Bergin, 1999; Schunk, Pintrich, & Meece, 2008) – interest is contagious and can best be conveyed if the teacher functions as an interested model. To accomplish these three conditions/principles, we contend that teachers should gradually relinquish their controls over the students, empower them in, say, self-directed or self-regulated re-engagement in the domain or the activities, and embodiment of their natural individual interests into the learning process.

In short, we position "extending interest" as the means to pave the way for students to develop individual interest out of the situational interest that teachers assisted them to trigger and maintain through "triggering interest" and "immersing interest" activities. In other words, this is where the individuals' affective (interest-related) goal would converge with or become compatible with the core cognitive (learning-related) goal of the subject matter, and better still,

to be compatible with one's preferred values and ideas of the growing self (Deci & Ryan, 1985; Krapp, 1999).

4. Discussion and Conclusion

Cognizant that 'interest is the mother of learning', we delineate a design framework for interest development in the students within the context of the IDC Theory. Curiosity-driven learning, flow experience and meaningful learning were the learning strategies being identified for realizing "triggering interest", "immersing interest" and "extending interest" respectively. Nevertheless, when it comes to concrete learning design, there may or may not be clear distinction among the three components/states. Instead, they can be seen as a continuum of various types of activities that support the students to walk through the early process of interest development. Moreover, the design considerations or design principles being laid out in the subsections of 3.1-3.3 are not necessarily restricted to the respective learning strategies. For example, while we emphasize meaningfulness only in the "extending interest" component, it does not mean that curiosity-driven learning and flow activities could not be designed in a meaningful manner. Another example is that "cautious use of seductive details" is discussed under the "triggering interest" component; yet this principle should apply to the designs of all other learning activities and learning environments. A novice "interest loop" designer may start with adhering to the delineated framework in this paper. Once (s)he becomes adept in the design skills and gain experience in enacting interest loops, (s)he may instead exercise flexible and differentiated designs to optimize the effectiveness of such activities. In particular, when such interest loop activities are repeated according to the school schedule (thus affording plenty of opportunities for reengagement) and when the student interest shifts from a situational interest to an individual interest, triggering interest will no longer be needed. Also, with the appropriate design of a school schedule, not only a learning interest will be developed, the learning interest may also become a learning habit (the last anchored concept of IDC), and, hopefully, a lifelong habit.

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References

Alexander, P. A. (2003). The development of expertise: The journey from acclimation to proficiency. *Educational Researcher, 32*(8), 10-14.

Alexander, P. A., Jetton, T. L., & Kulikowich, J. M. (1995). Interrelationship of knowledge, interest, and recall: Assessing a model of domain learning. *Journal of Educational Psychology, 87*(4), 559-575.

Arnone, M. P., Small, R. V., Chauncey, S. A., & McKenna, H. P. (2011). Curiosity, interest and engagement in technology-pervasive learning environments: a new research agenda. *Educational Technology Research and Development, 59*(2), 181-198.

Assor, A., Kaplan, H., & Roth, G. (2002). Choice is good, but relevance is excellent: Autonomy-enhancing and suppressing teacher behaviours predicting students' engagement in schoolwork. *British Journal of Educational Psychology, 72*(2), 261-278.

Bergin, D. A. (1999). Influences on classroom interest. *Educational Psychologist, 34*(2), 87-98.

Berlyne, D. E. (1954). A theory of human curiosity. *British Journal of Psychology. General Section, 45*(3), 180-191.

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

Berlyne, D. E. (1966). Curiosity and exploration. *Science, 153*, 25-33.

