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Interest-driven creator theory: towards a theory of learning design for Asia in the twenty-first century

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Abstract Asian education is known for its examination-driven orientation, with the downsides of distorting the processes of learning and teaching, diminishing students' interest in learning, and failing to nurture twenty-first century competencies among students. As a group of Asian researchers, we have been developing Interest-Driven Creator (IDC) Theory, a design theory based on three *anchored concepts*, namely *interest*, *creation*, and *habit*. Each of these anchored concepts is represented

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by a *loop* composed of three *components*. In the *interest loop*, the three components are triggering, immersing, and extending. The components of the *creation loop* are imitating, combining, and staging. The *habit loop* consists of cuing environment, routine, and harmony. These three loops are interconnected in various ways, with their characteristics revealed by the design process. We hypothesize that technology-supported learning activities that are designed with reference to IDC Theory will enable students to develop interest in learning, be immersed in the creation process, and, by repeating this process in their daily routines, strengthen habits of creation. Furthermore, students will excel in learning performance, develop twenty-first century competencies, and become lifelong interest-driven creators. To sharpen our understanding and further the development of the theory, we need more discussion and collaborative efforts in the community. Hypotheses arising from this theory can be tested, revised, or refined by setting up and investigating IDC Theory-based experimental sites. By disseminating the framework, foundations, and practices to the various countries and regions of Asia, we hope that it will bring about compelling examples and hence a form of quality education for the twenty-first century, which is an alternative to the examination-driven education system. In this paper, we present an overall introduction to IDC Theory and its history, and discuss some of the steps for advancing it in the future.

Keywords Interest-driven learning · Creator-based learning · Creation · Learning design theory · Twenty-first century competencies · Inquiry-based learning · Design thinking · Game-based learning · Seamless learning · Challenge

Background and motivation

As Asian researchers, we have come to realize that in efforts to make a significant impact on education, we face a prodigious barrier: a considerable part of formal education in Asia remains *examination-driven*. Across Asia, to fulfill the expectation of parents, and more broadly of society, educational practices are largely governed by the short-term goal of obtaining high scores in examinations. Thus, to gain admission into a good university, one has to enter a good senior high

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school, because parents believe that a student from a good senior high school has a greater chance to get into a good university. Similarly, to gain admission into a good senior high school, one has to enter a good junior high school first, and the process continues down to the kindergarten level. Likewise, to achieve high scores in public examinations, one has to obtain high scores in school examinations, and hence, in every examination. As a result, the entire effort of students and teachers is focused on obtaining high scores in one examination after the next.

In Taiwan, under this cultural pressure, it is alarming that half of the school children were found to be suffering from learning fatigue and 12.7 % from excessive fatigue (Lin 2017). In fact, many of the school teachers in Taiwan conduct tests daily. It is therefore not surprising that students develop a twisted concept of "learning." For example, in Taiwan, a significant number of students, including those at elementary level, regard "learning" as synonymous to "preparing for examinations" (Tsai 2004; Lee et al. 2008). Some teachers also admit that if there were no examinations, they would not know how to push their students to learn.[1]

In Singapore, students consider "working hard" as an intensive process of drilling and practicing prepackaged knowledge, whereas "working smart" is interpreted as seeking strategies and short-cuts for obtaining higher grades (Wong et al. 2012). South Korean students professed to be quite unhappy with their life in general (Park et al. 2010). This obsession can have tragic results. In Hong Kong, for example, 33 students from primary school to university level committed suicide during the academic year 2015/2016 (EDB 2016; Liu 2016), with the majority of these cases due to reasons of academic pressure.

In mainland China, examination pressure is high. Since only those learners who perform well on competitive examinations will obtain the best learning opportunities in higher education, examination results are often considered to be the only criteria that can prove students' worth, leading them to always feel overwhelmed (Kirkpatrick and Zang 2011). In Japan, the situation is similar: the higher a student's examination scores, the more likely the student can get to a more prestigious university (Ono 2005). However, there have been discussions about changing this situation within the Japanese government.

In India, most of the 1.5 million schools follow an examination-driven model at all levels. Another serious implication of the focus on examinations is that performance in the public exams in Grades 10 and 12 is the sole deciding factor for the choice of future study; the course of career, and thus the future life of the students, is decided by performance in these exams.

[1] According to a survey published in a magazine in Taiwan (Ho et al. 2012), 80% of middle school teachers agreed that most students would not study if there were no tests.

[2] Two examples are typical of this phenomenon. In 2011, Progress in International Reading Literacy Study (PIRLS) assessed the reading literacy achievement of the fourth-grade students from 45 countries/regions (Mullis et al. 2012). Hong Kong, Singapore, and Taiwan were ranked 1, 4, and 9, respectively, in the reading achievement among 45 countries/regions. However, in the "like reading" item, they were at the bottom, ranking 39, 38, and 34, respectively. In the same year, Trends in International Mathematics and Science Study (TIMSS) assessed the mathematics achievement of the fourth-grade students in 50 countries/regions. Singapore, Hong Kong, Korea, Japan, and Taiwan were the top five in terms of achievement, but in terms of confidence in mathematics, they were at the bottom (Mullis et al. 2012).

International assessments reveal that Asian students demonstrate low interest and suffer from a lack of confidence in their learning, an attitude expressed even by top academic performers.[2] The aforesaid scenarios paint a woeful picture of how deeply the examination-oriented culture is entrenched within the Asian education system. Alas, "interest" does not seem to be a word in the Asian educational dictionary.

In their book written a century ago, Dewey and Dewey (1915) described the school of the time as "arranged to make things easy for the teacher who wishes quick and tangible results; that it disregards the full development of the pupils… the ordinary school impressed the little one into a narrow area, into a melancholy silence, into a forced attitude of mind and body" (pp. 18-20). This scenario still exists in numerous schools today. The overemphasis on examination outcomes (tangible results) inevitably leads to severe drawbacks: learning and teaching are distorted; many students do not enjoy learning; and it becomes difficult for students to develop twenty-first century competencies. Worrying about the commercialized products of technology-enhanced learning, Ren (2015) warned that many technology-enhanced learning products developed by industry serve as examination-driven education (mainly teaching or drilling students to attain higher scores in examinations instead of genuine knowledge construction), and even then, many such products are unable to help students attain high scores.

