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Exploring the development of student teachers' interest in educational technology through Interest-Driven Creator theory

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Abstract

This qualitative study is one of the early attempts to provide empirical evidence to inform Interest-Driven Creator (IDC) theory through a discrete Educational Technology course. In this study involving 64 undergraduate students who majored in education, we focused on the interest loop (triggering, immersing and extending) as it acts as an impetus to nurturing habitual learners. Qualitative data were sought to answer two research questions that explored student teachers' initial interest in learning educational technology and to understand the development of their interest using IDC as the underpinning theory. The findings indicated that they initially showed little interest in the course. However, others felt good about and were drawn towards educational technology. The findings also indicated that interest development begins when situational interest is *triggered* and they become aroused by the course contents. The student teachers then willingly spend time accomplishing the given task when *immersed* in the learning process with a clear goal. They then progress to *extend* their interest, making sense of their newly acquired knowledge and connecting with other previously known knowledge to expand it further. Overall, our findings suggested that the interest loop of IDC was able to describe the development of student teachers' interest in educational technology.

Keywords: Interest-Driven Creator theory, Interest loop, Triggering, Immersing, Extending, Educational technology

Introduction

Societies are undergoing a transformation which calls for new forms of education to cultivate competencies beyond literacy and numeracy (UNESCO, 2015). Formal education needs to shift its focus from academic achievements to lifelong learning — students learn to live for greater justice, social equity and global solidarity (UNESCO, 2015). Although

government-initiated reforms have been in progress where alternative modes of assessment are being implemented in schools, students' future career choices still depend on national public examinations. Acknowledging that high-stakes examinations in many Asian schools will continue to be part of the school curriculum, Chan et al. (2018) advocated the need to develop student's interest in learning materials and the importance of nurturing creativity. At the same time, Kong and Wang (2019) advocated that the younger generation must be equipped with essential technological knowledge and skills to be successful in the real world. Therefore, educators must inspire their students to "engage in the learning of new technology, to undertake creative activities exploring technology, and to maintain the learning interest in technology" (Kong & Wang, 2019; p.1).

Chan et al. (2018) proposed the Interest-Driven Creator (IDC) theory to address the worrying trends of students' diminishing interest in learning. He and his colleagues positioned IDC as a theory of learning design that places more emphasis on the learning process. Chan et al. (2018) advocated that when IDC is adopted for learning with the appropriate design and technological support, it could be assumed that students will develop interest in learning, be engaged in the creation process and develop habits of learning through the repetition of the aforesaid process in their daily routine.

Interest and learning

Getzels (1966) defined interest as a "disposition organised through experience which impels an individual to seek out particular objects, activities, understandings, skills, or goals for attention or acquisition (p.98)". Similarly, Schunk et al. (2008) defined it as a person's wilful engagement with a specific object, activity or event. Interest is an affective characteristic that can be learnt and nurture interest in learning (Renninger & Hidi, 2019). Indeed, the introduction of programmable robots effectively nurtured school children's interest and motivation to learn about robotics (Kong & Wang, 2019). Students were given access to technological devices such as the mBot robots, computers, and tablets during the programmable robotics lessons to pique their interest in learning by creating robotics artefacts. The activities required the students to use the aforesaid gadgets to problem-solve and develop creative solutions. Their study supported the notion of programmable robotics as an effective tool to trigger students' interest in learning where active engagement in robotics activities ensues (immersing interest). This resulted in students becoming more aware of the value of programmable robotics activities (extending interest). Their findings provided empirical evidence of how IDC's interest loop influenced students' robotic creation.

Another study showed how students' interest in mathematics could be piqued in a technology-enhanced learning context. Geometer's Sketchpad (GSP) was used as a supporting tool to create, explore, and analyse a broad range of concepts in learning the

concept of Loci. This study found that lower-performing mathematics students were more interested in learning mathematics than their peers, who performed better (Wong & Wong, 2019). Wong and Wong's (2019) findings underlined the importance of triggering interest in academic choices and learning, especially among low achievers.

In a recent study, Huang et al. (2020) adopted IDC theory in learning mathematics through video creation. Students solved mathematics word problems individually and collaboratively through interest-driven creation video activities. They agreed that learning mathematics was enjoyable and engaging, especially when the video creation activity was related to their interest (Huang et al., 2020). In other words, interest in learning is nurtured when students participate in video creation activities that structure individual and group learning processes based on IDC creation loop that enables the student to be immersed in the creation process. The aforesaid context shows that interest can be ignited when students learn with technology. In addition, the literature (Huang et al., 2020; Kong & Wang, 2019; Wong & Wong, 2019) focused solely on school children. It provided evidence that interest could be triggered at the school level successfully. This present study showcases the application of the interest loop within a teacher education programme where older learners are involved as participants.

Interest-Driven Creator theory

IDC comprises three anchors — interest, creation and habits. These anchors are in the form of a loop comprising three components (Figure 1).

According to Wong et al. (2015), the interest loop promotes learning by *triggering* students' interest in learning through their curiosity about new knowledge and experience. Students will then *immerse* themselves in the learning process and advance into the flow state. As students are fully absorbed in the learning process, they start to make sense of what they are learning — experiencing meaningful learning. They then *extend* their learning interest when they want to learn more (Wong et al., 2020).

Next comes the creation loop that emphasises generating ideas and constructing artefacts to achieve student learning outcomes (Chan et al., 2015). It starts with the formation of students' background knowledge by imitating a learning model. Students then progress to

Fig. 1 Three anchored concepts of IDC

combine the acquired background knowledge with existing knowledge and artefacts to produce fresh ideas or knowledge. Students then move on to staging, where they share or showcase their creations to receive feedback from their peers or instructors.

