# IDC theory: interest and the interest loop

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**Abstract**

Numerous studies have shown that learning is enhanced when students show interest 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 and interest in learning in general. 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. 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

## Introduction

Interest has been recognized as a key component in learning. Indeed, according to Schiefele (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 be greater facilitated by promoting student interest in the subject matters to be learned. Interest consists of cognitive, affective, and situation elements. A design framework that taps into these can help students learn more effectively and efficiently by paying greater attention and exerting greater efforts, surpassing the expectations on academic outcomes required in school.

Notwithstanding, educators continue to grapple with the challenges of, or simply do not recognize their potential roles in, developing students' academic interest (Lipstein & Renninger, 2007) within the formal schooling system, and in general—in the sense of domain-independent lifelong learning. In particular, the mainstream examination-driven education and the assessment modes in Asia emphasize the duplication of knowledge, giving little attention to student interest. Consequently, much of the teaching and learning activities implemented in school tend to be boring to the students.

Especially for the young generation of learners 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, instruction falls short of offering similar learning experiences.

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; the "activity or subject," such as singing, sports, science, or philosophy, indicated in the third definition, is the person's object of interest. Imagine, for example, how much time soccer fans spend learning everything about their favorite team as well as gaining other relevant soccer knowledge. They have an emotional investment in their team and put in cognitive effort to learn more. Another example is that driven by interest, amateur astronomers pursue extended participation in observing celestial objects in the sky, as noted by Azevedo (2013).

In the contemporary educational psychology field, interest is defined as an interaction between a person and an object (i.e., a particular domain 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 (Krapp, 1999), and reduces 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). How can we change the teaching of school subjects such as reading, writing, mathematics, science, and history so that they become 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 to be creative, and learning habits—the three anchored concepts of IDC theory. The preliminary work giving an overview of IDC theory and highlighting its origin with some history was published in 2018 (Chan et al., 2018). This paper is first in a three-part series of IDC theory which examines in detail the first anchored concept—interest. It focuses on delineating a three-component "interest loop" to guide the development of a coherent learning process: triggering interest, immersing interest, and extending interest (Fig. 1). With that said, this paper is part of a series that includes two other papers on the following:

- Creation, which examines the second anchored concept of IDC emphasizing student learning through goal-directed creation activities
- Habits, which focuses specifically on the third and final anchored concept of IDC where learning habits are built through interest-driven creation activities undertaken as daily learning routines

### Development of interest

The meaning of interest may range from a single, situation-specific person-object relation (e.g., reading a stimulating text) towards enthusiasm for a particular domain (e.g., interest in physics) (Schiefele, 2009). Accordingly, two major types of interest have been identified as situational interest and individual interest (e.g., Hidi, 2000; Krapp, 1999; Silvia, 2006). From a developmental view, a transformative trajectory from situational to individual interest can be fostered when interest is initially aroused, then maintained, and further deepened and broadened. During this process, resources to generate ideas serve as "catalysts" to spark and develop interest (Barron, 2006).

More specifically, 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 (Knogler, Harackiewicz, Gegenfurtner, & Lewalter, 2015). Situational interest may not persist over time, unless it is maintained and subsequently developed into a more stable interest. Individual interest refers to an enduring predisposition for
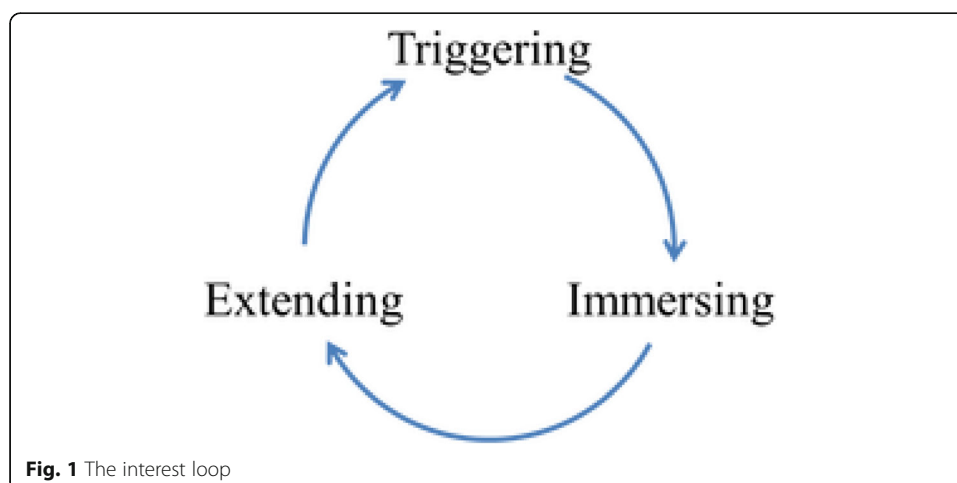


**Fig. 1** The interest loop

reengaging with particular activities or subjects (Rotgans & Schmidt, 2011). After triggering and maintaining situational interest with environmental stimuli, individual interest emerges and develops further.