Boekaerts, M., & Boscolo, P. (2002). Interest in learning, learning to be interested. *Learning and Instruction, 12*(4), 375-382.
Brookfield, S. D. (1995). *Becoming a critically reflective teacher*: Wiley.
Brophy, J. (1999). Toward a model of the value aspects of motivation in education: Developing appreciation for. *Educational Psychologist, 34*(2), 75-85.
Chan, T. S., & Ahern, T. C. (1999). Targeting motivation-adapting flow theory to instructional design. *Journal of Educational Computing Research, 21*(2), 151-163.
Clapper, T. C. (2014). Situational interest and instructional design: A guide for simulation facilitators. *Simulation & Gaming*, Published online: January 27, 2014.
Cordova, D. I., & Lepper, M. R. (1996). Intrinsic motivation and the process of learning: Beneficial effects of contextualization, personalization, and choice. *Journal of Educational Psychology, 88*, 715-730.
Csikszentmih áyi, M. (1990). Literacy and intrinsic motivation. *Daedalus, 119*(2), 115-140.
Csikszentmih áyi, M., & Rathunde, K. (1993). The measurement of flow in everyday life: toward a theory of emergent motivation. In J. E. Jacobs (Ed.), *Nebraska Symposium on Motivation 1992: : Developmental perspectives on motivation. Current theory and research in motivation* (pp. 57-97). Lincoln, NE: University of Nebraska Press.
Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum Press.
Dewey, J. (1913). *Interest and Effort in Education*: Houghton Mifflin.
Dohn, N. B., Madsen, P. T., & Malte, H. (2009). The situational interest of undergraduate students in zoophysiology. *Advances in Physiology Education, 33*(3), 196-201.
Flowerday, T., & Schraw, G. (2003). Effect of choice on cognitive and affective engagement. *Journal of Educational Research, 96*, 207-215.
Garner, R., Gillingham, M. G., & White, C. S. (1989). Effects of'seductive details' on macroprocessing and microprocessing in adults and children. *Cognition and Instruction, 6*(1), 41-57.
Geirland, J. (1996). Go with the Flow: According to Mihaly Csikzentmihalyi, great Web sites are not about navigating content, but staging experience. *WIRED-SAN FRANCISCO, 4*(160-161).
Harackiewicz, J. M., Barron, K. E., Tauer, J. M., Carter, S. M., & Elliot, A. J. (2000). Short-term and long-term consequences of achievement goals: Predicting interest and performance over time. *Journal of Educational Psychology, 92*(2), 316-330.
Harp, S. F., & Mayer, R. E. (1997). The role of interest in learning from scientific text and illustrations: On the distinction between emotional interest and cognitive interest. *Journal of Educational Psychology, 89*(1), 92-102.
Heath, R. G. (1963). Electrical self-stimulation of the brain in man. *American Journal of Psychiatry, 120*(6), 571-577.
Hickey, D. T. (1997). Motivation and contemporary socio-constructivist instructional perspectives. *Educational Psychologist, 32*(3), 175-193.
Hidi, S. (1995). A reexamination of the role of attention in learning from text. *Educational Psychology Review, 7*(4), 323-350.
Hidi, S. (2000). An interest researcher's perspective: The effects of extrinsic and intrinsic factors on motivation. In C. Sansone & J. M. Harackiewicz (Eds.), *Intrinsic and Extrinsic Motivation: The Search for Optimal Motivation and Performance* (pp. 311-342). San Diego, CA: Academic Press.
Hidi, S., & Baird, W. (1986). Interestingness - A neglected variable in discourse processing. *Cognitive Science, 10*(2), 179-194.
Hidi, S., Berndorff, D., & Ainley, M. (2002). Children's argument writing, interest and self-efficacy: an intervention study. *Learning and Instruction, 12*(4), 429-446.
Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111-127.
Hoffman, D. L., & Novak, T. P. (1996). Marketing in hypermedia computer-mediated environments: Conceptual foundations. *Journal of Marketing Research, 60*, 50-68.
Izard, C. E. (1977). *Human Emotions*: Springer.
Izard, C. E., & Ackerman, B. P. (2000). Motivational, organizational, and regulatory functions of discrete emotions. In M. Lewis & J. M. Haviland-Jones (Eds.), *Handbook of Emotions (2nd Ed.)* (pp. 253-264). New York: Guilford.
James, W. (1890). *The Principles of Psychology*. Cambridge, MA: Harvard University Press.
Kintsch, W. (1980). Learning from text, levels of comprehension, or: Why anyone would read a story anyway. *Poetics, 9*(1), 87-98.
Krapp, A. (1999). Interest, motivation and learning: An educational-psychological perspective. *European Journal of Psychology of Education, XIV*(1), 23-40.

