A school-based study on situational interest of investigative study in senior physics

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Abstract

This paper reports the findings from the interview data of a research aiming at studying how to trigger students' situational interest in physics and its implications on learning and teaching in the New Senior Secondary (NSS) physics curriculum. 49 students from a boys' school were invited to write one to three learning experiences in physics that they found to be interesting. Five of them with different levels of individual interest were then selected for interview to elaborate on what they had written. The results showed that investigative study (IS) was the most popular means to induce situational interests, in accordance with IS's contextual nature.

Keywords: Situational interest, investigative study, authentic task, contextual pedagogy

Introduction

Physics is one of the elective subjects under the new senior secondary (NSS) curriculum. It includes content-based topics and IS. IS aims on providing "*students with an opportunity to design and conduct an investigation with a view to solving an authentic problem*", and "*a portion of the curriculum time is set aside for this purpose. Students are expected to make use of their knowledge and understanding of physics, together with generic skills in a group-based investigative study*" (CDC & HKEAA, 2007, p.86). IS can therefore be perceived as a part of the curriculum with a purpose of providing students with experiences in solving authentic problems in order to raise their interest and sustain their motivation.

In 2013, a curriculum review on physics was conducted, in which some contents were trimmed (CDC & HKEAA, 2015). IS remains to be an optional component for schools in response to most physics teachers' concerns, who request higher flexibility when delivering the content while less emphasis on developing scientific process skills and interest through investigation. Does it mean IS's role in raising students' interest is less important? How effective is it in sustaining students' motivation to study physics? Is it worth to retain IS in the curriculum and conduct it within the suggested teaching hours? The author, who is a former physics teacher with experience in teaching NSS physics, conducted this research to study the effect of IS in triggering students' interest.

Recent development of investigation in physics education in Hong Kong

School-based assessment (SBA) has been adopted in the Hong Kong Advanced Level Examination physics since 2004 to assess students' practical skills, constituting 15% of the subject mark. For NSS physics, SBA, which includes practical experiments and IS if the school implements it, constitutes 20% of the subject mark. The change in curriculum and assessment reflected an increased emphasis on practical skills and investigations. However, Yeung *et al* (2012) found that physics teachers place greater emphasis on the examination written paper than that on SBA as the effect of the latter on students' final grades was negligible. Also, as teachers relied on cookbook-style experimental workbooks instead of developing inquiry or investigative teaching materials, there was no significant change in pedagogy (Yeung *et al*, 2012).

Although Hong Kong's education system is often seen as examination-oriented, Yung *et al* (2013) found that both teachers and students gave high priority to conceptions that good science teaching should focus on science learning, including ways to think with scientific methods and stimulate students' interest in learning. Besides, Tho *et al* (2015) found that in an one-day experiential learning programme of physics in a theme park, students were motivated and found it interesting, enjoyable and easy to learn. The programme used low-cost technology that provided students with possibility of science learning in real-life contexts. This successful experience provided an insight that doing authentic tasks in IS using technology in school could have a similar effect to stimulate students' interest.

Defining interest in physics

Krapp, Hidi & Renninger (1992) discussed interest as a phenomenon that emerges from an individual's interaction with his or her environment, including an object, stimulus or their interdependence. Someone who is interested in physics simply means he or she has specific curiosity in physics. The individual is motivated intrinsically to interact with physics knowledge, lecturing, extensive readings, assessments, group work, practical work, and other related environments in order to acquire new information with positive feeling, valuing and endurance. Two views of interest, individual and situational interest, are usually identified for researching about interest. According to Krapp, Hidi & Renninger (1992), individual interests are stable and specific to individuals while situational interests are generated by certain stimulus characteristics and tend to be shared among different persons.

Individual interest

Individual interests are usually associated with increased knowledge, positive emotions, and increased reference value to individuals (Krapp, Hidi & Renninger, 1992). A person's interest has integrated the interesting objects' values into his or her personal significance. The individual interests are some dispositions that are enduring characteristics or general orientations to actions.

Persons who possess individual interest in physics are resilient to difficult questions and able to attenuate frustration. They would generate and seek answers to curiosity questions, stored knowledge as well as self-maintained positive feelings without external support (Hidi & Renninger, 2006). By recognizing the characteristics or actions, the level of a person's individual interest could be determined.

