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How to Cultivate Students' Interests in Physics: A Challenge for Senior High School Teachers

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Abstract: Interest may be seen as the medium and the goal of educational processes. Students will learn physics better, and moreover, choose physics course intentionally if they are interested in it. Unfortunately, over the last two decades a persistent decline of students' interest in physics has found in many countries. This literature review mainly focused on student's interest in physics. It is concluded that the influential factors which cause students to disinterested in physics are: (1) they were lack of familiarity with physics; (2) they regarded physics as the most difficult science; (3) most school science courses rely on a large amount of memorization or rote learning; and (4) they are admittedly worried about failing the class. In addition, lack of student interest can be quite a challenge for teachers to combat such as by applying teaching-based technology, using project-based learning, increasing human being context or making cross-curricular connections, and showing the use of physics concept in the future. Teachers can cultivate students' situational interest to personal interest by revitalizing contents (topics), context, and learning activity in conjunction with the content and context.

Key Words: students' interests, factors affecting interest, challenges for physics teachers

Abstrak: Minat dapat dilihat sebagai media dan tujuan dari proses pendidikan. Siswa akan belajar fisika lebih baik, dan terlebih lagi, memilih mata pelajaran fisika dengan sengaja jika mereka tertarik. Sayangnya, selama dua dekade terakhir, penurunan minat siswa yang terus-menerus terhadap fisika telah ditemukan di banyak negara. Kajian literatur terutamanya berfokus pada minat siswa dalam fisika. Dapat disimpulkan bahwa faktor-faktor berpengaruh yang menyebabkan siswa tidak tertarik pada fisika adalah: (1) mereka kurang mengenal fisika; (2) mereka menganggap fisika sebagai ilmu yang paling sulit; (3) sebagian besar program sekolah bergantung pada sejumlah besar penghafalan atau pembelajaran hafalan; dan (4) mereka khawatir akan kegagalan dalam kelas. Selain itu, kurangnya minat siswa dapat menjadi tantangan bagi guru untuk mengatasi permasalahan tersebut dengan menerapkan teknologi berbasis pengajaran, menggunakan pembelajaran berbasis proyek, meningkatkan konteks manusia atau membuat koneksi lintas-kurikuler, dan menunjukkan penggunaan konsep fisika di masa depan. Guru dapat menumbuhkan minat situasional siswa untuk minat pribadi dengan menghidupkan konten (topik), konteks, dan aktivitas pembelajaran bersama dengan konten dan konteksnya.

Kata kunci: minat siswa, faktor-faktor yang mempengaruhi minat, tantangan guru fisika

INTRODUCTION

Two of major problems faced by science educators worldwide is the decline of students' interest in science and the corresponding swing away from science as soon as students have a choice, and the disappointing low scores students of some countries (Gardner, 1998; Haussler & Hoffmann, 2000; Hoffmann, 2002; Williams, et.al., 2003). Trumper (2006) reported that a persistent decline in high school science enrollment over the last two decades has generated concern in many countries, including the UK, Australia, Canada, India, Japan, USA, and every country in the European Union. Haussler & Hoffmann (2002) reported that, for instance, among total number of German students at upper secondary school (high school) of Gymnasium, the number of (girls) students who opt for physics is about 10 %. The Study conducted by SISS in Israel, as reported by Trumper, found that among the 17-year-old students who elected to study science only 48 % found

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the study of physics interesting. Many senior high school students in Israel shown a negative attitude toward physics which leads to lack of interest. When subjects can be selected, as in senior high school, they avoid the subject or course. According to a 1984 study by National Center for Education Statistics, only 3.9% of American ninth grade students will continue their education to obtain degree in science, only 0.5% will go on to obtain a master degree, and only 0.2% will receive a Doctorate in a science-related discipline (Mallory, 2004).

National Education Ministry of Indonesia reported that from 1.812.035 students of Senior High School Students who have followed the National Final Examination (*UAN*) in 2017, only 758.067 (41,8%) students who choose science major e.g physics, chemistry, and biology (National Education Ministry of Indonesia, 2017). It means that only about 14% students who choose physics as the examination subject. Moreover, Indonesia's average-score of 15-year-olds students in science is 403 which stand for in basic or low proficiency category and its ranking is 62 of the 72 participating countries (PISA, 2015). The lack of students' achievements indicates the lack of students interest in science and is more likely to acute for physics education.