Interest is the primary design consideration in IDC-based learning. Hence, to incorporate reading, writing, scientific inquiry, computer programming, and other domains into students' interests, the foremost concern is not what books to read, what articles to write, what scientific problems to investigate, what programs to compose, and how well they perform in such activities. Rather, the key is to first engage students in learning activities by triggering situational interest and maintain their engagement for a prolonged period of time toward developing their individual interests. When learning activities become interests, students will continue to improve and excel in their learning as past evidence has suggested that interests do relate to the performance in the academic context (Nye, Su, Rounds, & Drasgow, 2012).

## The interest loop in interest-driven creator 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 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 considerations 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 the triggering of the students' situational interest by tapping into their curiosity. Immersing students in relevant learning activities maintains interest by keeping them in a flow. Finally, emergent individual interest is nurtured when the students find the domain(s) to learn is/are genuinely meaningful for them. The respective design considerations of the three components and their theoretical underpins will be explicated next.

### Triggering interest—"curiosity"

"Triggering interest," the first component in the interest loop, concerns facilitating an activity that elicits initial interest in learning a particular object. This could be a new concept, skill, etc. For example, providing incongruous and surprising information around what is to be learned can intrigue students as well as point out an information gap (Loewenstein, 1994). In other words, it can pique curiosity. Curiosity is a well-studied topic within the educational psychology field (Grossnickle, 2016; Loewenstein, 1994). There is strong neuroscientific evidence that curiosity is strongly linked to the wanting and liking system in the brain (Litman, 2005). 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. In turn, minimal cognitive processing is needed 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, pertains to the desire to know. Specific curiosity enables investigating the details of a 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 the source or content.

Arousing *specific-epistemic* curiosity is particularly relevant to IDC because it closely aligns with triggering situational interest. According to the knowledge-deprivation hypothesis (Berlyne, 1954; Loewenstein, 1994), the emergence of epistemic curiosity is the consequence of a knowledge gap between what a person knows and what (s)he desires to know. At the point when a person's desire exceeds what (s)he knows, curiosity can drive the investigation into acquiring new knowledge. In addition, as satisfying curiosity is a pleasant experience (Csikszentmihályi, 1990; Izard, 1977), people voluntarily expose themselves to curiosity-inducing situations. For students, posing questions that foreground the students' knowledge deficit, presenting riddles or puzzles, exposure to a sequence of events with an anticipated but unknown outcome, violating an expectation that motivates a search for explanation, etc., can arouse their curiosity.

Such interest triggering activities, nevertheless, 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 decrease 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). However, these past accounts typically refer to interest development as a whole, that is, from situational interest to individual interest, or did not always distinguish the two types of interest in their relevant studies. Rotgans and Schmidt's focus on 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 knowledge gap is closed, then there is no additional impetus for further knowledge to be acquired, hence, reducing situational interest (Rotgans & Schmidt, 2014). To maintain students' interest beyond the triggering activity, it is crucial to facilitate "immersing interest."

### 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. As a result, there are emergent feelings of a sense of control or mastery, fully enjoying tackling the task at hand, being unaware of the passage of time, losing self-consciousness, and experiencing great gratification that the activity is intrinsically rewarding. 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 confront 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 students to build positive social relations by caring for and benefiting others. Thus, as Pintrich and Schunk (2002) posited, "…the flow experience requires skill, expertise, concentration, and perseverance, not just hanging out and feeling good" (p.284).

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 more novel 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."

### Extending interest—"meaningfulness"

"Extending interest," the final component in the interest loop, relates to designing activities to extend student interest in the domain after immersion in the learning activity. Extending interest also predisposes students to reengage in similar activities should the opportunities arise. This should be the right time where meaningfulness and self-directed learning enters to the interest loop-informed learning process. The intention is to assist the students in transforming their maintained situational interest into emergent individual interest.