Krapp, A. (2002). An Educational-Psychological Theory of Interest and Its Relation to SDT. In E. L. Deci & R. M. Ryan (Eds.), *Handbook of Self-Determination Research* (pp. 405-430). Rochester, NY: The University of Rochester Press.

Lipstein, R., & Renninger, K. A. (2007). "Putting things into words": The development of 12-15-year-old students' interest for writing. In S. Hidi & P. Boscolo (Eds.), *Motivation and writing: Research and school practice* (pp. 113-140). Bingley, UK: Emerald Group Publishing.

Litman, J. A., & Jimerson, T. L. (2004). The measurement of curiosity as a feeling of deprivation. *Journal of Personality Assessment, 82*(2), 147-157.

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin, 116*(1), 75-98.

Lynch, D. J. (2006). Motivational factors, learning strategies and resource management as predictors of course grades. *College Student Journal, 40*(2), 423-428.

Magner, U. I., Schwonke, R., Aleven, V., Popescu, O., & Renkl, A. (2014). Triggering situational interest by decorative illustrations both fosters and hinders learning in computer-based learning environments. *Learning and Instruction, 29*, 141-152.

Massimini, F., & Carli, M. (1988). The systematic assessment of flow in daily experience. In M. Csikszentmihalyi & I. S. Csikszentmihalyi (Eds.), *Optimal Experience: Psychological Studies of Flow in Consciousness*. 266-287: Cambridge University Press.

Meece, J. L. (1991). The classroom context and students' motivational goals. *Advances in Motivation and Achievement, 7*, 261-285.

Meyer, A., Rose, D. H., & Chall, J. S. (1998). *Learning to read in the computer age (Vol. 3)*: Brookline Books.

Millis, K. (2001). Making meaning brings pleasure: The influence of titles on aesthetic experience. *Emotion, 1*, 320-329.

Mitchell, M. (1993). Situational interest: Its multifaceted structure in the secondary school mathematics classroom. *Journal of Educational Psychology, 85*(3), 424-436.

Nakamura, J., & Csikszentmihalyi, M. (2002). The concept of flow. In C. R. Snyder & S. J. Lopez (Eds.), *Handbook of Positive Psychology* (pp. 89-105). New York, NY: Oxford University Press.

Panksepp, J. (1998). *Affective Neuroscience: The Foundations of Human and Animal Emotions*. New York, NY: Oxford University Press.

Pintrich, P. R. (2003). A motivational science perspective on the role of student motivation in learning and teaching contexts. *Journal of Educational Psychology, 95*, 667-686.

Pintrich, P. R., & Schunk, D. H. (2002). *Motivation ineducation: Theory, research, and applications*. Upper Saddle River, NJ: Merrill Prentice-Hall.

Renninger, K. A. (2009). Interest and identity development in instruction: An inductive model. *Educational Psychologist, 44*(2), 105-118.

Renninger, K. A., & Hidi, S. (2002). Student interest and achievement: Developmental issues raised by a case study. In A. Wigfield & J. S. Eccles (Eds.), *Development of Achievement Motivation* (pp. 173-195). New York: Academic.

Renninger, K. A., Sansone, C., & Smith, J. L. (2004). Love of learning. In C. Peterson & M. E. P. Seligman (Eds.), *Character Strengths and Virtues: A Classification and Handbook*. New York, NY: Oxford University Press.