Situational interest

Situational interest is generated by certain external stimuli from environment (Krapp, Hidi & Renninger, 1992). It often has a short-term effect and shared among individuals. For example, in a physics investigation activity, the learning environment is interesting to students. When they are experiencing the activity, they attain a psychological state of situational interest with positive emotions and engagement.

When a physics teacher adopts a teaching strategy such that a lot of students find it interesting, the strategy is regarded as the environment which sparkle students and trigger their positive feeling (Hidi & Renninger, 2006). Students with such an experiential state of situational interest result in a certain level of curiosity and exploratory behavior, but require external support to maintain.

Interest development – from situational to individual interest

Individual interest is stable and has positive effects in learning. It is, however, personally specific and makes it more difficult for teachers to trigger. Situational interest, on the other hand, is more readily affected by interventions. Teachers can adopt certain pedagogy or arrange certain learning environment for triggering students' situational interests, followed by strategies to facilitate the transition into individual interest. Various models about the transitions have been suggested by some previous studies.

In self-determination theory, children becoming self-determined means they are engaged intrinsically in an activity with a full sense of wanting, choosing and personal endorsement (Deci & Ryan, 1991). On the contrary, extrinsically motivated behaviors are those for achieving the outcome administered by others but not for spontaneous satisfaction of the activity (Deci, 1992). Extrinsic motivation can be transformed into internal regulation through an internalization process (Deci & Ryan, 1991). When a person internalizes the value of an activity, he or she transforms the external factors into intrinsic motivation. For a person to feel self-determined, he or she must be motivated by a combination of the psychological needs for competence, relatedness and autonomy (Deci, & Ryan, 1991). Krapp (2002) proposed an ontogenetic approach of interest development based on self-determination theory. The approach expresses an extended duration of situational interest in a person which facilitates the “internalization” on value and feeling on self. Thereafter the situational interest transited into a person’s individual interest.

Hidi and Renninger (2006) suggested a four-phase model of interest development: triggered situational interest, maintained situational interest, emerging individual interest and well-developed individual interest. The model generally describes how both affective and cognitive factors contribute in interest development. Affective component of interest refers to positive emotions accompanying engagement, and cognitive component means perceptual or representational activities to engagement (Hidi & Renninger, 2006). The roles of affects and cognitions vary among different phases.

Both ontogenetic transition and four-phase model of interest development mentioned the important roles of feeling and value components. The feeling-related valences are the positive feelings of enjoyment and involvement that precede, accompany, or follow activity associated the topic or object of interest, while value-related valances refer to personal significance ascribing to a topic (Schiefele *et al*, 1992). Situational interest required an extended period of time to facilitate individual interest development.

Methodology

The target participants were Form 6 physics students from an aided boys’ school with English as the medium of instruction. It enabled the researcher to explore how the boys experienced different situational interests in physics under mostly the same school-based context, curriculum and instruction. The school’s public examination performance varied across years with an average of about 30% to 50% graduates getting an offer for local university funded degree program, which was higher than the territory-wide average. It implied there were generally more high academic achievers.

The researcher was the participants' physics teacher during September 2011 to July 2013, and left the school afterwards. The researcher was quite familiar with their physics-related learning experiences as he taught the target participants when they were in Form 4 and 5. The researcher distributed the instruments (Appendix 1) to the participants and conducted a short briefing to explain the academic purpose of the research. The good teacher-students rapport assured the quality of students' responses.

The instrument is an A4 size paper that requests participants to write one to three interesting learning experiences in physics as shown in Appendix 1. A blank box of the size of two-thirds of the page is included to ensure participants high flexibility to illustrate their interesting learning experiences in various ways, such as writing, drawing figures, showing equations, etc. The instruments were distributed in January 2014. The participants had completed the whole NSS physics curriculum at that time, so they could make informed choices among all the subject contents or activities. They chose one to three perceptually interesting physics-related learning experiences that represented some triggered situational interests from external stimuli sparkled (Hidi & Renninger, 2006). The popularity of situational interests generated from topics or activities within the whole physics curriculum can be figured out.