Lastly, the habit loop starts with a *cueing environment* (arrangement of place, time, people, or incidents). A cueing environment can function as a habit trigger for a learning behaviour (Chen et al., 2020). When this learning behaviour is repeated incessantly over time, it then progresses into a routine until the student achieves a sense of harmony. This is where the student gains satisfaction, inner serenity, and a feeling of accomplishment.

In this study, we focused on the interest loop as it acts as an impetus to nurturing habitual learners. The subject of study is students enrolled in a teaching degree course at Universiti Putra Malaysia. Hence, it makes sense to trigger these future teachers' interest in learning, which can lead them to create new knowledge and ultimately become habitual interest-driven creator teachers in schools.

Objectives of the study

This study is based on the assumption that a discrete educational technology course could develop student teachers' interest in educational technology. It sought answers to the following research questions:

1. What is the extent of student teachers' interest in educational technology at the beginning of the discrete educational technology course?
2. How do student teachers' interest in educational technology develop throughout the discrete educational technology course?

Course description

All education major students at the Faculty of Educational Studies, Universiti Putra Malaysia must enrol in Educational Technology (FCE3401). Education major students usually apply for a teaching post in secondary schools upon graduation.

FCE3401 equipped student teachers with fundamental knowledge and educational technology skills in one semester (14 weeks). This course exposed them to a 2-hour lecture and a 3-hour laboratory session per week. During lectures, they learnt about the concepts, theories, principles, development and practices in educational technology. They also learnt to evaluate instructional media. They acquired knowledge and skills to create instructional media during their laboratory sessions.

Instructional context in relation to IDC

The course activities were designed by modelling them after IDC theory. The course instructor had created a WhatsApp (WA) group for all student teachers who signed up for FCE3401 before the start of the first lecture. In the first communication with the student

teachers a day before the first face-to-face lecture, the course instructor provided a link to a website about educational technology. They were required to read the website. They were also asked to visit two YouTube video links about educational technology. The website and videos provided them with new bite-size information to arouse their curiosity about a new subject they had no prior knowledge of — this is where the instructor ***triggered*** the student teachers' interest in the new subject. In the first face-to-face lecture, the course instructor discussed the definition of educational technology and introduced them to blogging. They were encouraged to blog about their learning journey in FCE3401 throughout the 14 weeks on a weekly basis. As the semester progressed, more YouTube videos related to subsequent educational technology topics were shared through WA to continue *triggering* student teachers' interest.

Once the student teachers' interest in educational technology were piqued, the course instructor engaged them further in learning activities that would *immerse* them in the learning process where they would go into a flow state. To illustrate this point, one such class activity is described here. This activity entailed student teachers learning about *Dale's Cone of Experience topic.* From this activity, they had to make sense of what it is like to learn through abstract experience (texts). At the start of the class activity, the course instructor asked them to draw an animal (narwhal) that they had never seen before based on a text description. They were not allowed to access the Internet to get a glimpse of the animal. As the activity progressed, more textual information was provided to describe the unknown animal to the student teachers. Once they had finished drawing the animal, the course instructor showed them a picture and a National Geographic video (Figure 2a). The student teachers were asked to compare their drawings with the actual graphical representation of the animal (Figure 2b). At this stage, they were exposed to a more concrete experience where the course instructor used learning materials (photos and video). The student teachers were then asked to reflect on what could be done to increase or concretise one's understanding of a narwhal. This is where they ***extend*** their learning interest by making sense of Dale's Cone of Experience and applying the theory in a more concrete and realistic situation. This activity aimed to enable them to understand the connection between abstract and concrete ideas underpinning the principles of teaching and learning. The learning experience gained from the narwhal's activity would be useful to the student teachers to make appropriate media selections for optimum knowledge transfer in their future classroom lessons.

Fig. 2a Actual photo of a narwhal

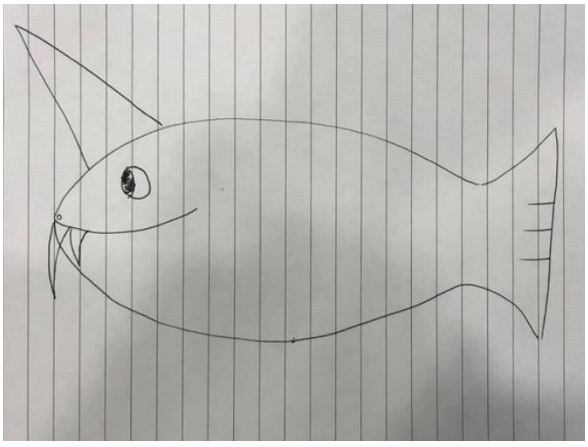


Fig. 2b Student's drawing of a narwhal

Methodology

Participants

This study was conducted at a public research university in Malaysia. It involved 64 undergraduate students who majored in education at the Faculty of Educational Studies, Universiti Putra Malaysia. Participants were enrolled in the fifth semester and reported having no prior knowledge about educational technology. All student teachers were in the fifth semester of their studies and their ages ranged between 22 and 23 years old (Table 1).

Table 1 Demographic information of participants

Characteristics	N	%
Gender		
Female (F)	39	61
Male (M)	25	39
Programme of study		
Physical Education (PE)	29	45
Agricultural Science (AS)	35	55
Semester		
Five (S5)	64	100
Age		
22-23	64	100

Research design and data collection

Qualitative data was sought to answer the first research question (RQ1) that explored student teachers' interest profiles towards learning educational technology at the beginning of the discrete course. Qualitative data were also sought to explore the development of student teachers' interest using IDC as the underpinning theory for the second research question (RQ2). The qualitative approach provides a more meaningful understanding of how student teachers' interest developed in parallel to IDC theory. The analysis of the blog text entries provided the primary data to answer RQ1. One learning artefact depicting the student teachers' feelings about educational technology was also analysed to answer RQ1. In addition to analysing the blog text entries for RQ2, notes obtained from in-class observations by the instructor and one written task were analysed to answer RQ2.