The concept of meaningfulness, or meaningful learning, is twofold, underpinned by constructivism and authenticity, respectively. The constructivist perspective of meaningfulness is, as argued by Ausubel (1968), that the most important factor in learning is what one already knows. He asserts that learning is meaningful if students can relate and integrate the new knowledge with their old knowledge structures—this cognitive process is known as assimilation. Therefore, students seek to make sense of what they encounter by incorporating it with what they have already learned. Meaningful learning, in other words, is the enrichment and extension of prior knowledge. Indeed, knowledge and interest reinforce each other: an increase in knowledge leads to an increase in interest and vice versa (Silvia, 2006). Thus, the more knowledge students acquired

about a domain, the more complex and intriguing they may find that domain, leading to the discovery of more interesting details and aspects to explore.

The authentic perspective of meaningful learning, also known as personal value, refers to students' perception of the target domain as being relevant to their daily lives (Schiefele, 2009). For example, theme-based learning or thematic learning (Chan, Hue, Chou, & Tzeng, 2001; Huang, Liu, Chu, & Cheng, 2007; Liu & Wang, 2010) and seamless learning (Chan et al., 2006; Wong & Looi, 2011; Wong, Milrad, & Specht, 2015) which associate learning in the context(s) of real-life situations and stress knowledge integration from different perspectives or across disciplines provide a coherent and holistic way to support meaningful learning.

Studies (e.g., Dohn, Madsen, & Malte, 2009; Harackiewicz, Barron, Tauer, Carter, & Elliot, 2000; Mitchell, 1993) have shown that perceived meaningfulness (in both aforementioned perspectives) of the learning tasks was a crucial factor in maintaining situational interest, and perhaps even invoking 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 reengage 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 short, we position "extending interest" as the means to pave the way for students to develop individual interest from the situational interest that teachers facilitate and maintain through "triggering interest" and "immersing interest" activities. This is where the individuals' affective (emotionally 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).

## Case study: designing reading with interest loop

Modeled sustained silent reading (MSSR) is an initiative that fosters K-12 students' interest and later habit of reading. The initiative was first introduced in Taiwan and later spread to Hong Kong and mainland China. Reading literacy is becoming a major issue on educational change and policy in Asia. In fact, MSSR, being an intensive book reading activity, plays a critical role in acquiring existing knowledge in the "imitating" component concept of the creation loop in IDC theory (Chan et al., 2019). Due to the rich background knowledge built through MSSR, students are able to form a solid foundation for their knowledge creation thereafter. Literally, MSSR can be described as follows:

Modeled: The teacher, serving as a reading model, reads together with students in the class.

Sustained: The class reads for a long period of time every day at school.
Silent: The classroom must be kept silent for the students to focus on their reading.
Reading: The students read books of their own choice.

A general description of MSSR is given in Chan et al. (2018, pp. 450–452). Chan (2016) described the detailed implementation of MSSR, both in school and at home. MSSR at home, called "Family MSSR," requires a parent or both parents, acting as a reading model, to read together with their children at home every day at a fixed period of time. Arranged by school, parents, once or twice in a semester, join the MSSR class in school so that they can experience and feel the atmosphere of reading together with all the children in the classroom. After such reading "exercises" and being aware that reading is the basis of acquiring knowledge, majority of parents are willing to spend time to read together with their children at home. Besides, parents are encouraged by the teacher to bring their children to a local library or bookshop during weekends or vacations.

This section mainly discusses a specific aspect of MSSR in schools that exemplifies the three components of the interest loop. First, we must ask what is it that *triggers* a student's interest in reading a book in the classroom. It could be a previous experience of enjoying silent reading in the classroom so that the student naturally reengages this reading activity. It is likely that the book in hand, especially if this volume is the second of a series, and the student has already read the first one. It is also possible that the student might be *curious* about the book's title or cover, or might expect to find an answer to a question in mind from the book, or the reason to read the book could be something entirely different. Also, it could be a trigger directly by the teacher, such as books that the teacher wants the students to read. To trigger students' interest in reading a particular book, the teacher could read a selected part aloud during class. Then, when it reaches a climax, the teacher could stop and raise some questions or ask students to guess what happens next. This creates an information gap—students now know some part in the book and wonder what will happen, arousing their curiosity. To fill the gap, the students are likely motivated to borrow the book and read it (Chan, 2016).