In spite of all this, high-stakes examinations are still regarded in Asian societies as the fairest way to distribute educational resources, such as deciding who gets into the best schools and universities. In many Asian countries, public examinations have long histories, in some cases over 2,000 years. In fact, getting into good universities to learn what a student is interested in is a great challenge and a long-term goal that is worthwhile to pursue. We also realize that changes in what and how students learn in the future as well as the rapid advancements in learning analytics will ultimately alter the way we assess students (for example, learning and assessment can take place simultaneously in a digitally supported environment). Still, we believe that high-stakes examinations will not be replaced, nor will they disappear in the foreseeable future, though government-initiated reforms have been undergoing in many countries. While we do not object to such high-stakes public examinations per se, we need to recognize the adverse effects of examination-driven education over the rest of this century.[3] Blind emphasis on exams and test scores interferes with the development of a deep understanding of subject knowledge. Students are also deprived of opportunities to develop interest in learning materials and creative thinking ability, which require free exploration and experimentation with learning materials in an environment in which failure is seen as a norm rather than something to be avoided. Clearly, examination-based measures of academic success, given their largely closed-ended assessment formats, do not prepare the next generation of students to excel in the ill-structured, unpredictable real world.

Asian education systems can be understood through the lens of "centralized-decentralization," which refers to the interaction between centering forces that maintain tight system coherence and decentering forces that allow local autonomy

[3] Some may say that education in Western countries is also examination driven, but in Asian education, this problem is much more serious with much more emphasis given to the examinations.

(Ng 2008). In other words, due to centralized forces, schools in Asian education systems adhere to highly prescribed curricula and focus on success in high-stakes examinations, but due to decentralized forces, schools and teachers make pedagogical decisions that respond to local conditions. Recent educational reforms in some Asian countries have resulted in increasingly decentralized forces that grant more autonomy and control in curriculum planning and assessment to schools, teachers, and students (Hung et al. 2017; Zhao 2015). A core impetus driving these changes to educational policies is the realization that traditional school systems do not adequately prepare learners for twenty-first century jobs.

The twenty-first century is an era of rapid and accelerated change. To succeed in a changing world, citizens must adopt habits of lifelong learning and acquire skills such as complex problem solving, collaboration and communication, critical thinking and reflection, and creativity and imagination (Chan 2013; Griffin et al. 2012). Therefore, how can we design learning that enables students to develop core competencies and prepare themselves for life in the twenty-first century? Our world is plagued with serious issues, such as climate change, uneven distribution of wealth, social injustice, religious intolerance, and conflicts within and between regions and countries. Can we inspire and challenge our students to undertake important and creative activities so that they will become the creators and contributors who will ultimately resolve the problems faced by the human race in the future? From the perspective of economic development, as described by Acs et al. (2008), society is in the process of transformation from a factor-driven economy (an economy driven by the availability of large amounts of human labor and natural resources), to an efficiency-driven economy (an economy driven by increased efficiency of production), and more recently, to an innovation-driven economy (an economy driven by innovation in every aspect of the economy). To enable society to move forward, in addition to assimilating existing knowledge, the next generation must be able to produce new knowledge and innovation. Can students become responsible for their own learning and become lifelong creators? How can we nurture the best in every student? Is there a solution that would enable society, schools, and families to help the next generation prepare for their future?

Advancements in digital technology have brought about disruptive changes to the nature of work, education, entertainment, communication, and transportation. Almost every part of our lives has been affected. During the mid-1990s, most computers were standalone desktops. Connecting personal computers to the Internet had only just begun, and notebook computers were also just beginning to become popular. In the early 2000s, right after the Internet investment (dot.com) bubble, mobile computing emerged, along with the rise of giant Internet corporations. Later on, the release of smart phones spurred a global wave of mobile computing. Since then, digital technologies have increasingly matured. In the 2010s, technologies such as cloud computing, big data, the Internet of things, virtual/augmented reality, robots, machine learning, and other such innovation received wide public attention. Indeed, many dreams of artificial intelligence researchers in the 1970s and 1980s have become reality, such as computers that support multimodal inputs beyond text such as voice, video, and images. In the future, it is expected that advances in artificial intelligence and robotics will have a significant effect on the jobs of the

future. For example, autonomous vehicles, both ground and aerial, will be widely used in transportation. And artificial intelligence will enable aspects of the roles of knowledge workers, such as doctors, accountants, lawyers, and other professionals, to be carried out by computers.

The next generation is our future. To prepare students for the future, education must change—which means that why they learn, what they learn, how they learn, what tools they employ to learn, who they learn with, and how their learning is assessed all will change. For example, one-to-one technology-enhanced learning, in which every student is equipped with a mobile device, will become essential. Seamless learning, supported by mobile and cloud computing technology, will connect individuals (such as students, teachers, parents, and volunteers) to places (such as classrooms, homes, museums, and the outdoors) as well as to things (such as tangible learning tools, makers, and robots) (Chan et al. 2006; Wong et al. 2015). Game-based learning will engage attention and increase the motivation of students to learn. Learning analytics will help teachers and parents to better understand the learning process and also provide students with timely feedback. Educational robots will be welcomed by school children and parents alike and be ubiquitous in the educational arena. In consideration of long-standing research on intelligent tutoring and computer-supported collaborative learning, as well as the proliferation of massive open online courses and flipped classrooms, the domain of learning will undergo a transformation from single teacher lectures to individual learning and collaborative learning. The evolution of learning, from teacher-centered to student-centered learning, is an inevitable and irreversible transformation. In light of the history of education, and with respect to these imminent changes to learning, not only in Asia but all over the world, we ask the following question (Chan 2010): *What will Asian education be like in the next 20 years?*

Many researchers have sought to investigate the challenges faced by the education field. Various research studies and experiments have been developed with the intention of improving the learning experience, evaluating learning outcomes, developing a deeper understanding of learning and teaching, and articulating theories. However, we have observed that most of the effort was carried out at a micro-level. To transform Asian education, to make a sustainable impact on a large scale, and to enable future-proof education, we feel that a macro-level theory to guide research and design is needed.