A qualitative method of interview was used for an in-depth understanding of students' situational interest by selecting five students with varied interest and academic performance in physics. The researcher identified the students with high, medium and low interest in physics according to observations on their behavior and engagement in activities. Students with a higher interest used to be self-motivated and engaged in the related activities, while the one with a lower interest would be less likely to show those behaviors (Hidi & Renninger, 2006). The researcher also referred to the students' internal assessment results so as to select students with varied academic performance.

The researcher compared interviewees' feeling and value related valences on interest development in order to generate an all-rounded understanding on how their experiences affect their interest. A general interview protocol is shown in table 1. The order of questions may not be strictly followed for smooth conversation purpose during the interview.

Table 1. Interview protocol

1. How do you rank your interest level in physics? Score "10" represents highly interested while "0" represents absolutely no interest.

2. According to your mentioned learning experience(s) on the paper,

1) Can you provide more details on what is that learning experience?
2) What are the elements of an interesting learning experience?
3) Why do you find it interesting?

3. What are the reasons for you to choose chose physics as your elective in senior form?

4. *You had experienced two investigative studies, one in form 4 and another in form 5.

1) Do you find them interesting? Why?
2) Do you enjoy the collaborative work?
3) Do you have any undesirable experiences in the investigation? What are they? Why?

5. According to your ranked interest level, you are interested / not interested in physics.

1) Can you describe some undesirable experience in physics? Why do you find it undesirable?
2) How could you encounter such undesirable experience so that you retain highly interested in physics? / you continue to sit for HKDSE examination?

** will be asked only if interviewees did not mention in the instrument*

The interview began with asking interviewees to rank their self-interest level in physics so as to triangulate the researcher's and students' perception. Then interviewees would be asked to elaborate on their learning experience mentioned in the instrument to facilitate the conversation. Follow-up and confirmation questions were made whenever the researcher deemed necessary for an in-depth understanding on why students found the learning experience interesting.

A selected learning activity of IS would be asked for those who did not mention IS in the instrument. An in-depth understanding on how students perceived on IS possibly yields insights on its worth and merit in NSS physics. The researcher asked for their undesirable experiences afterwards to triangulate their responses to interesting learning experiences as well as explore how students encounter negative experiences or lost interest.

Results

Totally 49 valid responses of instruments were received from the participants. For each learning experience mentioned in an instrument, the figures, sentences, paragraphs were simplified into a short phrase that was regarded as one item. All the items were grouped and the frequency was counted. The result is shown in table 2.

Table 2. Analysis of situational interests among main topics

Interesting activity / Content		**Frequency**
Heat & gases	Specific heat capacity	1
Mechanics	Monkey and hunter experiment	5
	Investigative study (IS)	15
	Equations of uniformly accelerating motion	1
	Apparent weight changes in a lift	1
Wave	Plane transmission grating	3
	Observing light spectrum	2
	Reflection and refraction of light	1
	Electromagnetic wave song	3
	Interference of sound	1
Electricity & magnetism	Van de Graff generator	1
	Connecting circuit	2
	Floating ring in electromagnetic induction	2
	Super conductor	2
	Tesla coil	1
	Search coil	1
Radioactivity & Nuclear energy	Radioactivity	2
Astronomy	Celestial sphere & simulation (stellarium)	5
	Star gazing activity	2
	Astronomy (write one word only)	1
Not specified to particular topics	Total (*Movies, TV films or comic related to physics)*	27 *(12 out of 27)*

There are totally 79 items provided that each respondent could present one to three items. Individuals never repeated the same item in one instrument so a base total of

49 can be used. The items with higher frequency means such learning experience is more popular in triggering students' situational interest. The most popular one is IS as the frequency is 15 out of 49. It implies that IS is highly popular in triggering students' situational interest.

Five interviews (M1 to M5) were conducted, of which two are with students of a high interest, two with a moderate interest and one with a low interest in physics. Table 3 shows their perceived interest levels and situational interests mentioned in the instruments.