To summarise, this data collection and analysis process involved non-numerical information collected from blog text entries, in-class observations, and learning artefacts. Participants' consent was obtained before data collection.

Blog text entries

The student teachers documented their expressions of their learning experience on a weekly basis throughout the 14-week semester. These expressions were conveyed through various materials such as text, videos and photographs. Only text and photographic materials were utilised for this study. In other words, these personal expressions encapsulated their feelings and thoughts about learning educational technology as student teachers.

Observations

Since the course instructor was also the researcher (first author) in this study, participant observation was chosen as the most appropriate role for her during data collection. When taking on the role of participant-as-observer, the course instructor participated fully in the learning activities. Fraenkel et al. (2019) emphasised the importance of doing an overt

observation in a natural setting to elicit normal behaviour from the research participants. The course instructor observed the student teachers' in the classroom (natural setting) by making notes discreetly during the aforementioned learning activity (Dale's Cone of Experience), which lasted 45 minutes. Participant observation was conducted to generate data for the immersing stage.

Learning artefacts

The student teachers created artefacts such as drawings and completed one written task about the learning activities. These artefacts were analysed to learn more or better understand their interest development in educational technology.

Data analysis

For the qualitative data, the first author reviewed all text entries rigorously in the student teachers' weekly blog, highlighting all texts that appeared to parallel the interest loop in the IDC theory. Employing qualitative content analysis, the first author read and analysed the texts to identify initial codes. All highlighted texts were coded using the predetermined categories wherever possible. All the categories were then conflated into the relevant themes. To ensure the trustworthiness of the findings, the second author was involved in further discussion with the first author until an agreement was reached between the two concerning the coding of the text entries.

Results and findings

Table 2 provides a few key examples of codes with descriptions that correspond with the condensations of texts.

Table 2 Examples of condensations, codes and descriptions

Meaning units (condensations)	Codes	Descriptions
Theme: Poor initial interest		
Feeling sleepy Don't know much about technology Feel so blur about educational technology on first day	Poor focus Poor understanding Unsure	Student teachers had a poor understanding of educational technology. They could not focus well during the class in the first week. They were unsure about educational technology.
Theme: Triggering		
Novelty		
Learn something new about technology Felt happy to know new things Have been waiting to learn about technology Begin to enjoy after learning more Like learning in PFC due to comfort and sophisticated ICT gadgets	New knowledge Happiness (new knowledge) Excitement (new knowledge) Enjoyable (new knowledge) High tech devices	Student teachers acquired new knowledge and experienced positive emotions such as being happy, excited and enjoying. Students also exhibited positive emotions because of sophisticated devices in PFC.
Curiosity		
Enthusiastic and eager to learn more Educational technology benefits me Excited to learn about educational technology Know the importance of educational technology Gained new experience with WordPress	Enthusiastic (More knowledge) Eagerness (More knowledge) Benefits Excited (More knowledge) Importance Open	Student teachers desired to gain more knowledge and expressed positive emotions such as enthusiasm, eagerness and excitement. They understood the benefits and importance. They were open to unfamiliar experiences.
Theme: Immersing		
Flow		
Harder than imagine Strive to draw without seeing Laughed a lot but achieved learning outcome	Challenging Try hard Pleased	Student teachers found the activity challenging and tried hard to complete it. They felt pleased with themselves for completing it.
Attention		
Drawing look like actual creature Activity was fun, hilarious Activity was absorbing Understand better about Dale's Cone of Experience One particular activity attracted attention Could remember better because of teaching strategy	Goal Good time Absorbing Enhance understanding Attention Retention	Student teachers paid attention to achieve a goal. The activity was absorbing and enhanced their understanding of new concepts. They could retain what they had learnt and had a good time.

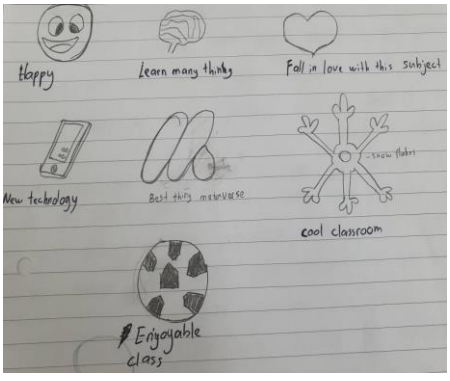
Theme: Extending		
Meaningfulness		
Photo gives better representation but video is even better	Sense	Student teachers made sense of what they learnt and understood learning is more effective with more concrete information. They found the activities, to be helpful and saw value in them.
Concrete experience is more effective for learning	Effective	
Interesting activities were helpful to understand that effective learning can occur because of graphics	Helpful	
Could understand better, opened up mind how to teach future students	Value	
Relevancy		
Play games, visit library and visit zoo for better student learning experience	Apply knowledge	Student teachers applied their newly acquired knowledge in the context of being a school teacher to achieve better learning experience for their future students.
To improve students' learning experience, include more media in delivery to give clear understanding to students	Better learning experience	
Theme: Confusion and wonder		
Instructor conducted activity, I was very confused at first	Confusion	Student teachers were initially confused and wondered about the learning activity.
Feeling confused at first	Confusion	
Kept asking myself what instructor will teach	Wonder	