A short history of IDC theory

Beginning in 2009, Tak-Wai Chan and his team conducted a one-year experiment on reading and writing in a Grade 3 class in Taiwan. Students were given two tasks: extensive book reading, based on an activity model called Modeled Sustained Silent Reading (MSSR) (further described in later sections), which is a critical component of the Reading for Tomorrow Project, and essay writing, based on reading articles, freewriting and peer responses (Elbow 1973; DiPardo and Freedman 1988) with the support of one-to-one technology. After 1 year, each student had read about 170 books on average. Furthermore, they exceled in writing (Wang et al. 2014), writing

at approximately a grade six level, as determined by an informal assessment of teachers in Taiwan, Hong Kong, and China. After the experiment, other teachers in the school were interested in MSSR and started to adopt it in their classrooms on their own initiative. The wider diffusion of MSSR in Taiwan began in 2012, with over 600 schools having adopted it to date.

It should be noted that extensive book reading has been promoted in Asia, particularly in Taiwan, Hong Kong, and Singapore, since the early 2000s. Nonetheless, the majority of such initiatives have not led to sustained practice for a number of reasons. Most teachers assign students to read books that are not of the latter's own choice, but the teachers' choice. Teachers require students to write summaries, and assign other tasks, such as identifying good words and sentences, after reading a book. Thus, reading is not an enjoyment but a burden or an additional homework assignment. Despite their effort, teachers felt frustrated when they found students did not like reading. Why did students in Hong Kong perform so well in reading performance (comprehension) but did not become more interested in reading? "This is because comprehension needs to be examined but not interest," explained by Sylvia Chan, a Hong Kong elementary school principal, in 2015.

Sometime in 2011, Tak-Wai Chan's team noted that a theory was needed to explain why students in the one-year experiment exceled in reading and writing; in particular, why they enjoyed reading in MSSR. There was some attempt to develop a theory based on contemporary theories in the learning sciences, from which an extremely primitive framework emerged (Chan et al. 2016). The team realized that such a theory, if fully developed, could also serve as a guide for designing learning activities for Asia in the future. A collective endeavor to develop the theory then commenced. After an informal meeting with a group of Asian researchers during the International Conference on Computers in Education (ICCE) in 2014 in Japan, the Interest-driven creator (IDC) Initiative was formed for articulating and developing the theory and the design principles. Thereafter, a series of events such as panels were held during ICCEs and GCCCEs (Global Chinese Conference on Computers in Education), with a few workshop papers presented in ICCE 2015 (Chan et al. 2015; Chen et al. 2015; Looi et al. 2015; Wong et al. 2015).

This paper gives an overall introduction to IDC Theory. Some researchers have already used IDC Theory to guide the design of learning activities and curriculum in computer programming education (Kong 2016; Kong and Li 2016; Liu et al. 2016; Kong et al. 2018). Subsequent papers will respectively expound on the topics of interest, creation, and habit.

Interest-driven creator theory: a brief overview

An assumption of IDC Theory is that learning is a process that is composed of three *anchored concepts*: *interest*, *creation*, and *habit*. Interest is critical for this process, because when students learn with interest, learning is enjoyable and effective. This is particularly the case when what they learn is of their own interests. Creation makes learning productive and full of achievement. Habit is an indicator of students becoming interest-driven creators because their self-directed behaviors shape who

they are. Thus, if we can imbue students with habits of creating with interest, they will ultimately become lifelong interest-driven creators.

More specifically, with the appropriate design and technological support, we put forward the following assumptions for the design of learning activities:

1. Learning can be tuned to the individual *interests* of students by vigorous contextual design and nurturing.
2. Learning activities, by means of a rigorous design process, can be developed as interest-driven *creation* activities.
3. For interest-driven creation activities to have lasting effects, they need to be incorporated into the daily routine so that students can form *habits* of learning through such daily activities.

Furthermore, assuming that the aforesaid assumptions are valid, we arrive at the following expected outcomes.

i. Students will enjoy and endeavor to learn.
ii. Students will excel in terms of learning performance, and thus, will be prepared for high-stakes examinations.
iii. Students will develop the twenty-first century competencies and prepare the foundations for lifelong learning.
iv. Students will explore and develop their potential and talents.

Designing a learning activity is a complex process. Designers who incorporate too many design concepts simultaneously encounter difficulties. To alleviate problems arising from complexity, IDC Theory uses the three anchored concepts—interest, creation, and habit—which deal with various domains, such as affective, cognitive, behavioral, and social. With respect to these anchored concepts, designers may design at the macro-level. Subsequently in the design process, the implementation details, or *component concepts,* within these anchored concepts are then unpacked and addressed. For the same reason, the number of component concepts for each anchored concept is limited to three, connected in a loop (Figs. 1, 2, 3). Note that, from a design point of view, an anchored concept constitutes a first-level consideration, while a component concept denotes a second-level consideration. For example, the anchored concept *interest* comprises three component concepts:

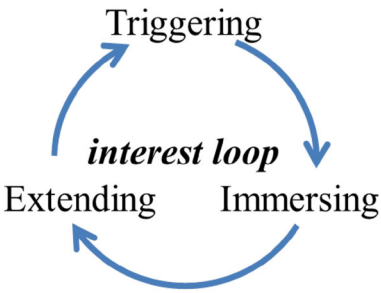

Fig. 1 Interest loop

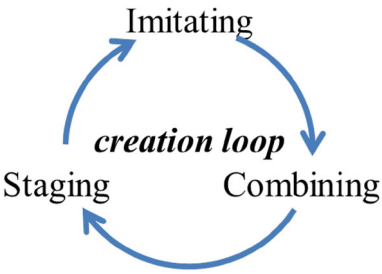

Fig. 2 Creation loop

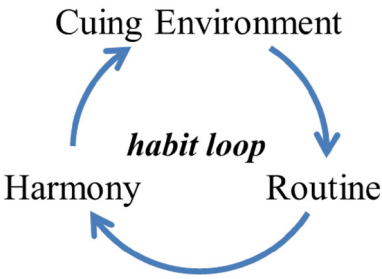

Fig. 3 Habit loop

triggering, immersing, and extending that form a loop (Fig. 1). In the next three papers, examples are provided that can show how these three loops can be interconnected in a variety of ways when designing learning activities. With further experimentation and investigation, it is likely that each component concept will include several *sub-component concepts* (third level of design consideration). Concrete activity design occurs at the micro-level, when it goes into the details of a component or subcomponent concept. Both the macro- and micro-levels are essential for design.