When students start to read, they are gradually immersing themselves into reading with enjoyment (*immersing* interest). Reading is one of the most often mentioned *flow* activities around the world. It requires concentration of attention and skills that "include not only literacy but also the ability to translate words into images, to empathize with fictional characters, to recognize historical and cultural contexts…" (Csíkszentmihályi, 1991, pp. 49–50). A student in Hong Kong reflected, "I have finally found the pleasure of reading! When I read, I felt I have entered the story. Sometimes I did not even hear the bell ring" (Chan, 2016). A student in the USA described the reading experience as follows, "It's like a TV show or movie. I can see it really well" (Atwell, 2007, p. 21).

After experiencing reading with enjoyment, students *extend* their interest by seeking more books *meaningful* for them to read, that is, books that are related to what they have read before. There are, however, cases where children favor books of a particular

domain, but not others. For example, some children only read books about dinosaurs. To extend the scope of the students' interest, the teacher can arrange students in pairs or small groups to talk about the books that they have read, or organize individual students to share what they have read in front of the class. Such book-talk activities essentially encourage students to recommend books to each other, broadening their reading horizon. For example, if the recommended book talks about the conjecture that the birds today are descendants of dinosaurs, the student who reads only about dinosaurs may want to pick it up, which could also trigger interest in birds.

Extending interest also implies advancing learning both in breadth and depth. Most children initially read books with lots of pictures, but as time goes by, they gradually move on to books comprising mainly text and few illustrations; thin books, then thicker books. Students seem to have their own reading goals. This is not a surprise, because as students acquire more skills or knowledge through reading, such as mastering more vocabulary and sentence patterns, or gaining more knowledge about a domain, they will advance to higher caliber books. These new books not only match their current skills and level of knowledge, but also are more meaningful and rewarding. However, the teacher may find a few students who always stick to books of the same level. In such cases, the teacher could encourage these students to set a goal to attempt more challenging books, so that they can gain more and be more satisfied with their reading. With goals set by students themselves, the teacher can monitor how they pursue their goals and advise them whenever needed. Furthermore, the teacher may sometimes suggest to students to take on a challenging book that may lead to a transformative experience, one that causes the student to see the world in a new way and contribute additional meaning and value (Pugh, Linnenbrink-Garcia, Koskey, Stewart, & Manzey, 2010).

To summarize, in order to trigger *situational interest* (initial and unstable interest) in reading, either the content of the book should arouse the students' curiosity, or the teacher could read a book aloud and ask the students questions. To make reading an *individual interest* (stable interest), the teacher must arrange time for the students to experience total immersion and enjoyment in reading, in other words, the flow experience. To extend reading interest, students may recommend books to their peers, undertake book talks in groups, or set themselves the goal of reading books at a more advanced level.

The role of technology is to support, sustain, and scale up MSSR. Even after a class has carried out MSSR for several months, it is likely that the teacher may not be fully aware of the particulars of each student's reading situation, such as what books they have read or what kind of progress they have made. Technology can be employed to address the gap. For example, My-Bookstore (Chien, Chen, Ku, Ko, & Chan, 2015) is an online gaming platform where the student plays the role of an online bookstore manager. After reading a book, a simple record is made of it. This represents the entry of that book in one's bookstore which then becomes for sale. Books that the student has particularly enjoyed can be reviewed and recommended to other students. Through this activity, the student learns reading comprehension strategies such as summarization, elaboration, and connection with experience. Furthermore, the bookstore format allows online book talk not only with fellow classmates but also with other students from different classes or even different schools.

### Connecting interest loop with creation and habit loops

We contend that within the context of IDC theory, interest (a mental and affective/ emotional state) and creation (an act) and interest and habit (a repetitive way of behaving) form intriguing reciprocal relationships. In this section, we will postulate and unpack the relationships between the IDC loops.

#### Interest and creation

The three types of interest-nurturing activities that we have foregrounded in earlier sections, namely, curiosity-driven activities, flow activities, and meaningful learning activities, could come in the form of student artifact creation. In a related vein, the staging component of the creation loop may become an interest-triggering strategy. An example is reported by Wong and colleagues (Wong, Chai, Aw, & King, 2015; Wong, King, Chai, & Liu, 2016) on a project code-named MyCLOUD. In the project, a techno-socio-pedagogical model for Chinese language learning was developed to facilitate students' learning through creating social media that report their daily lives in Chinese. When students shared (or "showed off") their artifacts in the online social space, they created more than what their teachers instructed and improved in their Chinese writing. This shows immersed/maintained interest as prior noted in the "Immersing interest—"flow"" section. The opportunities to create more artifacts can become a part of developing students' creativity via interest-driven strategies.