Research has shown that pupils will study and learn physics better, and moreover, choose physics course in upper secondary school if they are interested in it (Lavonen, et.al,2005). Interest-based motivation to learn has positive effect both in studying process and the quantity and the quality of learning outcomes (Hidi, Renninger, & Krapp, 2004). However, there is a considerable discrepancy between students' interest in physics and the kind of physics instruction practiced in the classroom (Haussler & Hoffmann, 2000). Thus, students' interest in physics learning is notably important to future involvement in the subject, then it is useful to the teachers to cultivate students' interest or to make physics is more favourable in the classroom. Howes (2002) argued that physics as it is taught in the majority of physics courses does not seriously take into account students' interests.

As noted by several researchers, the investigation of students' attitude and interest toward studying science has been a substantive feature of the work of science education (Osborne, et.al., 2003; Trumper, 2006). Unfortunately, from the distribution of physics education articles according to their research titles between the years of 2008 and 2013, Uzunboylu and Asiksoy (2014) confirmed that only 13 (12.38%) articles that concentrated in emotional dimension or affective domains particularly students' interest. Fortus (2014) argued that educational researchers focusing on students' interest in the field of physics, yet some researchers state that affective motivational variables of students are still under attended in science education.In addition, in published Educational Psychology literatures, the learning interest-point of views are generally described in terms of extrinsic (external) and intrinsic (internal) factors of individual (Woolfolk, 1995; Slameto, 2010), while very few literatures which concerned with students' interest physics in connection with topics (contents), context, and activity. Theoretically, these are a three-dimensional construct of interest in physics (Haussler, 1987; Hoffman, 2002; Lavonen, et.al., 2005). This article describes briefly the theoretical viewpoints and empirical background of interest, factors affecting students' interest in physics, and challenges for teacher regarding for curriculum and textbook development.

THEORETICAL VIEWPOINTS AND EMPIRICAL BACKGROUND OF INTEREST

As far as the conceptualization of the psychological construct 'interest'is differentiated into two main directions of research. *First*, interest is understood as a *trait* of the individual, i.e. as enduring preference for a particular field of knowledge or action (known as invidual or personal interest). *Second*, interest is interpreted as a *state* that is related to the specific appeal of a given situation (known as situational interest or interestingness) (Haussler, et.al., 1998). Personal interest, which is always specific to individual, persist over time, and can be subdivided into latent and actualized interest (Schiefele, 1999), develops slowly and tends to have long-lasting effects on person's knowledge and values (Schraw, Flowerday, & Lehman, 2001). Situational interest is assumed to be spontaneous, fleeting, and shared among individuals (Schiefele, 1999), is an emotional state that is evoked suddenly by something in the immediate environment and that may have only a short term effect on individual's knowledge and values, and is aroused as a function of the interestingness of the content and context and partially under the regulation of teacher (Schraw, Flowerday, & Lehman, 2001).

Following the suggestion of Gardner (1985), Haussler, et.al (1998) differentiate the situational aspect of interest construct in the following way: (1) interest in a particular subject matter or topic in physic (e.g.in optics); (2) interest in a particular context in which that topic is presented (e.g.optical device that are in every day use); and (3) interest in a particular activity one allowed to engage in in conjunction with that topic and context (e.g.building a simple but functioning telescope). Consistent to the three situational aspects of interest—topics/areas, context, and activity in conjunction with topic and context—Hoffmann (1989) compiled the ideas of a group of experts referring to desirable physics education which contain 3 formal elements: (1) situations, contexts, motives, etc., in or for which education in physics is meaningful today and will be so in the immediate future (Element I); (2) areas of physics, familiarity with which is required for an understanding of physics, or which are considered to have significance for physics in connection which the situations, contexts, and motives named in fulfillment of preceding condition (Element II); (3) the appropriate or desirable modality of an individual's disposition over, or of his dealing with an education in physics (Element III).

Haussler, et.al (1998) gave an illustration of how topic, context, an activity aspect of situational interest in the 11 different configurations applied to the topic of 'heat' as shown in Table 1.