There has been substantial prior research on the three anchored concepts, as well as their components. School is a social institution. When we talk about the concepts of interest, creation, and habit, we may refer to the characteristics of an individual or to those of a group. We can consider an individual's interest or a group's, an individual's creation or a group's, or an individual's habit or a group's. Each of the three concepts functions differently in an individual than in a collaborative context. Envisage the following scenario: in a class with a strong general interest in learning about robots, any individual student has been exposed to what the student has seen and heard about robots from his or her classmates, and this will certainly affect the development of the student's interest in robots. This means that when we talk about a group's interest within a certain domain, the group as a whole has developed interest in that domain for a period of time. Habit works similarly. Thus, even though interest and habit are usually considered to be characteristics exhibited by individuals, they can also be regarded as characteristics possessed by groups: we can talk about a group's interests and a group's habits.

When speaking of creation, however, there are two possibilities: individual creation or group creation. Writing can be taken as an example. If a student writes

an essay and finishes it individually, it is certainly an individual creation. However, if one student prepares a draft and then asks for comments from fellow classmates to make improvements on it, then the writing process involves group creation, because other students also contribute ideas to the essay. Let us look at another case. When writing a report for a group project, group members may divide a writing task into different parts, with individual students writing their own parts. Subsequently, the group combines all of these parts to form the final report. Thus, whether a piece of writing is an individual or a group creation depends on the context at that moment. However, if we consider the final creative product and the whole process of creating it from beginning to end, the writing task is likely to involve both individual and group creations.

Interest, creation, and habit

When students are interested in a learning activity, they pay closer attention to it and put greater effort into it; without interest, the learning activity cannot be sustained. Interest is the key to high academic performance. It is not surprising that some researchers state that interest is the mother of learning (Aggarwal 2009; Wong et al. 2016). Interest, the first anchored concept of IDC Theory, concerns whether we can design learning so that it becomes the object of enthusiasm. The online Oxford Dictionary[4] defines interest as "the feeling of wanting to know or learn about something or someone," "a quality of exciting curiosity or holding the attention," or "an activity or subject which one enjoys doing or studying." Human beings dedicate a great deal of effort to endeavors that interest them. Imagine, for example, how much time soccer fans spend learning everything about their favorite team as well as other relevant soccer knowledge (Silvia 2006). Amateur astronomers pursue extended participation in observing celestial objects in the sky, as noted by Azevedo (2013). Examples of learning driven by interest are abundant.

In order to promote interest in a learning activity, we propose a three-component loop model, composed of *triggering interest*, *immersing interest*, and *extending interest* (see Fig. 1), which are respectively characterized by curiosity (Loewenstein 1994), flow (Csíkszentmihályi 1991), and meaningfulness (Ausubel 1968). Lim (2016) maintained that the arousal of curiosity is the essential way to trigger the initial interest to learn new things. *Curiosity* denotes the realization of an "information gap" and a desire to bridge that gap. Strategies that can arouse a student's curiosity include exposing a student to a sequence of events with an anticipated but unknown outcome, or violating expectations, which motivates a search for an explanation.

The optimal experience, when people are fully immersed in an activity, is referred to as *flow* (Csíkszentmihályi 1991). In terms of a learning task, a student may enter the flow state if it has clear goals, provides immediate feedback, and maintains a good balance between the perceived challenge level (or difficulty level) of the task at hand and the student's own self-perceived skill level. Once in the flow

[4] Retrieved August 29 2017, https://en.oxforddictionaries.com/definition/interest.

state, the student enjoys a feeling of energized focus, a suspension of time, a loss of self-consciousness, a sense of connection to the inner self, and, also, sometimes a connection with others. In terms of learning, *flow* means that the student is immersed into the learning activity.

Extending interest is characterized by *meaningfulness,* which refers to the relatedness and integration of newly encountered knowledge with prior knowledge (Ausubel 1968; Mayer 2002), and the students' perception of the target domain as being relevant to their authentic daily lives (Schiefele 2009). Students extend their interests when they seek to make sense of what they encounter. They incorporate what they have already learned, or they associate the context of real-life situations with what they are learning. Subsequently, meaningfulness is generated when students integrate knowledge from different perspectives or across disciplines.

Creation, the second anchored concept, is the foundation of IDC Theory, which sees the learning process as a process of creation. The Oxford Dictionary[5] defines the verb "learn" as "gain or acquire knowledge of or skill in something by study, experience, or being taught," "commit to memory," or "become aware of something by information or from observation." However, for educational purposes, learning is the process of preparing our next generation for life in the twenty-first century. Therefore, learning is not only acquiring knowledge, but also generating ideas and constructing artifacts. Researchers such as Scardamalia and Bereiter (2003, 2006) and Tan et al. (2014) have advocated for knowledge creation, arguing that the fundamental task of education is to nurture a knowledge-creating culture.