Arthur Shawlow, a Nobel Prize-winning physicist, posited eloquently, "The labor of love aspect is important. The most successful scientists often are not the most talented, but the ones who are just impelled by curiosity" (Schawlow, 1982, p. 42). Indeed, for both the remarkable and the ordinary people, creativity requires the perseverance and the intensity from strong interest or motivation (Amabile, 1996). Students with low interest levels in a domain (or learning in general) are likely to put in little effort in relevant creative endeavors and produce low-quality work. On the contrary, students who are highly engaged in the creative activities due to their intrinsic on-topic interest tend to be persistent, resilient, and productive, resulting in high-quality outputs. Moreover, such interest-driven creators may sporadically and spontaneously venture into self-initiated, exploratory learning tasks (Azevedo, 2006) that depart from the teacher-prescribed activities. That is, they would enjoy novelty and risk by creating (generating) new hypotheses, new tools (or inventing new ways of combining or utilizing existing tools) or new methods/strategies to tackle novel challenges, overcome constraints, and/ or elevate the quality of their creative products (e.g., Azevedo, 2013; Bricker et al., 2008; Wong, Chen, & Jan, 2012). Thus, their creativity is not only restricted to product-oriented creativity but also process-oriented creativity or "methodological creativity." Such process-oriented creativity is indeed a key ability in performing ill-structured problem solving. Ultimately, the sense of achievement and the increase of self-efficacy due to overcoming a tedious problem or creating a product that exceeds expected quality would further advance one's interest in the related domain.

#### Interest and habit of creation

It is common sense that one's specific habit may arise from related interest. For example, a passionate basketball player would make basketball practice a habit, and you

might even find him/her casually exercising the shooting posture off the court. Similarly, a student involved in the MSSR initiative may habitually find pocket time to read books after her/his interest in reading is fostered. In deriving the habit loop of IDC theory, we aim to move beyond conventional behaviorist connotations of habit-forming and instead place our main interest in fostering a habit of *creation*. That is, a student learns with interest incessantly and habitually, and her/his learning process emulates the creation process, as elaborated in the previous section. Habit of creation can be seen as intellectual, related to psychological processes requiring our mental abilities and affective states. This tends to be less automated (i.e., oft-repeated action cued by specific contexts, requiring little thought), but more goal-oriented (i.e., repeatedly pursuing a goal via a specific behavior in a given context). Neal, Wood, and Quinn (2006) coin the term "implicit-goal model" to describe the indirect association that forms between the context and behavior (in the context of IDC, this refers to the creation activities) within the broader goal system. These goal-driven responses tend to be dynamic and flexible, as evidenced by people sometimes substituting behaviors that serve a common purpose.

As an illustration, a software engineering student who is inspired to become a skillful app programmer may foster a personal habit of developing different types of apps (beyond class assignments) for solving authentic problems, for improving personal productivity, or just for self-challenging, practicing coding, or pleasure. What this student is doing as a habit is repetitive in the sense that (s)he repeatedly creates new apps in a self-directed manner—often triggered by a real-life need or an inspiration from her/his day-to-day life. Yet they are *not* repetitive in the sense that a variety of functionalities/affordances and user interfaces of different apps are being developed for different purposes and with the employment of different underlying technologies or coding techniques. The development and sustenance of such a cognitively challenging personal habit are typically driven by intrinsic interest or passion.

Over the time, the student accumulates coding experience, new or improved coding knowledge and skills. That may constitute a snowball effect in her/his subsequent habitual endeavors with apps of higher quality being developed and/or with improved process and strategies of app development being employed. Indeed, the process of app programming can be seen as a flow experience. Due to her/his intrinsic interest in app development, the student may routinely seek such flow experiences as a habit (Conti, 2001; Csikszentmihályi, 1990), often by seeking higher challenges; as (s)he gains skills, (s)he seeks higher challenges that require an increase of skills (Freer, 2009). Consequently, similar to what we have postulated in the previous subsection (regarding the reciprocal relationship between interest and creation activities), the sense of achievement and satisfaction and the establishment of self-identity as an app development expert through such a habit would reciprocally enhance the student's interest in programming.

### How could challenges deepen interest as passion?

Interest is regarded as the seed of passion (Duckworth, 2016). In the context of IDC theory, we define passion as "a deep and intense level of individual interest towards an activity, in which people have a great feeling of enthusiasm and enjoyment, and are willing to invest a lot of time and efforts in the activity." According to Vellerand (2012),

people constantly interact with their environment. Over time, individuals begin to show strong preference for particularly enjoyable and perceived meaningful activities. A special bond is then created between the person and the activities, which grows into passion.