Based on the previous studies, Schraw, Flowerday, and Lehman (2001) confirmed that it is essential to make the content of learning meaningful and personally relevant to pupils. Through this phase pupils affective responses to teaching and learning material is also relevant that enable to cultivate the students' situational interest as well. Lavonen, et.al.(2005) argued that teachers can promote the change of situational interest to personal interest by choosing of the content, context, and teaching methods. Therefore, it is important for a teacher to know what content and context interest pupils. As a summary, interest can be seen as an integrated component of an interrelated network psychical, social, and physical factors in a certain learning situation.

It seems logical that learning experiences should be related to the interest of the students. However, this is not always an easy or even a desirable strategy; there are times when students must master basic skills that hold no intrinsic interest for them (Woolfolk, 1995). Based on their study, Haussler & Hoffmann (2000) concluded, the specific context that are effective in stimulating interest: (1) physics as vehicle to promote practical competence; (2) phyisics as a socio-economic enterprise; (3) physics as vehicle to enhance emotional experience; (4) physics as an intellectually challenging scientific enterprise; and (5) physics as vehicle to quality for the work-world.

FACTORS AFFECTING STUDENTS' INTEREST IN PHYSICS

The lack of students' achievement in physics can be caused by many factors such as internal and external factors of the students (Carbone, et.al., 2009; Slameto, 2010). The internal factors e.g. student's attitude, motivation, interest, knowledge, skills, hope, assumption, and goals. The external factor is the student study environment condition, e.g. the utilization of teaching

Table 1. The 11 Context/activity Configurations that Represent Different Facets of Interest in Physics Applied to The Topic of 'Heat'

	Context/activity configuration	Application to the topic of ' heat'
1	Calculating physical quantities	Calculating how much a certain amount of heat energy may be transformed into kinetic energy
2	Learning more about the quantitative of physics	Learning more about why heat may not completely transformed into movement
3	Planning experiments	Planning experiments to find out what influences the speed at which an object cools down
4	Learning more about the qualititative of physics	Learning more about why heat essential is
5	Gaining an insight into technical vocations	Gaining an insight into how people work in a thermal power stat
6	Learning about how technical objects function	Learning more about how thermos jugs function
7	Building of devices	Building and testing a device from simple materials (e.g.chips of wood or straw) that keeps things warm
8	Gaining an insight into vocations that serve humankind	Gaining an insight into how people work in a weather station
9	Learning more about natural phenomena	Learning more about what causes the weather
10	Learning more about the social impact of technologies	Learning more about how improved insulation of houses may sa a lot of energy
11	Discussing controversial technologies	Learning about the disadvantages of thermal power stations and discussing alternatives

method by the teachers, family environment, and the availability of learning facility and infrastructure.

Through the use of survey of 191 students of the early years of secondary school, Mallory (2004) identified the influential factors which cause students to be interested or disinterested in physics, they are: (1) one reason that so many people have such a lack of familiarity with physics is the fact that very few people ever actually take a physics course; (2) another possibility for the small number students enrolling in physics classes is the means by which most high schools arrange their science program. Many high school students regarded physics as 'the most difficult science'. Therefore, they would decide not to take physics in place of a less difficult elective and would simply not be in science long enough to take a physics course; (3) Most other high school science courses rely on a large amount of memorization. Physics, on the other hand, deals more with quantitative skills and connections or relationships between concepts. The students who have done well in other science courses could possibly go into a physics course with the same mentality that was previously successful. Those students could then become frustrated the "methods" that work for biology or chemistry do not work for physics; (4) Finally, many students do no take a physics course because they are admittedly worried about struggling with the class or even failing the class because of the extreme level of difficulty that they associate with physics.

Several studies have identified a number of factors affecting students' attitudes towards science in science. These can be largely categorized as gender, personality traits, structural variables, and the curriculum variables. Of these, the most significance is gender (Haussler, 1987; Trumper, 2006). Many studies reported that males have more positive attitudes toward science than females (Sjoberg, 2000; Osborne,et.al., 2003), while others found no statistically significant gender differences (Selim & Shrigley, 1983). Unfortunately, these less favourable attitudes of females often translate into less interest in science.