Creation consists of three components—imitating, combining, and staging—forming the creation loop (Fig. 2). In other words, creation activities are composed of these three subactivities. *Imitating*, the first component of the creation loop, is to prepare creation by absorbing (inputting) abundant existing knowledge. Creators must know a great deal or possess rich background knowledge before generating creations of their own. Outsiders who know little of a domain seldom contribute new ideas to it because they are trapped by their own misconceptions and biases. Imitating is an innate and prevalent mechanism for acquiring existing real-world knowledge. Newborn babies, for example, as young as 41-min old, are able to imitate basic manual and facial gestures from an adult (Meltzoff and Moore 1977). Scientists have discovered a special class of brain cells, called mirror neurons (di Pellegrino et al. 1992; Rizzolatti and Fabbri-Destro 2010). It was found that, for example, when we are listening to other people, we are mirroring the speakers with our tongues as if we are simulating their speech by speaking the same speech ourselves (Fadiga et al. 2002). This could be the way our brain understands other people's speech (Liberman and Mattingly 1985). Likewise, reading also invokes a mirroring mechanism. Both watching a video about an action (e.g., "grasp the banana" or "bite the peach") and reading sentences describing the same action activate the same specific areas of the brain related to the control of hand and mouth movements. The implication is that the mirroring process may help us understand what we read by internally simulating the actions we are reading about. It may also

[5] Retrieved August 29 2017, https://en.oxforddictionaries.com/definition/learn.

suggest that when we read a novel, the mirror neurons in our brain simulates the actions described in the novel, as if we were performing those actions ourselves (Aziz-Zadeh et al. 2006). After all, we cannot learn every existing knowledge in the world through the experience of recreating it again. Thus, in terms of gaining existing knowledge, imitating occurs naturally, especially when it is interest driven or what is observed is appealing to the student. Besides, educational scientists who study social learning (Bandura 1977) and cognitive apprenticeship (Collins et al. 1989) advocate *modeling*, in which a student observes what a role model does, builds a conceptual model, and acts out what the role model does. *Community of practice* (Wenger 1998), talking about organization of learning activities through peripheral participation in communities of real-world practice, essentially indicates that learning involves imitative behavior within a community. As there are usually varying degrees of resemblance between what is observed and what is reproduced, we may view imitation as a spectrum of activities. With this view, we may regard the three lower-level educational objectives of Bloom's taxonomy (Bloom 1956; Anderson and Krathwohl 2000)—remembering, understanding, and applying—as an imitation spectrum of different extents. As an example of designing imitating activity, Kong and Li (2016) engage students to observe and adopt the programming code of others as the first step in the process of learning how to develop their own code.

Combining, the second component of creation loop, is the actual creation process. Nothing comes from nothing. All concepts are combinations of existing concepts, and all artifacts that seem to be radically novel are actually combinations of features of existing artifacts. One may imagine that in ancient times, our ancestors had come across different axes before they created their own by combining features of axes they had previously encountered. To create their own axes, they had to analyze and evaluate what features to be selected or given up. If necessary, they altered those selected features so that they could be combined together. In the meantime, they might also have generated ideas or flesh insights on some unusual ways of combining the selected features. The actual combination then took place, producing novel axes that were different from the other existing axes. A combination of different features is not a mere summation, but brings forth emergent features that are not present in the individual artifacts (Ward and Kolomyts 2010). Today, we are not much different from our ancestors. Combining is the process of generating new ideas or artifacts through a series of transformations and integrations of existing concepts or artifacts and our own ideas from our background knowledge (Knobel and Lankshear 2008; Lessing 2008; Liu et al. 2017).

In fact, Bloom's taxonomy of educational objectives (Bloom 1956; Anderson and Krathwohl 2000)—*remember, understand, apply, analyze, evaluate, create*—delineates the pathway from imitating (remember, understand, and apply) to combining (analyze, evaluate, and create). In learning coding (Kong and Li 2016), for example, students study about various works of others through imitating. Afterward, they combine other people's ideas as well as their own to come up with new ideas in generating their own new codes.

Whether the constructed knowledge or artifacts are creative depends on their novelty and value, as evaluated by the relevant community, which is mainly

composed of the students themselves. Receiving feedback from fellow students is instrumental in improving the quality of student creations (knowledge or artifacts). *Staging*, the third component of creation loop, means that students are provided opportunities to reveal, describe, and demonstrate their creations to their peers, thereby receiving feedback regarding the quality of their creations. Staging results in a deeper understanding of creativity (e.g. factors such as novelty and value). Moreover, provided a stage on which to share their creations, with a progressive expansion of the audience, students gain a sense of achievement and build up self-efficacy.

So far, we have described two anchored concepts: interest and creation. What we mean by designing an *interest-driven creation activity* is essentially to decompose a learning activity into the three component activities of creation: imitating, combining, and staging. Then, when designing each of these components, we consider how to trigger, immerse, and extend the interest of students, as shown in Fig. 4.

Before we move to the third anchored concept, two remarks follow. First, depending on the domain or subject to learn, the creation activity may not need to be fully decomposed into three components; two may suffice, for example. Similarly, to nurture student interest in a creation component activity, we may not need to consider all three interest components in our design. Second, the designed creation activity intends to be the students' daily routine activity so that it will become their interest and habit.

Thus, to design a learning activity is essentially to design a creation activity, which involves designing three subactivities. Every subactivity must be able to engage students with interest; that is, it must be an interest-driven activity itself. However, to enable students to become creators, or even lifelong creators, the habits of creation must be instilled by incorporating creation activities into their daily routines.

Habit, the third anchored concept, concerns nurturing the habits of creation. The online Oxford Dictionary[6] defines a habit as "a settled or regular tendency or practice, especially one that is hard to give up" and "an automatic reaction to a specific situation." Students are shaped by their daily repeated behaviors, which are in turn governed by the habits of creation. In terms of learning, habits not only substantiate the effects of learning, but also determine whether students are creators. In short, if students engage in creation activities with interest, both incessantly and habitually, then they have become interest-driven creators. Furthermore, if they are lifelong interest-driven creators, they have a higher chance to excel in the future.