Poor initial interest

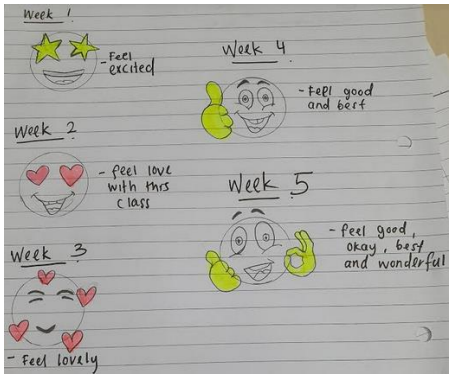
The student teachers' initial interest in the course was captured qualitatively when they were asked to write their first thoughts about the course in a blog. The blog entries written during the first week of the semester indicated that they had a poor interest in the course. The student teachers reported that they did not know about educational technology before attending the first class of FCE3401. They had no idea about the subject matter and could not relate technology to other areas. Their lack of knowledge made them feel uninterested in the first lesson, as seen in the following expressions. They felt a little lost about educational technology and found it hard to focus on the first day of lectures at such an early time (8.00 am). The lack of interest in the subject is captured in the following two expressions:

> *I could not focus in the first day of class…I think this was because the subject was new and I needed more time to understand about it.* [Student teacher #3, male, PE]
>
> *I wasn't in the mood to study and felt blur…I am feeling sleepy in the class, it's just too early (8.00am). I hope I will enjoy the next class. Good luck to myself.* [Student teacher #15, male, PE]

On the contrary, the following two artefacts showed that others had some interest at the start of the course. The drawings depicted a happy atmosphere in the classroom despite having a knowledge deficit about educational technology (Figures 3a and 3b).



[Student teacher #1, male, PE]



[Student teacher #2, female, PE]

Fig. 3a and 3b Student teachers' positive expressions from weeks 1 to 5

Triggering

Two characteristics emerged under the triggering loop — novelty and curiosity. Positive emotions such as curiosity can lead learners to have more interest in learning when they embrace novelty (Kashdan & Silvia, 2009).

Novelty

The student teachers commented that despite not knowing much about technology, they enjoyed the first day of the lecture because of the novelty of learning new knowledge. The following two expressions captured the novelty effect:

> *I had no idea about technology in the first day of lecture but the class was very enjoyable. I learnt many new things such as the history of technology, definition of technology, difference between technology and educational technology. I was also exposed to a blogging application (WordPress). My friends and I will be able to reflect what we have learnt through blogging.* [Student teacher #7, female, PE]

> *During the course registration week, this is the course that I have been waiting for. I was attracted to it when I saw the term "Technology" and I am pretty sure I would be acquiring new and interesting knowledge. What I gathered in the first lecture met my expectations. I will be learning many new apps and partake in activities.* [Student teacher #14, male, PE]

Apart from acquiring new knowledge, the novelty of being in a high-tech classroom — the Putra Future Classroom (PFC) excited them to attend lectures. The PFC is a new teaching laboratory equipped with state-of-the-art technologies where student teachers learn in a conducive environment. It is the only laboratory equipped with interactive whiteboards and video conference technologies. It also has high Internet bandwidth for seamless learning. The physical layout is unlike a traditional laboratory — it is furnished with movable tables and chairs, sofas and bean bags. The student teachers also have the option to sit on the floor as it is fully carpeted. Only those enrolled in technology-based courses would have the opportunity to use the PFC. Given that it was the first time the student teachers attended lessons in the PFC, there was some excitement among them. The following two excerpts showed the novelty of learning in the PFC:

> *I really like learning in the PFC because it is so comfortable and equipped with sophisticated ICT gadgets. It makes me happy.* [Student teacher #11, male, PE]

> *My initial feeling of being in this class is joy because we get to experience using sophisticated ICT equipment as a teaching tool. We will not feel bored in class. In addition, we are in the PFC, it is beautiful.* [Student teacher #2, female, PE]

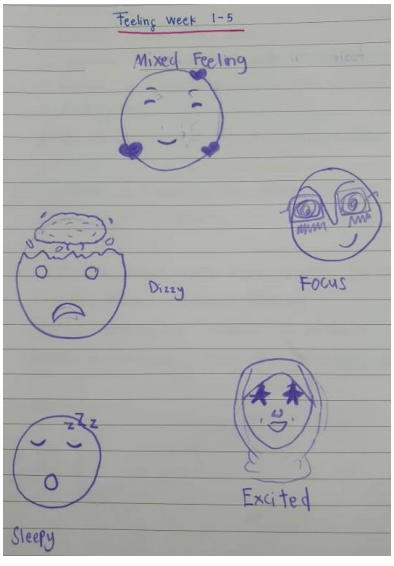
They mentioned that the course instructor took the initiative to share important information about educational technology before the start of the first lecture by using a social media tool — WhatsApp. The following excerpt encapsulated the feeling of novelty as WhatsApp is usually used for communication and rarely for learning:

> *Before the class started, the course instructor used WhatsApp, to facilitate discussions among us. Not only that, through the use of WhatsApp we were able to learn about educational technology through some video links before starting our first class…I enjoyed it because I could experience first-hand the use of technology as a learning tool.* [Student teacher #2, female, PE]

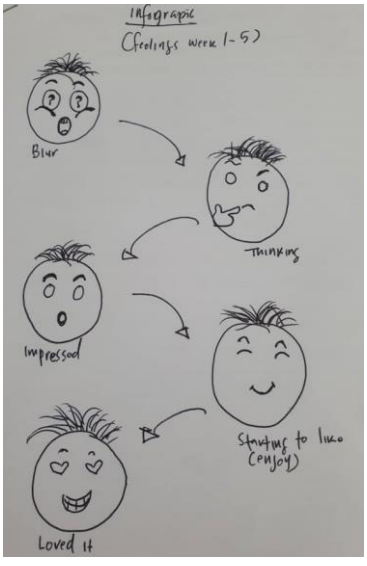
As the course progressed, those who felt uninterested began to enjoy the subject. They began to be convinced about the benefits of learning new technology and their interest was piqued as seen from the following comments:

> *I didn't know about this subject before enrolling in this course. I wasn't interested because I am not good with IT. But after learning more about it, I begin to enjoy and I feel excited each time the class starts.* [Student teacher #5, female, PE]

The following artefacts show some evidence of two student teachers who initially had a negative experience with the course but it later turned into a more positive and pleasant experience for them (Figures 4a and 4b).