Table 3. Interviewees' situational interests and interest level

Students' code	**Situational interests**	**Responded interest level (Highest: 10, lowest: 1)**
M1	• Investigative study • Connecting circuit • Reading physics books • See demonstration	8-9
M2	• Floating ring in electromagnetic induction • Celestial sphere & simulation (stellarium)	9
M3	• Monkey and hunter experiment • Light spectrum	6-7
M4	• Investigative study • Electromagnetic wave song • Comic (Konan), TV film (Raymond Lam)	6
M5	• Specific heat capacity • Interference of sound	2-3

Reasons for many students to be interested in IS

Quite a significant portion of students got in-depth memory and a positive feeling on IS when they were writing the research instrument. The progress of IS would be briefly described before going into discussion on how IS stimulated students' interest.

The students were asked to do a short project after the first term examination in Form 4, which was so-called the first IS. Students worked in groups to design and construct two setups to demonstrate one uniform motion and one uniformly accelerating motion. A technique of analyzing the filmed motion videos into motion graph, which is called motion video analysis (MVA) by using a free software *Tracker* developed by Open Source Physics Project, was taught by the researcher. The software enables dynamic modeling of center-of-mass (Brown& Anne, 2009). Afterwards, students carried out their experiment. Their experimental result was analyzed by MVA to find out the values of velocity or acceleration of the motions. Finally, they conducted a presentation to the whole class to share their work and be questioned by peers. IS was scored as daily marks for the school's internal examination mark.

After a year, when they were in form 5, the second IS "projectile motion" was assigned to investigate the relationship between two parameters involved in the motion. They had to design a workable setup to investigate their proposed task and they were encouraged to use MVA during the progress. After the investigation, they needed to submit a full written report and the assessment would be scored for school examination, as well as SBA for public examination.

Student M1 is highly positive towards IS,

> *"… In such a tight curriculum, a flexible time could be provided for me to collaborate with group members to design an experiment and implement it. I found it interesting. It is not just directly delivered by teacher. I like to have freedom to exert… It was enjoyable when brainstorming the design of experiment."*
>
> *"…During daily lessons, the curriculum was tight, so the teacher delivered the content in a rush. If such chance was absent, I thought that the meaning of learning was lost… It means to learn something new, and have freedom to deliberate and to prove something. It is not just revision and then sits in the examination, although currently this is the fact."*

He understood that academic performance is very important and revision for examination should be of concern. He also understood that the teaching time under the NSS curriculum is tight. However, he recognized that IS was worth because he perceived it as "*the meaning of learning*" (學習的意義), which is the autonomy and room to exert and design an experimental setup. The adequate arena for exceling his intended tasks provided the feeling of autonomy, and this feeling motivated his learning (Krapp., 2002a).

Student M4, who came from the same elite class as student M1, wrote IS as one of his interesting learning experiences. He described in detail during the interview,

> *"… I can use software to accurately analyze something familiar and learned in lessons. The concepts would remain theoretical on calculation unless I personally experience the analysis of an experiment to verify what I learned in lessons. This is quite interesting."*
> *"(I like) the practical part that I did the work by myself and minimized the error."*

He was satisfied with manipulating MVA to verify the concepts learned in lessons. Similar to student M1, he got the feeling of autonomy such that he was highly engaged in analyzing motions. He did hands-on work by himself on minimizing the error of the setup in order to obtain more accurate results, which is coherent to what he expected from his prior knowledge.

Both students M1 and M4 appreciated the feeling of autonomy and engagement in IS. Student M4 appreciated his engagement on practically experimenting theory. They appreciated the engagement in practical work with adequate autonomy. Student M3 from another class of a mixed ability, was asked about his perception on IS,

> *"The two projects involved fast motions which were difficult to measure. Some technology could help me to find the velocity and their relationship (kinematics). The software helped me to plot a graph which can clearly figure out their relationship. It is unlike the rigid one from textbook. After talking (by teacher) about it I could not understand. But after doing (using MVA), I set the distance and locate the motion point by point, I could understand how the graph was established."*

When he learned motion graphs in normal lessons, he did not understand thoroughly. Through learning in IS, he was engaged to study motions through MVA. The software guided him to locate the motion of point mass by incrementing each frame, showing detailed movement of an object across same time intervals. Motion graphs were rendered instantaneously when he was analyzing the motion. He was able to view the motion graphs of his setup simultaneously. The use of technology enabled the investigation of realistic task (Tho *et al*, 2015). In addition to his appreciation of the MVA technology, he got a solid understanding on how motion graphs are formulated through locating the object from the frames (Brown *et al*, 2009). His cognitive achievement, appreciation on technology and engagement are the elements of triggering his situational interest.