William James (1890) wrote that "any sequence of mental action which has been frequently repeated tends to perpetuate itself" (pp. 439). In addition, he indicated that people tend to do the same things in similar circumstances. To this psychological framework, Duhigg (2012) added the concept of "reward" and posited that a habit is composed of three parts: a cue, a routine, and a reward. Adapting the framework of James and Duhigg, IDC Theory calls habit formation in the context of learning the habit loop which consists of three components: *cuing*

[6] Retrieved January 1 2018, https://en.oxforddictionaries.com/definition/habit.

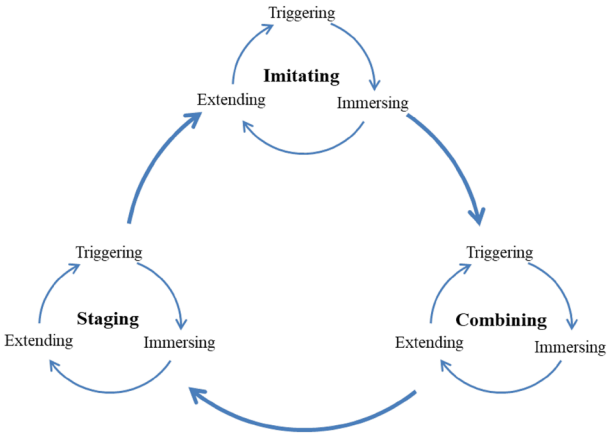

Fig. 4 Design of interest-driven creation routine activity

environment (arrangement of place, time, people, or incidents), *routine* (repetitive pattern of activities), and *harmony* (Fig. 3).

Habits are cued by context (Wood and Neal 2007). *Environmental cues* are habit triggers, or signals to the brain to prepare for an automatic mode, whereby a habit forms when a behavior is initiated in a consistent cuing environment (Lally and Gardner 2013). In other words, the arrangement of environmental cues in creation activities may facilitate students to become self-directed learners by promoting sustainable learning and instilling the habits of learning. The creation activities that students repeat often form a *routine*, just as the daily routine governed by the school timetable. *Harmony* refers to the outcomes of habits. Through routine, students engage with interest; through harmony, they gain the awareness that their energy has been well invested and that their needs are fulfilled, they enjoy a sense of satisfaction and inner serenity, and they feel at peace with their surroundings and the world.

Context plays an influential role in the design of learning activities and hence in the three concepts of IDC Theory. Context is a complex and enveloping presence (Tessmer and Richey 1997), and learning is shaped by its relationship with a given context (Snow 1994). Context drives the interest of learners in an activity. Similarly, creation becomes meaningful only when the learning activities that foster creation are contextualized to the learner. Context is crucial for the cuing of learners' habits. Without contextualization, learning activities become abstract and eventually learners may disconnect. Thus, interest-driven creation activities must address and accommodate various contexts in their design.

In sum, the three anchored concepts described above form a framework for learning design, from fostering interest to establishing habits through creation activities. To nurture interest-driven creators, interest is the first concern. Learning activities must be designed such that students are engaged, learn with interest, and are assisted. Interest must be sustained, and intrinsic motivation improved, especially in challenging situations. However, from a design standpoint, learning

activities may be composed of imitating, combining, and staging, such that students acquire existing knowledge by imitating what they observe, create new knowledge or artifacts by combining existing knowledge in the world with their own ideas or insights when connected with their background knowledge, and demonstrate and refine their constructed knowledge or artifacts by staging, thereby fulfilling their needs for self-actualization. Subsequent to decomposition, each of these three creation components may be designed in accordance with the interest loop (Fig. 4). In other words, creation activities must be sufficient to arouse curiosity, engage students in the activities, and extend the scope (both the breath and the depth) of those activities in the pursuit of personal interests. Finally, to accumulate the effects, interest-driven creation activities must be undertaken as daily routines so as to form the habits of students. Through years of practicing these daily routines, students will, hopefully, become lifelong interest-driven creators.

Student-initiated challenges: virtuous cycles from interest to passion, from creation to innovation, and from habit to goal (and back to habit)

Thus far, we have described the three anchored concepts and their loops, and briefly illustrated how students can become interest-driven creators. Most creation tasks, however, are common and achievable, but the delivered creations (ideas or artifacts) do not necessarily contribute value to the community. To be able to develop truly useful creations, students should periodically engage in challenging tasks. As time goes by, and the various loops are iterated and repeated, challenges emerge. Challenges are self-initiated or generated by a group of students themselves, though sometimes inspired by the teacher. To overcome a challenge, students may plan for an adventure, in which they try out some new ideas and take risks, possibly experiencing an unusual and exciting journey. In the process, some interests evolve into passions, some creations turn into innovation, and some habit-triggered efforts are replaced by goal-directed efforts. As Marine (2017) puts it, "Challenges are what make life interesting, and overcoming them is what makes life meaningful."[7]

In the interest loop, students may become particularly curious about issues that emerge, or they may discover problems that they are willing to expend enormous energy to solve. When enthusiasm intensifies, issues and problems become challenges; when journeys are taken to tackle such challenges, deep interests become passions.

In the creation loop, students accumulate the experience of creating, and gradually realize the importance, novelty, and value of their creations. A challenge, probably inspired by some insight, epiphany, or imagination, slowly emerges: to create something new and useful for their community. It is true that most creations, including radically novel ones, are reorganizations of elements of existing thoughts and concepts. However, identifying and combining those elements in an innovative way to produce something truly novel and valuable is not an easy task. Creation demands effort and insight, and possibly results in failure. Every attempt is

[7] *Joshua J. Marine is well known for his quotes, which are selected by many websites.*

worthwhile because the efforts prepare them for the future, and successful attempts at creation enable students to contribute to their community.

A challenge represents a goal that may contribute to the community. Achieving such goals is significant and meaningful; students may put every spare moment towards them. Thus, when seeking to complete a challenge, actions and efforts are goal-directed, instead of habitual. Goal-directed efforts are rapidly regulated by their outcomes, while habitual actions are reflexive, elicited by antecedent stimuli rather than their consequences. Nevertheless, if students engage in goal-directed creation activities on a routine basis, such efforts may become habitual. A habit may initially be triggered by a goal, but over the time that goal becomes less necessary and the habit becomes more automatic. Thus, frequently undertaking challenging creation tasks may be a signal that a student will ultimately become a successful lifelong creator.