[Student teacher #5, female, PE]



[Student teacher #7, female, PE]

Fig. 4a and 4b Student teachers' expression from week 1 to 5 (negative to positive)

Curiosity

Despite having inferior knowledge about educational technology, most student teachers felt excited and curious about learning a new subject because they understood the importance of educational technology in their lives as student teachers and future teachers. The following two expressions captured their excitement and curiosity about the educational technology course and how these affective emotions led them to want to learn more about this new area:

> *I felt very enthusiastic and eager to know more about educational technology when I was exposed to a blogging platform known as WordPress. I feel so excited to learn about educational technology and I am curious to learn more and how it benefits me in the next lessons. I felt satisfied that I am learning useful things.* [Student teacher #1, male, PE]
>
> *We learn about the definition of educational technology and its importance. I am very excited to learn about this topic as I know how important educational technology is to students now and in the future.* [Student teacher #4, male, PE]

The student teachers described being engaged in a new experience. In other words, they were open to unfamiliar experience. This experience is captured in the following two excerpts:

> *In the first lesson, I had a new experience, I was exposed to WordPress. I didn't know about it but I learnt that using WordPress is helpful to improve my writing skills. In the blog, I could tell a story expressing my feelings about educational technology.* [Student teacher #1, male, PE]
>
> *I learnt about a new experience in preparing a lesson plan. I could use this experience in the future or when I become a teacher later. This experience is really useful for me.* [Student teacher #60, female, PE]

Immersing

Flow and attention emerged from the immersing loop. Students enter the flow state where they are immersed in the learning activity (Chan et. al., 2018). Enjoyment can be derived from an intense learning activity where the students' attention is fully absorbed (Csikszentmihalyi, 1990).

Flow

At this stage, the course instructor observed that the student teachers were deeply engaged in the learning activity — a topic related to Dale's Cone of Experience. The student

teachers were focused on drawing the animal — narwhal, and no one was seen talking to one another. Some student teachers even drew more than one variation of the animal they thought to be a narwhal. Csikszentmihalyi (1990) called this the flow state, where learners experience intense emotions and are wholly engaged with the activity.

The student teachers commented that they had to think hard as they wanted to draw an accurate picture of the animal given the limited text explanation provided. This flow experience came when the learning activity was challenging and stretched the students' capacity (Biasutti, 2011). They were also pleased that they achieved the learning outcome for the activity. It was also apparent that they enjoyed the learning activity, although it was difficult. The following two excerpts captured the essence of their positive expressions despite the difficulty:

> *Today's learning activity is based on our drawing skills and imagination. It was not easy to draw the creature, and it was tougher than I thought. I tried my best to draw it without being able to see what a narwhal looks like. I tried to imagine that it was an animal in the sea. It is truly funny when we discovered that our drawings did not reflect the actual creature. Everyone is laughing because of the hilarious drawing. Although we laughed so much, we achieved the learning outcome for that day, that is abstract information can be changed into something more concrete.* [Student #6, male, PE]

> *When I saw my friends' narwhal drawings, they were humorous until I laughed. I found that every individual's understanding is different based on the given text. The stage that I experienced was abstractness (text). So what I was experiencing at this stage was difficult for me to imagine what an actual narwhal looks like.* [Student #51, female, AS]

Attention

The student teachers devoted much attention to completing the narwhal drawing with the limited textual information presented to them. Their attention was wholly absorbed as they tried to concretise their understanding of a narwhal through thinking and imagination. Their full attention is on the activity, as drawing an unknown animal based on abstract information is challenging. Their attention was sustained as the instructor showed them the actual photo and video of narwhals right after they had finished drawing. Such immediate feedback enabled students to assess their performance and progress, thus narrowing their attention (O'Keefe et al., 2017). The following excerpts showed the student teachers focusing their attention on the task at hand and having a good time:

> *Technology involves art. This week, we were required to draw a narwhal. We were given some clues and we had to draw based on*

> *the clues. Through this activity, we had to think and imagine. Through my imagination, I drew a narwhal that was quite close to the actual animal.* [Student teacher #14, male, PE]
>
> *I can conclude that the activity was fun, hilarious, absorbing and at the same time I could understand more clearly the message put across and especially about every level of Dale's Cone of Experience…It is a good and effective activity.* [Student teacher #58, female, AS]

At the same time, the student teachers stated that they could understand the important concepts of the topic taught and felt that the learning activity was effective in making them remember the contents better. There was satisfaction among the student teachers because they acquired not only new knowledge but also retained such knowledge. The following two expressions reflected the student teachers' positive learning experience:

> *What I learnt from week 4 activity: 1). To translate words into drawing, requires more text description in stages 2). We need more information to turn something from abstract into something more concrete 3). Basic information about certain things helps in the learning process.* [Student teacher #10, male, PE]
>
> *I learnt many new things in today's lesson. I cannot remember all but there was this activity that really attracted my attention…it was a game where I had to draw based on the text description about an animal that I do not have a clue about. The drawings by my friends were really funny, ha ha. What I noticed, this way of teaching is good because it helps me to remember important things.* [Student teacher #13, male, PE]

Extending

The extending loop is characterised by meaningfulness and relevancy. Student teachers tend to extend their interest when they can make sense of what they have learnt and its relevance to their lives.