Fredricks, Alfeld, and Eccles (2010) postulated key characteristics of learning environments where students are more likely to experience passion: "where they feel supported by peers who are of similar ability and motivation levels, where teachers model enthusiasm and press for understanding, where there is adequate challenge, and where are opportunities to work on varied, meaningful, and cognitively complex tasks" (p.18). These characteristics are comparable with many of the design principles we have laid out in the "The interest loop in interest-driven creator theory" section of this paper. In this section, we single out the notion of "challenge" as the key strategy to further develop one's learning interest into learning passion. Challenges—difficult tasks that call for learning in order to advance one's current ability—establish concrete goals that direct students' actions and efforts. Indeed, we believe that challenges play a critical role in terms of triggering, immersing, and extending interest.

For *triggering*, challenges drive curiosity. Although curiosity—the desire to learn new things, to explore the world, and to seek the novelty—is our basic drive, it means different things as beginners move towards expertise. For instance, curiosity refers more to novelty in acquiring knowledge for beginners as they make discoveries, but for experts, it denotes noticing nuances in knowledge (Duckworth, 2016). As beginners become experts, they begin to distinguish subtle differences in concepts and can become more deeply engaged in what they find, re-triggering their interest. This reinforcement cycle around curiosity, from being beginners to experts, helps interest develop into passion.

For *immersing*, challenges can deepen a person's involvement in the activity of interest. Challenges refer to a balance between the difficulty level of tasks and the degree of one's ability (Pintrich, 2003). While an appropriate challenge is highlighted, some related factors and designs (e.g., a clearly defined goal, immediate and informative feedback, and repetition with refinement) would be taken into account, which would contribute to optimal experience. Thus, students are easily and deeply immersed in the tasks while meeting challenges.

For *extending*, challenges can represent goals for students. Since different levels of goals drive various degrees of efforts and insistency (Erez & Zidon, 1984), students are encouraged to set up enhanced goals through overcoming a set of challenging tasks. With challenges, students would drive themselves to attain the goals, in which deliberate practice (Ericsson & Pool, 2016) is further involved. They endeavor to improve their skills or knowledge and never give up the pursuits easily. This process of pursuing is meaningful for the students because what they do is enriching and extending their prior knowledge and is related to their daily lives. Consequently, challenges are helpful to goal setting and further enhance and deepen their interest as long-term passion.

## Discussion and conclusion: operationalizing the interest loop in school settings

Cognizant that "interest is the mother of learning," we delineate a design framework for interest development in the students within the context of IDC theory. Curiosity-driven learning, flow experience, and meaningful learning ground the learning

strategies being identified for "triggering interest," "immersing interest," and "extending interest." Nevertheless, when it comes to concrete learning design, there may or may not be clear distinctions among the three components/states. Instead, they can be seen as a continuum of various types of activities that support the students in the process of interest development. Moreover, the design considerations being laid out in the "Triggering interest—"curiosity"," "Immersing interest—"flow"," and "Extending interest—"meaningfulness"" sections 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. An "interest loop" designer may start with adhering to the delineated framework in this paper. Once (s)he becomes adept in the design skills and gains experience in enacting interest loops, (s)he may then exercise flexible and differentiated designs to optimize the effectiveness of learning activities. When such interest loop activities are repeated according to the school curriculum (thus affording plenty of opportunities for reengagement) and when student interest develops from situational interest into individual interest, *triggering* interest will no longer be needed. Also, with the appropriate design of a school curriculum and challenging activities, not only a learning interest will be developed but also the learning interest may also become a passion, a learning habit (the last anchored concept of IDC), and, hopefully, a lifelong habit.

To conclude, this paper has captured the essence of the interest loop in developing student *interest* in learning while at the same time providing glimpses of (1) how learning occurs through interest-driven *creation* activities which then (2) leads to learning *habits*. These two anchor concepts of IDC will be the specific foci respectively in the subsequent two papers of this thematic series.

**Availability of data and materials**
This is a conceptual paper. No empirical data was used for analysis and reporting in developing the paper.

**Ethics approval and consent to participate**
This is a conceptual paper which did not involve any empirical study. Therefore, no ethical approval and consent to participate is required.

**Consent for publication**
This is a conceptual paper which does not involve any funding or organization. As the authors, we consent for publication on RPTEL should it be accepted.

**Competing interests**
The authors declare that they have no competing interests.

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