To develop the competencies necessary to reach a goal, students need to relate what they learn with prior knowledge and past experience. They may also need the assistance of a teacher who is knowledgeable about their learning. Going further in this direction, students should know what they want to learn and attain in the more distant future and, from time to time, they should try to discover the ultimate purpose of learning on their own: what is important and valuable to them in their lives. Only by melding learning with achieving goals can students extend their interest and develop their potential leading to their future careers.

Put forward by Joseph Campbell (1949), the notion of the archetypal hero's journey that recurs in the mythologies and religions around the world perhaps can summarize the implication of challenge to students. Being a future creator, every student, like a hero or heroine, at some stage during their cycling of the interest-driver creation habit loop, feels a call for undertaking some challenge. Following their heart, students go forth of their own volition to take on the adventure—overcoming a bold, sometimes risky, challenge. Such challenges, in the path of their personal growth, become the guiding light of their endeavor, not only leveraging creativity of their creations and cultivating the well-being of their community around, but also exploring, developing, and validating their own potential and talent.

Challenges may be initiated by individual students or student groups: for example, in inquiry-based projects where students seek to discover knowledge (Urhahne et al. 2010), or "design thinking" projects where students design artifacts that match the needs of specific people (Razzouk and Shute 2012). Challenges, which creators thrive on initiating and overcoming, are an essential part of IDC Theory.

Modeled sustained silent reading: a case study

In this section, we introduce the MSSR activity, which is the major activity of the Reading for Tomorrow Project. Together with its technological supports, will serve as a case study to illustrate each anchored concept of IDC Theory. This will be addressed in the next three papers.

The conceptualization of MSSR is the distillation of several models of reading developed over the last half a century. In the early 1960s, Lyman Hunt (1967) proposed a model of reading called Uninterrupted Sustained Silent Reading (USSR), now referred to by different names and acronyms, such as Sustained Silent Reading (SSR, the most commonly used), Drop Everything And Read (DEAR), and Free Voluntary Reading (FVR). During the 1970s, SSR gained popularity in the United States, and, in the 1980s, numerous schools experienced rooms of quiet readers (Gardiner 2005).

Essentially, MSSR is simple to describe. It is the reading of different books. Except for a minimum of follow-up activities, it is self-paced. MSSR is described as follows:

Modeled	The teacher, serving as a model, reads alongside students
Sustained	The class reads for a long period of time every day at school
Silent	The classroom must be kept silent, allowing students to focus on reading
Reading	The students read books of their own choice

In addition, with MSSR, there is no book report, no answering questions, no looking up the meaning of every new word, and no copying of good sentences after reading. As an everyday activity, MSSR instills the habit of reading in students who, ultimately, become lifelong readers. Indeed, silent reading is the way that highly literate people read, and they do so obsessively (Krashen 1993). If reading is the foundation of learning, then lifelong reading is the foundation of lifelong learning.

We added "M" before SSR to reflect that teacher modeling plays a key role in SSR. As reported by McCracken and McCracken (1978), in most situations in which SSR failed, it was found that rather than reading, teachers carried out their own work or watched students read. Furthermore, nuisance students did not participate in the practice of sustained silent reading in the classroom. In one case, the McCrackens reported that a secondary school teacher told his class that he was going to read silently for 5–15 min when he entered the classroom every morning. He asked his students not to disturb him. Sometimes, after reading, he spoke to the class aloud commenting about what he had read. Some students began to bring their own reading material to the class and read silently by themselves. Soon, the whole class read every morning. Interestingly, in another case, when a teacher read silently while scratching his head, the teacher noticed that several students started to scratch their heads too. Subsequently, almost all students in the class started scratching their heads. When the teacher stopped scratching, so did the students. These two cases demonstrate that teacher modeling is a powerful force for the success of MSSR. Students effortlessly pick up the habits of silent reading from a teacher.

The McCrackens concluded that, to yield desirable outcomes, a teacher must be a serious reader and serve as a model for the students. We argue that the modeling of reading by teachers is crucial to SSR due to the nature of mankind. Humans are born to imitate—by copying models. The discovery of mirror neurons (di Pellegrino et al. 1992), a special class of brain cells, perhaps indicates that modeling is a basic and powerful learning mechanism that produces far-reaching effects on learning (Fadiga et al. 2002; Iacoboni 2008). Thus, we argue that teacher modeling is essential to the

success of SSR, and to reflect this, in disseminating the practice of silent sustained reading in Asian education systems, we prefer Modeled Sustained Silent Reading (MSSR).

Another area of application area of MSSR is language learning. Krashen (1993) provides various evidences that silent reading improves comprehension, vocabulary, grammar and writing. He argues that language is too complex to be deliberately and consciously learned through one rule (like grammar) or one item at a time (like vocabulary). To learn a new word, for example, one has to acquire an understanding of its subtle and complex properties, such as its meanings in different contexts as well as its grammatical properties. In fact, it is 10 times faster to understand the meanings of words by reading rather than through intensive vocabulary instruction (Nagy et al. 1987). McCracken and McCracken (1987, p. 10) also pointed out that silent reading can provide an extensive supply of language models. In their own words, "Students who are exposed to a multitude of good books and read a great many such books will imitate the language of these books in their speaking and writing… They must have unrestrictive language models to achieve language growth."

As a classroom activity, MSSR runs contrary to learning from the same textbook at the same pace, the mode of learning that is prevalent throughout Asia. MSSR is a good case study for IDC Theory because although it is a simple activity, it offers significant benefit to the classroom over traditional learning, and in the process, it builds interest, creation, and learning habits. When designing a MSSR activity with technological supports via IDC Theory, we consider on the whole how such an activity is to become an interest-driven learning activity. As a result of our view that learning is creating, that a learning activity is a creation activity, we decompose such an activity into three subactivities: imitating, combining, and staging. Consequently, when designing each subactivity of creation, we incorporate the three components of the interest loop: triggering, immersing, and extending. To build learning habits, the interest-driven creation subactivities are prepared as daily learning routines. In doing so, we consider the design in terms of the cuing environment (the school and even the home). Limited by the scope of this paper, the details of learning design for the anchored concepts of interest, creation, and habits will be further elaborated in three subsequent papers, respectively, appearing in a later issue in the Journal of Computers in Education.