Meaningfulness

Student teachers sought to make sense of what they encountered in the written task by incorporating it with what they had already learnt earlier about the concepts of abstractness and concreteness. This is reflected in the following excerpts:

> *…when we go through abstract experience, it's difficult to imagine what a narwhal looks like. When we see a photo of a narwhal, it gives a better representation of a narwhal…through video, it can increase the concrete experience. This means concrete experience is more effective for learning.* [Student teacher #39, male, AS]

> *The model [Dale's Cone of Learning] is about the quality of learning and the senses involved in learning. The more senses are involved during learning, the better learning becomes. The use of video in teaching-learning is very helpful to students because the information is more realistic. Video presentation incorporates image and audio which reflects the real world. Video presentation stimulates the hearing and sight senses which enhances learning.* [Student #44, female, AS]

> *…With text, the degree of abstractness is high when compared to the use of photo, video and study trip. Students' understanding of a topic will be higher when presented with lower abstract information.* [Student#57, female, AS]

Figure 5 shows four student teachers' responses captured through their written tasks. These responses are aligned with the aforesaid reflections about student teachers being able to comprehend how learning could be made more effective through sensory based learning — learning by doing.

The student teachers realised that their learning can be more effective when the degree of their concrete experience is increased. They discovered that their understanding of the lesson could help them become better learners. They perceived the experience obtained through the learning tasks as useful. The task designed by the instructor was essential to them in some way in attaining the learning outcome, as seen in the following two excerpts:

> *At the end of today's class, I was able to understand Dale's Cone of Experience better. I can conclude I experienced the concept of Dale's Cone of Experience myself in the class through the narwhal's activities. It was not only enjoyable but effective for learning.* [Student teacher #49, female, AS]

> *…the activities were very interesting and helped me understand that effective learning can occur when there is more information with graphics. At first, I didn't know what a narwhal looks like but after I saw the video, I knew about its characteristics and habitat. Because I experienced it myself, I understood more about Dale's Cone of Experience rather than just reading about it. It is proven that learning will be effective if one experiences it.* [Student teacher #50, female, AS]

The student teachers perceived the learning experience as necessary to themselves as learners and future school teachers. They were able to see the value of what they learnt in their present context and also in the future. One student teacher described how she saw the value of her learning experience in class:

> *…the course instructor explained Dale's Cone of Experience, I understood better, this indirectly opened up my mind on how to teach my students in the future. I enjoyed today's learning activities, they were interesting and unique. Apart from opening*

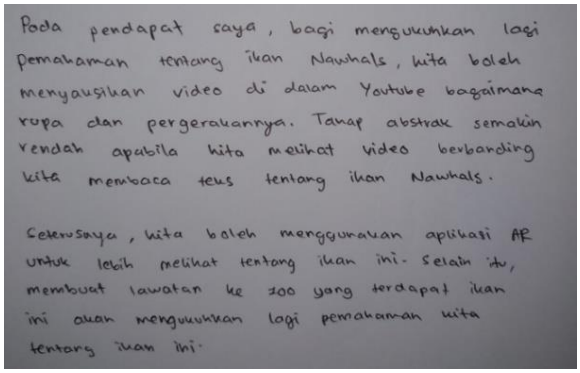
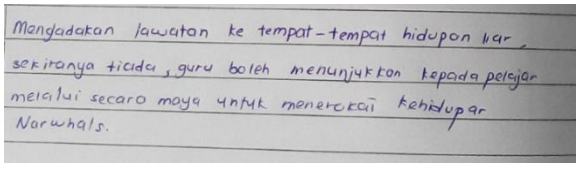
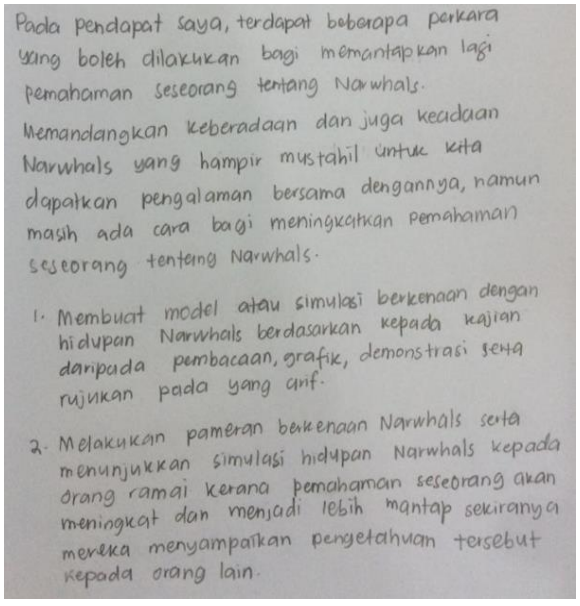
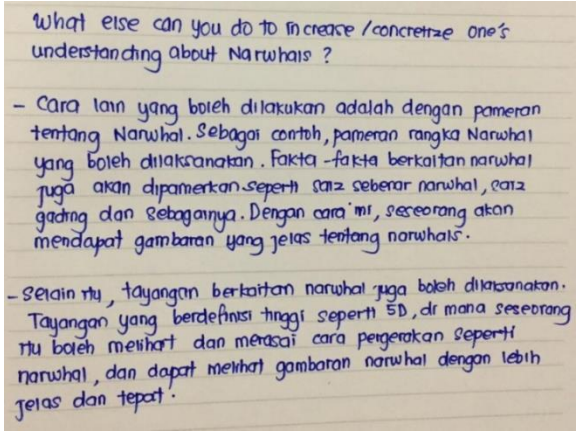
Learning artefact #3: Written task	Translation
	*In my opinion, to strengthen one's understanding of narwhals, we can watch videos on YouTube to know how it looks and moves. The degree of abstractness reduces when we watch videos compared to reading text about narwhals.* *Then, we can use AR apps to see more about the fish. Other than that, we can visit a zoo which has this fish to strengthen our understanding.* [Student teacher #39, male, AS]
	*Visit the wildlife areas, if that is not available, the teacher can show the students virtually how narwhals live.* [Student teacher #44, female, AS]
	*In my opinion, there are several things that can be done to enforce students' understanding of narwhals. Given that it is impossible to have experience together with narwhals, there are ways to enhance one's understanding about Narwhals:* 1. *Make a model or simulation of narwhal based on readings, graphic, demonstration as well as expert reference.* 2. *Organise an exhibition on narwhals and show the simulation on narwhals to the public because one's understanding will increase and become more concrete if one conveys the knowledge to others.* [Student teacher #54, female, AS]
	*Other ways that can be done are by having an exhibition on narwhal. For example, exhibiting a narwhal's skeleton. Facts about narwhal such as its actual size, tusk size etc., can be exhibited. Through this way, one will get a clear picture of narwhals.* *Other than that, a show on narwhals can be displayed. The show in 5D where a person can see and feel the movement of narwhals, and also see narwhals more clearly and accurately.* [Student teacher #57, female, AS]