From the perspective of those who were less positive towards IS such as student M2,

> *"…At the beginning when we were thinking about hypothesis and theory, I contributed only a little so I got no special feeling… On the day of introducing the project, while I was still thinking about the setup, the others had already completed the plan. Consequently, I followed their plan. So, in the planning stage I did not involve much… My group members were too smart. They are elites in physics. I am weaker than them. I am less confident so I was less willing to participate."*

He found his group members even more able in planning the project. Comparatively, he became less confident in contributing to the planning. Later on he was assigned to work on finding the errors of the setups,

> *"I found it difficult… It is difficult to investigate the sources of error. It is challenging. Usually when doing questions and calculations, we omitted the real situations. Calculations are theoretical. In reality, there are other factors affecting the results. It is difficult to find the sources. And it is even more challenging to tackle the sources of error for improvement."*
> *"… My main duty was to think about the possible error. I enjoyed this work because I could think and solve the problem by myself. We cannot copy from others."*

Although he was less involved in the planning stage, he was engaged in the later stages of investigating the sources of error. He realized the realistic uncertainties in the physical world through the experiments. The error in this form of analysis makes it more realistic as a scientific process than other kinds of simulations (Bryan, 2010). He enjoyed engaging in this task as it is a perceptually challenging task, and it aroused his feeling of competence that motivated his learning (Krapp, 2002). He appreciated his work on identifying errors with a sense of belonging which could not be copied from others.

Another student M5 showed much less interest in IS.

> *"I found the process fun. But it was not very interesting as it looked similar to the usual homework. After experiment I had to complete and submit a report. I thought it looked like completing a task as normal assignment, so it did not impress me. Perhaps it is because I am not interested in the topic (of the project)."*

The process he mentioned refers to the planning and implementation of IS. His first response is positive which reflected that IS provided a positive impression. He explained that IS was not interesting at all because he thought the submission of written report looked similar to the normal assignment. He associated the feeling of report submission with the usual practice of written homework, while is not the nature of IS.

From the interviews, the participants generally show positive feelings based on autonomy and engagement. Some of them got the feeling of autonomy because the given task allowed a flexible design and manipulation. They could make their own setup, operate, modify and identify errors by themselves. During the whole process, they could be highly engaged in interacting with peers, constructing setups, measuring and observing. The high involvement with given autonomy were the main elements of maintaining students' interest in ontogenetic transitions (Krapp, 2002).

In addition, they were taught to use MVA as an advanced technology for experimenting theory into practical. When compared with learning mechanics in theoretical basis, they got higher appreciation on the use of technology and got a better understanding on theory through the IS experience. The strengthened knowledge development also helped improve their perception of the subject. Their competence experience on subject theory and appreciation of analyzing authentic videos contributed to the feeding-relatedness in transition of motivation from external to intrinsic (Deci, 1992). Students' understanding played a significant role in forming their perception of a subject. Student M4 found learning through IS interesting because he understood more by making an effort,

> *"This was a process of finding materials. For example, we thought about a track that should have less friction and workable. At the beginning, we thought about using a circular tube. However, when taping the video, the ball cannot be seen. We had to buy and know whether it was feasible after trail. During the*

trials I understood the properties of each kind of material. For example, the track should be flexible for bending and be fixed at a certain shape after bending. An iron bar cannot be used. I cannot learn them from textbooks. This is quite interesting."

He tried different materials to build tracks for performing projectile motion in IS. After he tested different materials to construct the tracks for a ball, he understood how to choose the most suitable one based on their properties. Once the experiment succeeded in performing and became measurable, he found his effort was worth making to solve the problem. He gained a fruitful experience through a self-directed learning process on reflecting their learning by reviewing, revising and justifying. Every student can gain knowledge depending on how devoted they are. Students build up knowledge as a cognitive part for contributing to the value-relatedness in interest development (Hidi & Renninger, 2006).