Renninger, K. A., & Shumar, W. (2002). Community building with and for teachers: The Math Forum as a resource for teacher professional development. In K. A. Renninger & W. Shumar (Eds.), *Building Virtual Communities: Learning and Change in Cyberspace* (pp. 60-95). New York: Cambridge University Press.

Renninger, K. A., & Wozniak, R. H. (1985). Effect of interest on attentional shift, recognition, and recall in young children. *Developmental Psychology, 21*(4), 624.

Rotgans, J. I., & Schmidt, H. G. (2011). Situational interest and academic achievement in the active-learning classroom. *Learning and Instruction, 21*(1), 58-67.

Rotgans, J. I., & Schmidt, H. G. (2014). Situational interest and learning: Thirst for knowledge. *Learning and Instruction, 32*, 37-50.

Sansone, C., Thoman, D. B., & Smith, J. L. (2000). Interest and self-regulation. Intrinsic and extrinsic motivation: The search for optimal motivation and performance. In R. H. Hoyle (Ed.), *Handbook of Personality and Self-Regulation* (pp. 343-374): Wiley-Blackwell.

Schank, R. C. (1979). Interestingness: controlling inferences. *Artificial intelligence, 12*(3), 273-297.

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

Schiefele, U. (1996). Topic interest, text representation, and quality of experience. *Contemporary Educational Psychology, 21*(1), 3-18.

Schiefele, U. (2009). Situational and individual interest. In K. R. Wentzel & A. Wigfield (Eds.), *Handbook of Motivation at School* (pp. 197-222). New York, NY: Routledge.

Schnotz, W., Fries, S., & Horz, H. (2009). Motivational aspects of cognitive load theory. In M. Wosnitza, S. A. Karabenick, A. Efklides, & P. Nenninger (Eds.), *Contemporary Motivation Research: From Global to Local Perspectives* (pp. 69-96). Cambridge, MA: Hogrefe Publishing.

Schraw, G., Flowerday, T., & Lehman, S. (2001). Increasing situational interest in the classroom. *Educational Psychology Review, 13*(3), 211-224.

Schraw, G., & Lehman, S. (2001). Situational interest: A review of the literature and directions for future research. *Educational Psychology Review, 13*(1), 23-52.

Schunk, D. H., Pintrich, P. R., & Meece, J. L. (2008). *Motivation in Education*. Upper Saddle River, NJ: Pearson Education.

Shen, B., McCaughtry, N., Martin, J., & Dillion, S. (2006). Does "sneaky fox" facilitate learning? Examining the effects of seductive details in physical education. *Research Quarterly for Exercise and Sport, 77*(4), 498-506.

Shernoff, D. J., & Csikszentmihalyi, M. (2009). Cultivating engaged learners and optimal learning environments. In R. Gilman, E. S. Huebner, & M. J. Furlong (Eds.), *Handbook of Positive Psychology in Schools* (pp. 131-145). New York, NY: Routledge.

Silvia, P. J. (2005). What is interesting? Exploring the appraisal structure of interest. *Emotion, 5*(1), 89-102.

Silvia, P. J. (2006). *Exploring the Psychology of Interest*. New York, NY: Oxford University Press.

Wade, S. E., & Moje, E. B. (2000). The role of text in classroom learning. In M. L. Kamil, P. B. Mosenthal, P. D. Pearson, & R. Barr (Eds.), *Handbook of Reading Research Volume III* (pp. 609-628). Mahwah, NJ: Lawrence Erlbaum.

Wong, L.-H., Jan, M., Toh, Y., & Chai, C. S. (2012). *Exploratory Study on the Physical Tool-based Conceptions of Learning of Young Students in a Technology-Rich Primary School.* Paper presented at the Proceedings of International Conference of the Learning Sciences 2012, Sydney, Australia.

Zimmerman, B. J., & Kitsantas, A. (1997). Developmental phases in self-regulation: Shifting from process goals to outcome goals. *Journal of Educational Psychology, 89*(1), 29-36.