Fig. 5 Student teachers' written artefacts

> *my mind, the activities taught me to be a more creative and innovative person. I hope with this experience gained, I can implement it when I am in school.* [Student teacher #53, female, AS]

Relevancy

At this stage, the student teachers discerned Dale's Cone of Experience and applied their newly acquired knowledge in an authentic learning situation. They associated what they had learnt within the context of being a school teacher. It is clear that they had an idea of how they would concretise their students' understanding of narwhal, as shown in the following two reflections from their blogs:

> *…today, I was given a question to reflect on how I concretise understanding of narwhals…I would be playing games, bringing students to the library and visiting a zoo for a better learning experience for all students.* [Student teacher #20, male, PE]
>
> *I can conclude that it is important to include graphics and videos in our explanation to enhance students' understanding because the text is very abstract…text only information can cause different understanding and interpretation. As a result of relying on only text, there will be many variations of what a real narwhal looks like.* [Student teacher #31, female, AS]
>
> *Overall, based on Dale's Cone of Experience, to improve students' concrete learning experience, teachers should increase elements such text, graphics, video with audio in delivering the contents. By doing so, it would give a clear understanding to students.* [Student teacher #38, male, AS]

They could apply their knowledge, as seen from the aforesaid reflections on how they would improve the student learning experience.

Confusion and wonder

One additional theme that did not match any IDC interest loops emerged in this study. This theme showed elements of confusion and wonder. Although the student teachers were confused at the early stage of the learning activity, they understood the concept of abstractness and concreteness. They described being confused but could still draw the creature to completion. In other words, they were uncertain about what to do, but the activity was interesting enough to capture their attention. The following three excerpts show their confusion:

> *The class today was quite interesting because we had an interesting activity to draw. No, it was not an ordinary drawing class but we had to draw based on the textual description provided*

> *by our course instructor. It was a narwhal, an animal that looks like a dolphin but with a tusk on its head! I was very confused at first and I couldn't understand the descriptions provided. However, I can say that I enjoyed the activity a lot.* [Student teacher #17, Female, PE]
>
> *When my instructor conducted the activity, I was very confused at first. However, it was very interesting and the activity helped me to understand the learning session, and how understanding occurs more effectively with the aid of description and photos. At first, I had no idea what narwhals look like because of the lack of information. But after the instructor gave more information and a video link, I knew about the narwhal's characteristics and habitat. Because I experience it myself, I understand better than just reading about it.* [Student teacher #50, female, AS]
>
> *I was feeling very confused at first and asked myself what the instructor was going to teach. Initially, I was not confident with what I drew. After the instructor explained, I finally understood.* [Student teacher #53, female, AS]

Discussion

This study aims to explore student teachers' initial interest in educational technology and to understand how their interest develop. The findings indicated that they initially showed little interest in the course. Other student teachers felt good about and are drawn towards educational technology. Exposing them to several websites and YouTube through a social media platform helped introduce fundamental concepts of educational technology before the start of the actual lessons. This activity that foregrounded student teachers' knowledge deficit led them to be curious. It is anticipated that curious learners will seek new knowledge on their own volition. The findings also suggested that interest development begins when situational interest is *triggered* when student teachers become aroused about the course contents. The emergence of two characteristics — novelty and curiosity lend credence to Kashdan and Silvia (2009) assertion that curious learners who are willing to embrace novelty tend to have more interest in learning. These findings support the first component of the interest loop in IDC theory — triggering. Wong et al. (2020) assert that triggering involves facilitating an activity that can evoke a sense of initial interest in an object. This is true when there is a shift from being clueless about educational technology to being more eager with excitement in wanting to learn more, given that the learning activity was designed to pique student teachers' interest. This was made possible when the course instructor shared information about the topic to be taught through the social media app a day before the first lesson. The student teachers could easily access the information given the affordances of their mobile phones. It makes sense that triggering students' interest would serve as a function to motivate exploratory behaviour and knowledge-seeking (Tin, 2016). It would also be apt to suggest that arousing curiosity in students

before or during the lesson is crucial in triggering situational interest especially when it is incorporated into the learning activity as a general design strategy (Wong et al., 2020). Echoing Berlyne's views on curiosity (1949), Silvia (2006) proposes that learners explore and seek information when curious about an object. However, curiosity diminishes over time when the knowledge deficit gap narrows.