Test anxiety in school-based assessment

The Hong Kong Diploma of Secondary Education Examination (HKDSE) is a high-stakes public examination which is determinative of students' admissions to tertiary studies. Students easily get nervous or anxious in HKDSE. Schunk, *et al* (2014) represents this type of emotion that can have negative effects on learning as test anxiety, in contrast to the positive effect generated by individual or situational interest.

IS is a part of the curriculum and assesses students by means of SBA (CDC & HKEAA, 2007). The rationale behind SBA is to assess more comprehensively on students' attitude, practical skills and knowledge than hand-written examination papers. From the assessment scheme by HKEAA in 2014, practical work and IS contributed to 12% and 8% of the score of HKDSE respectively. When students were working in IS, they knew that their teacher was assessing them and the scores constituted a significant part of their public examination result. Although most of the interviewees responded IS was an interesting learning experience, they showed negative feelings to the SBA nature in IS.

Test anxiety could be analyzed in terms of phenomenological and behavioral responses concerning possible negative consequence of scoring low mark (Zeidner, 1998). In phenomenological aspect, it includes the cognitive thinking of worrying the consequences of failing and the emotion aroused like fear, unease or uncomfortableness. The behavioral aspect of anxiety refers to the various responses

that people use to cope with their anxiety (Zeidner, 1998).
Student M1 stated clearly on why he disliked report writing in IS,

> *"…The report will be marked and the mark is part of the final score. If it will not be marked, then it is fine for me to write the report. I have to make good formatting. Personally, I want to do it perfectly to ensure that the score is not too low. Actually I just dislike being scored, but am fine with writing the report. If the whole project would not be assessed, then I like it."*

He also mentioned one experience in practical work about his situational interest in connecting circuit,

> *"…After the SBA, I connected the components in whichever way I like. It was just like playing…The key point was that after finishing the worksheets we can connect the components in whichever way we want. It looks like a design."*

He is self-motivated in learning physics without extrinsic motives as he possessed well-developed individual interest. He generated the feeling of anxiety when writing the report because of the external factor of assessment. In phenomenological aspect, student M1 was worried about getting a low mark, leading to the arousal of uncomfortable emotion on doing the report. His behavioral response to his anxiety was working seriously on the report, especially on its formatting which is out of any learning scope of physics.

Student M3 has a generally positive impression of IS. However, he did not write it as one of the most interesting learning experiences because of the SBA,

> *"…tends to be positive. I can learn how to conduct an experiment with the assistance of software. It is better than measuring manually. I felt good by using new technology."*
> *"…I haven't written IS as the most interesting because it was assessed as a part of the public examination. It gives a negative image to me… I treated it as an examination and did it seriously. I could not enjoy doing the experiment… If it would not be assessed, the experience was quite good because I could try some new methods to do experiments."*

He tried to express the negative feelings to the assessment. His scientific knowledge on repeated measurements in minimizing random errors was justified.

> *"...I do it(experiment) seriously when being assessed. In order to do well, I had to repeat the work several times so it became boring… (Repeated measurement) is better (as it is more accurate). But it would be assessed and I am afraid of making mistakes… (and) time is limited."*

He disliked being assessed, with reasons different from that of student M1. In phenomenological aspect, he was worried about getting inaccurate experimental results, leading to a negative emotion of feeling bored on repeated measurements. His behavioral response was to measure the same set of data repeatedly to cope with his anxiety of being assessed for the accuracy of data.

Both students M1 and M3 showed a significant degree of test anxiety in IS. To cope with the anxiety, their responses are similar: to work more seriously. This is a desirable attitude, though certain negative feelings were generated and they did irrelevant work. It comes to a question of whether the SBA in IS is worth conducting or not. Student M4 expressed his view on SBA,

> *"I feel that is okay. Assessment would make us serious. But the percentage (of SBA) in the public examination should not be too high. The current mark allocation is quite good as only the experiment with the highest mark will be selected. Making some mistakes would not cause a big problem. The assessment has a function on making us serious as well as providing an atmosphere to learn and work seriously."*

He stated clearly that students tend to work seriously when being assessed. Such working atmosphere is desirable. He suggested that SBA should allow students to make mistakes and provide them with opportunities to self-correct. Also, for those who score a low mark in SBA, they can still get a high score in HKDSE if he or she can do well in the written examination, which constitutes to 80% of the subject mark. Although test anxiety has a negative effect by generating anxious feeling, it encourages students to work seriously. Student M1 disliked being assessed in writing reports, but the fact was that he typed the report in a cautious manner. Student M3 disliked being assessed in measurements, and the outcome was that he tried his best to obtain accurate results.