Discussion

In the earlier sections, we delineated our motivations for developing IDC Theory and proposed its basic tenets. In this section, we lay out the plans for advancing this macro-level design theory in the future. Separate papers in this issue will delve in greater detail into the components of IDC Theory, namely, interest, creation and habits.

IDC Theory aims to provide predictive power of what works and under what circumstances. The theory is operationalized through the design principle of three components: the development of interest, learning through creating, and nurturing

habits. We review the literature that provides evidence on validation of the components of the theory and develop a research agenda for new applications of IDC Theory to study the cultivation and sustenance of interest, creation, and habits.

IDC Theory as a macro-level theory embodies values in its theoretical orientation, methodological considerations, and ground-level applications. Firstly, a core value of IDC Theory is to build upon the reality of the Asian schools, particularly towards resolving tensions between academic performance and interest in learning. In essence, the aim is to bring about changes to the current culture of learning, assessment systems, and pedagogical practices in Asian schools. Another value of IDC Theory is its consideration of both fundamental understanding and practical use. The aim is to provide fundamental understanding of the development of interest, creation, and learning habits among Asian students, but also to make it accessible through concrete cases and design principles that embody its central ideas. Finally, IDC Theory can serve as a useful methodological framework for post-facto (retrospective) analysis of the progressive development of interest, creation, and habit formation in learning. In particular, the subcomponent concepts can function as indicators of how students are (or are not) progressing through each loop and where in the loop disjunctures are occurring.

Certain challenges remain. A design theory should contain intrinsic power or principles that can easily be translated into practice. The key concern of a design theory is 'preferability', meaning "the extent to which a method is 'better' than other known methods for attaining the desired outcome" (Reigeluth and Frick 1999, p. 634). Accordingly, an immediate challenge for IDC Theory is for it to evolve as a design theory and demonstrate its effectiveness and appeal in achieving its acclaimed goals compared to its contemporary counterparts. At this stage, the design principles remain at the macro-level and are not expressed in a way that practitioners can easily understand, translate and apply. While all this does not mean that IDC Theory needs to be highly prescriptive, the collection of more concrete cases and descriptions of conditions where IDC works (or fails) will be necessary to build robust but translatable design principles.

The application of IDC Theory also faces methodological challenges. Thorough investigation of the three loops requires a longer time scale than is feasible for many Asian researchers. Short term interventions are unlikely to capture the parameters of what and how each IDC loop works. Changing the research culture and practices, hence, is another necessary condition that should accompany with the evolution of the IDC Theory.

The final challenge for IDC Theory is associated with its scope of application and disciplinary orientation. Currently, IDC Theory has primarily been applied to creation-oriented subjects and activities, e.g., science, technology, engineering and math (STEM), as well as language and art. Another crucial step is to demonstrate the efficacy, preferability and applicability of IDC Theory to other subject areas, particularly to disciplines that closely relate to socio-emotional well-being and moral development, such as philosophy, civil and character education, and physical education. Beyond the creation of concrete tangible or digital student artifacts (creation in the product-oriented aspect), a useful measure for such contexts is the creation of strategies or tools that enable learning to be accomplished or interest-

driven goals to be realized (creation in the process-oriented aspect). As IDC Theory may not be practiced in the same way for every subject matter, it is essential to refine it such that it guides the practitioner towards methods and processes that work even in novel contexts.

More discussion in the community will assist us to recognize those points critical of IDC Theory, as well as sharpen our understanding and the application of it. We hope that more discourse will center on an understanding of how to design learning that involves the loops appropriately: whether to use them as predictive, descriptive, prescriptive or proscriptive mechanisms. Moving forward, to assist in the development of a more rigorous theoretical framework, we envisage the involvement of more researchers, who will reflect upon and discuss the coherency of and contradictions in our current articulation of the theory, and provide their spin on the theoretical framing of IDC Theory. For example, research can be conducted to reveal the thoughts of scholars from different research paradigms or traditions, or otherwise approach IDC Theory differently. We seek to position the theory to benefit from an interdisciplinary lens that encompasses manifold perspectives on education, including behaviorist, cognitive, brain science, pedagogical and other perspectives.

As researchers, we are ultimately interested in the application of these loops that can lead to better future learning. IDC Theory, rather than just to being descriptive and summative, is deemed to play a key guidance role and have a transformative effect on current education practices. Thus, we call for IDC Theory for action. To this end, we can establish IDC Theory-based experimental sites, at which education practitioners and researchers will work together in school settings to address important issues faced by education systems in Asia. A wide range of theoretical and practical questions are relevant, such as:

- How to transform current pedagogical practices to be aligned with IDC theory?
- What are the contextual factors to facilitate the strengthening of interests and creations as habits?
- In the context of learning, how are different levels and stages of interest, creation and habit best characterized or measured, and what are their indicators?
- How can current practices inform the refinement of IDC Theory?
- How can IDC Theory be used to conceptualize and consolidate interest-based learning in conjunction with schools, e.g. via makerspaces, coding, co-curricular activities, or other design thinking projects?
- What are the mechanisms by which the acquisition of knowledge necessary for creation may be integrated into learning activities?
- How can teachers be trained to nurture the interests of students, provide opportunities for meaningful creation, and support the development of good habits?

Thus, this paper ends with an invitation to all scholars to provide responses to the current articulation of IDC Theory, so that as a community effort, we can move forward the tenets of the theory to serve as a guide to future learners in developing, sustaining and growing their interests, to provide opportunities for creating and solving challenging problems and tasks, and to make these repertoires habitual processes so that learners get better and better in regulating their own learning to be habitual interest-driven creators.

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