Wong et al. (2020) stressed that to maintain the initial interest in an object beyond "triggering", it is important to immerse students in the learning activity. The student teachers' experiences during the Dale's Cone of Experience activity appear to be aligned with the second component of the interest loop of IDC theory — immersing. At this stage, the flow and attention characteristics emerged. Chan et al. (2018) and Wong et al. (2020) contend that when students reach the immersing stage, they experience flow as espoused by Csikszentmihalyi (1990) and Csikszentmihalyi and Rathunde (1993). According to Wong et al. (2020, p.6), flow refers to an "experience of intense emotional involvement, being completely engaged in the activity for its own sake". The learning activity appeared to have not only captured the student teachers' attention to learn about the abstract and concrete concepts but had them engaged in the activity. In other words, when student teachers are immersed in the learning process with a clear goal, they willingly spend time to accomplish the given task. It is a moment when student teachers are intrinsically motivated to complete their tasks where time is immaterial. The use of the national geographic video almost at the end of the lesson made it possible to reinforce the student teachers' understanding of an abstract concept. Understandably, the knowledge gap is narrowed through the concretisation of the concepts in the lesson.

According to IDC theory, after students immerse themselves in the learning activities, they progress to make sense of what they encounter (Chan et al., 2018). At the stage when the student teachers start to discern Dale's Cone of Experience, their experiences support the final loop of interest in IDC theory — extending the learners' interest where learning is meaningful to them. Two characteristics emerged — meaningfulness and relevancy.

Meaningful learning is characterised by learners relating and integrating new knowledge with their existing knowledge (Wong et al., 2020). This is described as assimilation (Ausubel, 1968). At this stage, the student teachers make sense of their newly acquired knowledge and make connections with other previously known knowledge to expand it further. Equally important is another characteristic of meaningful learning which entails authenticity — learners are convinced of the relevancy of what they encounter in class in their own lives as undergraduate students and in their future careers. This means interest can increase when students' engagement in the classroom is personally relevant to them (O'Keefe et al., 2017). In other words, it is possible to have a more profound interest when the student teachers make sense of what they have learnt and its relevance to their lives.

The additional theme of confusion and wonder among the student teachers provided evidence that they managed to apply knowledge to new situations. According to Genin (2021), emotions such as confusion can create mental space for student teachers to respond to new situations, leading them to exercise critical thinking. D'Mello et al. (2012) stressed that induced confusion that is properly regulated can be beneficial because it can cause students to process information more deeply.

Conclusion

Given that interest is pertinent in learning, educators must design their lessons to develop interest — particularly in subjects that students have no prior knowledge of or find uninteresting. This study presented the design tenets of cultivating interest among student teachers through the interest loop — triggering, immersing and extending. It provided concrete evidence that these components played a crucial role in learning. In addition, it provided evidence that the application of IDC theory in the design of learning activities has a role in stimulating interest among older learners in the context of teacher education.

Indeed, the interest loop of IDC was able to describe the development of student teachers' interest in educational technology and allowed the interest process to be viewed across three different points of time throughout the semester.

This study is one of the early attempts to provide empirical evidence to inform IDC theory from a teacher education perspective. The findings will spur others to empirically investigate interest from the lens of IDC to sharpen our understanding of how best to promote it through instructional interventions when using technology. The additional theme (confusion and wonder) that emerged in this study provides impetus to further this unexplored phenomenon not found in IDC.

Implications of the study and recommendation for future studies

The narratives captured in this study show the relevance and importance of interest in learning. These narratives validate the IDC theory, albeit on a small scale — interest can be learnt through carefully designed learning activities infused with appropriate technologies. It must be stressed that cultivating interest should not be an afterthought in any learning situation (Harackiewicz et al., 2016) and the onus of making lessons interesting lies in the hands of the instructors. Suffice to say, nurturing interest is pertinent for more favourable student learning outcomes in the 21st century learning environment. The elements of confusion and wonder that arose in this study were unintentional in the learning activity design. The narratives show to some extent that it may be worth harnessing the impact of confusion and wonder as well-regulated confusion in classroom activities can hold student teachers' attention and may very likely support deeper learning. However, it is advisable to induce confusion in low-stakes activities.

To make this study more impactful, it is recommended that future studies include more participants from various education programmes and that the coding derived from the students' blog be analysed quantitatively in percentages to capture their interest indicators throughout the 14 weeks of study. The pattern emerging from the interest indicators can give a bigger picture of how IDC theory impacts student teachers' interest in educational technology.

Given that the study participants are student teachers, there is a strong likelihood that their favourable experiences with IDC-related class activities would spur them to apply IDC tenets in their instructional design when transitioning to school teachers. Therefore, it is worth promoting IDC-based education through professional teacher training so that student teachers can internalise IDC theory. They would then design IDC-driven class activities willingly and with ease to achieve better learning outcomes for their students.

Abbreviations
IDC theory: Interest-Driven Creator theory; GSP: Geometer's Sketchpad; WA: WhatsApp; PFC: Putra Future Classroom.

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Authors' contributions
Su Luan Wong was the main author of the paper who conducted the data collection and wrote the majority part of the paper. Mas Nida Md. Khambari and Lung Hsiang Wong offered crucial ideas in conceptualising the research. Sai Hong Tang assisted with the revisions on the manuscript based on the reviewers' comments.

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