SBA, as part of a high-stakes public examination, certainly generates test anxiety for many students (Hill & Wigfield, 1984). However, it is effective to ensure students to work seriously in IS or practical work. To consider the effect of high anxiety in lowering the achievement (Hill & Wigfield, 1984), the assessment scheme of SBA should be formulated carefully to avoid overwhelming students' anxiety. From the comment of student M3, test anxiety could be reduced by providing students allowance on making mistakes without or with less consequence. Their anxiety can be relieved if opportunities for correction are given. Although the detailed implementations vary among schools, the intention to reduce test anxiety in SBA should be the same.

Discussions

Discussion about interest, academic achievement and learning outcome

This research also intends to study how students' interest in physics possibility affects academic achievement and the enrollment in physics-related further studies. Table 4 shows the interviewees' responses.

Table 4. The intended subject choices on university admission

Students' code	Interest level	HKDSE result	Intended choice on University admission	Interest decided subject choice	Rationale of subject choice
M1	8-9	5*	Actuarial science	✗	-To challenge something advanced - good perceptual career prospect
M2	9	5*	Engineering	✓	- highly interested - good perception of engineer
M3	6-7	3	Engineering	✓	- moderately interested - easier for admission
M4	6	3	Business	✗	- poor perceptual career prospect in science-related field
M5	2-3	5*	Business and law	✓	- Low interest

The result is consistent with the findings by Stokking (2000) in the Netherlands that the most significant factor on subject selection for further studies is the future relevance. Interest, together with students' perceived understanding on the career and perceptual ability, are other significant factors affecting their decision of further studies. Three out of the five interviewees made their decision consistent to their interest in physics.

For the relationship between interest and academic achievement, a larger sample size is required to generate a significant correlation for a quantitative study. Schunk *et al*(2014) found that generally both situational interest and personal interest have a positive effect on various academic achievements. Schiefel *et al* (1992) found that there is a positive interest-achievement correlation in physics such that interest explains about 9.61% of achievement, which suggests that interest has a positive effect on academic achievement. However, someone who is not interested but treats it as "important" may still strive for good achievement (Krapp *et al*, 1992).

Besides considering interest as a positive factor affecting further studies or academic achievement, interest is one of the learning outcomes (Krapp *et al*, 1992). Students who are interested in physics could better sustain 3-year studies in senior forms so as to prepare for the HKDSE. Citizens being interested in physics or science are one of the key elements in developing public scientific literacy. They are willing to learn science or physics-related matters in the future, and are aware of those issues in society or appreciation of science and technology (Thomas & Durant, 1987).

Limitations of the research

The research instrument asked students to present their most interested learning experiences and the wording "learning experiences" may lead students to write experiments. Although bias may exist, they had to make the decision on choosing what is perceived to be interesting. In fact, 32 out of 79 items are some non-experiment experiences.

Another limitation may be the time lag. Students learned different topics throughout a 4-year time frame, i.e. from Form 3 to 6. They may have fresh memory for the more recent learning experience. Among the 79 items, 14 are not specified to any topics and 11 items belong to those taught in Form 3 to 4. The data did not show any crucial effect of memory lost. Instead, all interviewees were form 6 students who were preparing HKDSE. They began to revise all the topics, which somehow refreshes their memories of learning.

The data from the interviews may not be able to describe the process of students' interest development completely. It may be due to the limited interview time. The researcher, who was the participants' teacher in the previous years, supported them to express themselves with supplement of background information according to the researcher's record of learning and teaching. The identity of the researcher as the interviewees' teacher facilitated the expression of students, while students may respond selectively during interviews due to this relationship. To minimize this effect, at the beginning of each interview the researcher declared that the research was for academic purposes such that the interviewee shall response honestly regardless of their relationship with the researcher.