The study of Awodun, et.al.(2014) revealed that students' variables (study habit, attitude to and interest of students in Physics) are better predictors of students' performance in Physics, while student gender has no influence on students academic performance (is a poor predictor). Lavonen, et.al.(2005) identified factors that interrelate with interest in physics learning: nationality, gender, relevance for further studies or occupation, interest in the contents of physics, interest in a context where certain physics content or topics are met, interest and enjoyment in activity type or the teaching methods used, perceived achievement, level of difficulty, and appreciation of the topic. Based on his study, Weno (2014) concluded: (1) there is a positive and significant relation between interest in physics and student's ability to solve physics problems; (2) there is a positive and significant relation between interest and knowledge of mathematics basic concept with student's ability to solve physics problems.

Hong and Lin-Siegler (2012) found that the achievement-oriented background information had negative effects on students' perceptions of scientists, producing no effects on students' interest in physics lessons. In contrast, the struggle-oriented background information helped students create perceptions of scientists as hardworking individuals who struggled to make scientific progress. In addition, it also increased students' interest in science, increased their delayed recall of the key science concepts, and improved their abilities to solve complex problems. Keller, Neumann, and Fischer (2017) concluded that teachers' motivation in the form of interest for teaching physics had a positive effect on students' interest. Neither did teacher pedagogical content knowledge predict students' interest, nor teacher motivation students' achievement. Hadzigeorgiou, et.al.(2017) concluded that there were significant correlations between students' overall beliefs about physics and learning physics with their self-rated level of interest in physics.

THE CHALLENGES FOR A TEACHER TO CULTIVATE STUDENTS' INTEREST IN PHYSICS

In order to increase students' interest in physics, Lavonen, et.al.(2005) indicated at least four challenges for physics teacher regarding the curriculum and textbook development. *The first challenge* is to assume that the context where science in discussed in situations of everyday life is interesting for pupils. The content to be learned is embeded in the fantasy context, e.g., the skill to be learned and the fantasy are related to each other (endogenous fantasy). In exogenous fantasy, the relationship between the content of the study and the fantasy is purely arbitrary. For example, it might be possible that a physics teacher can explain how phenomena that are paranormal have been researched or what the origins of the electromagnetic waves are.

The second challenge is to clarify how content and its context can be increased in the school physics. Pupils would like to learn more about physics contents if they are taught in the others context. There is a wide spectrum of topics that can be approached in different context of another topic. For example, discussion on satellites and space research/exploration seems to be exciting topic for pupils if it is taught from mechanics, electromagnetic radiation, and nuclear fusion. *The third challenge* is to increase human being context, health education, and examples of life sciences to physics teaching. It is valuable phenomena can be connected to real contexts pupils are interested about or what concerns directly themselves, e.g., human beings and especially pupils themselves in everyday life, sports or hobbies, animals or plants they see in their surroundings. Some physical conceptions can be used in the context of various records of animals and plants (mass, weight, volume, acceleration, velocity, kinetics energy, etc.) instead of various physical instruments.

The fourth challenge is teaching-based technology. It is important to find more versatile approachs to show technical application's interestingness and importance for all pupils. Everyone uses technical applications; therefore, usability testing and user-centered design could be interesting study contexts. Futhermore, it would be useful to make an intervention study on pupils' motivation and learning physics in the context where technological context is combined with human being context or astonomical context. A good example of integration of human context with technological context can be seen in numerous college level physics textbook. These theme help student both to understand the individual's relationship to technology and to see the importance of technology in our daily lives. Therefore, there is a great potential to change the shape of technology teaching in schools. Hazari,et.al.(2017) concluded that creating classroom environment that increase students' intentions toward STEM (science, technology, engineering, and mathematics) careers can promote students interest and enhance or maintain course performance as well.

Krapp (2002) has suggested that in certain conditions situational interest (interestingness) can transform into personal interest. According to him, this ontogenic transformation is a two-step mental process where internalization and identification have a central role. *The first step* is catching or triggering situational interest. Catching or triggering refers to variables that initially stimulated pupils to become interested in a specific topic.While holding refers to variables that empower pupils with a clear goal or purpose. It is essential to the shift from catching to holding a pupils's situational interest are learning conditions that make the content of learning meaningful and personally relevant to pu-pils. *The second step* is through an internalization proc-ess this situational interest can develop into personal or individual interest. Therefore, motivation and interest is no longer seen as simply an individual variable.