Implications for learning and teaching

It is a kind of contextual pedagogy that refers to emerging content, didactics and world views into the learning situation (Malka *et al*, 2003). It is not only teaching knowledge in certain contexts but also from the students' authentic interests and needs as human beings. Students took videos on their own designed setups and used MVA to analyze such that the context-based framework provided a high degree of autonomy (Klein *et al*， 2014). The hands-on experiments enabled students to have a better insight into the physics principles covered in normal lessons (Tho *et al*, 2015). Their engagement in discussion based on their knowledge supported the cognitive meaning construction (Malka *et al*, 2003). The creation of a motivating learning environment and students' active engagement in the lesson are both the students and teachers' conceptions of good science teaching (Yung *et al*, 2013). Since the pedagogy embedded content into a meaningful context, school's internal and external environments are bridged and integrated (Malka *et al*, 2003). From the interviews, the authentic nature of IS provided opportunities to students to apply knowledge that facilitated the development of their personal significance towards the content (Schiefele *et al*, 1992), so as to trigger their situational interest.

With a strategic planning for a period for IS, it is favorable for students to internalize the value and enhance the positive feeling to support the development of individual interest (Krapp, 2002). IS provided students autonomy and flexibility to plan, construct and implement their setup. Students usually appreciated the probable integration of technology, such as the use of MVA, into the IS as they felt competence when being able to operate something advanced. They were highly engaged in operating an authentic setup and got an in-depth understanding on the concepts applied in the tasks.

The implementation of IS met two major hindrances. The first one is the test anxiety based on the SBA nature in IS. Students are anxious in such a high-stakes assessment. The negative feelings lowered their interest and performance while assuring students' serious working attitude. Therefore, when planning SBA, there should be cautious consideration on striking a balance between maintaining students' attitude and minimizing their anxiety.

The second hindrance is a deal of teaching time. Teachers may argue that lesson time will be sacrificed for IS which seems to have no apparent effect on students' academic performance. From the findings of this research, IS is effective in developing students' interest, appreciation on applying technology and improved understanding of the relevant concepts. Interest development depends on both short-time feelings and long-term valuing and building knowledge on the subject. Students who got well-developed individual interest can be enduring to frustrations and resourceful when situations do not allow them to have answers immediately (Hidi & Renninger, 2006). These are desirable qualities for students to sustain a 3-years study in NSS physics. Students who are interested in physics are intrinsically motivated to study independently to strive for a better performance. This is worth considering as students' interest is raised through IS, with due consideration of relevant concepts to be emphasized for students.

IS, as a contextual pedagogy, relies on whether students have the opportunity to learn through authentic tasks. From the experience in Scotland, its application-led course for Standard Grade curriculum was able to retain the enrollment in physics and arouse students' interest (Norman *et al*, 2002). The rationale behind contextual pedagogy is close to the application-led course of which integrates content into a meaningful context. Scotland's successful experience inspired that the contextual pedagogy, such as IS, can promote students' interest and retain the enrollment in physics.

Conclusion

This research showed a positive effect of IS on triggering students' interest. Interviewees expressed the feeling of autonomy, competency and engagement under IS's contextual nature. They appreciated the use of technology which facilitated an in-depth understanding of the concepts applied. Students got a flexible period of time to investigate authentic tasks that strengthened their feeling and value development of individual interest.

The implementation of IS in NSS physics is optional and schools make their choices based on their readiness. Teachers have the autonomy in the implementation of IS. When considering the worth of implementing IS within the suggested teaching hours, the effect of students' interest in physics on sustaining their studies and retaining the enrollment for the field-related further studies or career should be taken into account. These desirable outcomes are essential for sustaining a long-term development in physics and science education, which in turn help build the scientific literacy of future citizens.

Note

This paper reports the major findings of the author's research in the study of Master of Education. The author was a former physics teacher in the boys' school until 2013, and currently serves as an inspector in Education Bureau, the Government of Hong Kong Special Administrative Region.

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