To make the science teaching and learning materials could be interesting, Schraw, Flowerdwy, and Lehman (2001) suggested that teachers should 1) offer meaningful choices to pupils, 2) use well-organised texts, 3) select texts that are vivid, 4) use texts that pupils know about, 5) encourage pupils to be active learners, and 6) provide relevance cues for pupils. In relation to learning activity, Haussler, et.al (1998) confirmed that the teaching of physics should take the following guidelines into consideration: (1) providing opportunities to be amazed; (2) linking content to prior experiences for the students; (3) providing first-hand experiences; (4) encouraging discussions and reflections on the social importance of science; (5) letting physics appear in application-oriented contexts; (6) showing physics in relation to the human body; and (7) letting students experience the benefit and use of treating physics quantitatively.

Kelly (2018) argued that lack of student interest and motivation can be quite a challenge for teachers to combat. She noted the following methods shown to be effective in getting the students motivated and eager to learn are as follows.

First, Be Warm and Inviting in Your Classroom. The classes have a distinctive personality or "climate" which influences the learning efficiency of their members. No one wants to enter your class where they do not feel welcome. Your classroom should be an inviting place where students feel safe and accepted.

Second, Give Choice. Once students have learned a skill or have become familiar with some content, there is always an opportunity to offer a student a choice. Giving students choice is critical to increasing student engagement. In all disciplines, students can be given a choice of questions to answer or a choice between writing prompts and for doing a research and problem-solving activities that allow students to have more control over learning to a greater sense of ownership and interest.

Third, Authentic Learning. The students are more engaged when they feel that what they are learning is connected to life outside the classroom. The basic idea is that students are more likely to be interested in what they are learning mirrors real-life contexts, equips them with practical and useful skills, and addresses topics that are relevant and applicable to their lives outside of school.

Fourth, Use Project-Based Learning. The process of project-based learning takes place when students start with a problem to solve, complete research, and then finally solve the problem using tools and information that you would typically teach in a number of lessons.

Fifth, Make Learning Objectives Obvious. Certain topics can be overwhelming because of the amount of information and details involved. Providing students with a roadmap through accurate learning objectives that shows them exactly what it is you want them to learn can help allay some of these concerns.

Sixth, Make Cross-Curricular Connections. Sometimes students do not see how what they learn in one class intersects with what they are learning in other classes. Cross-curricular connections can provide students with a sense of context while increasing interest in all classes involved. Magnet schools that are based around specific themes like health, engineering, or the arts take advantage of this by having all classes in the curriculum find ways to integrate the students' career interests into their classroom lessons.

Seventh, Show How Students Can Use This Information in the Future. Some students are not interested because they see no point in what they are learning. A common theme among students is, "Why do I need to know this?" Instead of waiting for them to ask this question, why not make it part of the lesson plans that you create. Add a line in your lesson plan template that specifically relates to how students might apply this information in the future. Then make this clear to students as you teach the lesson.

Eighth, Provide Incentives for Learning. Incentives and rewards can be everything from free time at the end of a class. Make it clear to students exactly what they need to do to earn their reward while some people do not like the idea of giving students incentives to learn.

Ninth, Use Hands-On Learning and Include Supporting Materials. Well-designed hands-on activities focus learners on the world around them, spark their curiosity, and guide them through engaging experiences–all while achieving the expected learning outcomes. When students are able to feel artifacts or be involved in experiments, the information being taught can acquire more meaning and spark more interest.

CONCLUSION

It is concluded that teachers can cultivate students' situational interest to personal interest by revitalizing a three-dimensional aspects of interest e.g. contents (topics), context, and learning activity in conjunction with the content and context. The influential factors which cause students to disinterested in physics are: (1) they are lack of familiarity with physics; (2) they regarded physics as the most difficult science; (3) most school science courses rely on a large amount of memorization or rote learning; and (4) they are admittedly worried about failing the class. The lack of student interest can be quite a challenge for teachers to combat by employing the strategies such as to show physics as a human enterprise, apply teaching-based technology, use project-based learning, make cross-curricular connections, and show the use of physics concept in the future. Adaptation of the curriculum by adding topics students are interested in could be a very effective means to solve some of the current problems of physics education especially regarding the decline of students' interested in physics. If the new science and technology curriculum is to succeed so that students become more science-literate and increase their interest in physics, then this shortcoming must be taken into account and overcome.

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