HUMANIZING SCIENCE WITH CONTEXT: SOME CONTEXT-RICH APPROACHES TO TEACHING PHYSICS

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Abstract

The school science is often criticized as being too remote from learners' interest and needs. Although science is mainly taught based on textbooks inside classrooms, the learning of science can not be confined to the boundaries of curriculum and school. Firstly, this paper reviews briefly and characterizes the historical development of science education with a series analogies, and then suggests a new analogy so-called 'Hearts-On' science education which emphasizes the humanistic aspects and the context dimension of science education. Secondly, it critically examines how much traditional school science, particularly physics, teaching is limited in terms of the context of learning (i.e. textbook, laboratory, classroom, local, and global) as well as in terms of the context of contents (i.e. physical, personal, social, and global). Thirdly, some recent attempts initiated by the author and colleagues are explained as the examples of the Hearts-On science education. Especially, a series of community-based science programs led by SNU and the development of the books of 'Contextual Physics' (i.e. Body Physics, Wearing Physics, Dining Table Physics, and Sports Physics) are outlined with their processes and outcomes. It is hoped that these attempts help us reconsider what would be the goals of science education and how we could expand the world of science education beyond the boundaries of curriculum and school.

Keywords: context, physics education, humanizing science, community

1. Introduction

> The science curricula we need are those that will help close the gaps between science and human affairs. Such programs should emphasize the utilization of science knowledge to extend human capacities as a social as well as a biological species. This means a focus on the operational use of the findings of science to enhance human adaptation. By contrast, the traditional view is that a science course should stress the structure of a discipline from an academic and a career viewpoint, a view that sees a school science as preparation for college rather than preparation for life. (P. D. Hurd, 1997, p.79) [1]

Recently in Korea, like in many developed countries, there has been a serious socio-cultural phenomenon of avoiding the study of science and engineering by secondary and tertiary students. During the fast expanding period of Korean industry, from 1960s to mid 1990s, science and engineering were considered as the areas of prosperity and the most talented students were willingly joined the stream. Since the economic crisis in 1997, the condition of the job market of Korea has been considerably shrunk and the finding a secure job in science and engineering became much tougher too. Once this relative prosperity disappeared, science (and technology) in school quickly had to confront with the overwhelming reluctance of students to the studying of science. Students, particularly in secondary schools, were quick to realize that studying science can satisfy neither their future jobs nor their present curiosity. School science is still being considered to be too remote from their interest and needs [2].

On the other hand, ordinary citizens of modern society live in an age of science and technology (S&T). Continuing advances in S&T had a pervasive impact on both the ways of producing and consuming of wealth. Citizens are now no longer the outsiders or mere receivers of science. Modern society needs the active participation of citizen and 'citizen science', which assists the need and concerns of citizens and comprises their contextual knowledge [3]. Scientific literacy became essential part not only of general education but also of citizen science [4], [5]. Furthermore, as the influence of S&T on society increases rapidly, various science-related social issues become serious topics which often divide the society apart. Stem cell research and the ethics of scientific research would be just a few examples of it.

Thus, today, science education is facing hard the double challenges from the both sides, one from the students who are losing their interest and the other from the society which is demanding much broader and more active interaction. If school science can not properly respond to these challenges, it would be easily neglected both by the students and by the society.

With this understanding, this paper tries to review critically the current situation of school science, particularly from the viewpoint of the context of physics education, and to suggest some alternative, hopefully constructive, ways for changing the situation.

2. The Paradigm Changes in the History of Science Education

Although science is now considered as one of the core subjects of school across the world, science was first introduced into school as a rather late comer after the beginning of the 19th century. Before the introduction of science into schools, it used to be taught largely in universities either as a part of mathematics or of natural philosophy mostly from the perspectives of philosophy, especially of deduction. Reading classics, such as of Aristotle, Galileo, Descartes, Bacon and Newton, was the main means of teaching science without experimental work or practical knowledge, with some exceptions like Comenius and sense realism [6].

Despite some degree of the shift toward a more elite-oriented subject around the turn of the century by a few legendary figures of early science education (e.g. T. H. Huxley and H. E. Armstrong) [7],[8], under the influence of Industrial Revolution in England and Europe, school science during the 19th century was largely taught as a body of practical knowledge supposed to be useful for individuals' profession as well as for countries' competitive power. The typical examples of this tendency would be the Mechanics' Institution movement during the first half of the 19th century [9]. The tendency toward practical knowledge continued throughout the first half of the 20th century, but this time with more emphasis on individuals' life and science in society. While in Britain there was 'Citizen Science' movement during 1930s-40s led by a group of socialist scientist group (esp. L. Hogben) [10], [11], in the US there was a movement of progressive education and of everyday life science with more capitalistic flavor during 1920s-50s [7].

Toward the end of 1950s there was an accumulating pressure largely from the community of scientists for a radical reform of school science at the both sides of the Atlantic. The movement, often called Curriculum Reform Movement represented by PSSC and CHEM Study in the US and Nuffield sciences in the UK, emphasized scientific inquiry rather than the body of scientific knowledge. This was largely based on the positivist philosophy of science of which the focal interest was the experimental method (in other words, discovery) of science. Students were usually asked to have authentic experience of discovery and the understanding of the conceptual structure of science. Due to the emphasis on the inquiry activity, science education during this period is often identified with a phrase of 'Hands-On'.

During the 1980s-90s, with a philosophical background of constructivism largely initiated by J. Piaget and D. Ausubel, there were a huge shift toward the studying of scientific conceptions of students across the world (e.g. [12],[13]). Through out the period, however, the main locus of the research had been gradually shifted from identifying students' misconceptions to investigating the nature of conceptual understanding and developing effective strategies of conceptual changes. The focus of the studies was to make students experience their own cognitive conflict which is considered as an important precondition for successful conceptual change, and students were expected to construct their own conceptual framework through the interaction with peer students and teachers. Since the movement emphasized students' conceptual understanding rather than their activity, it is often referred as 'Minds-On' movement.

Around the turn of the 21st century a cultural approach gradually gained the attention of science educators. Socio-cultural interactions between students and between a student and a teacher became one of the main research topics accompanied by the theory of situated cognition [14],[15]. Within this framework, the contexts of science and of science learning were the focal points of consideration. The communicative nature of science learning, inside and outside of classroom, needs to be investigated in-depth, for example in terms of argumentation inside the classroom and in terms informal / free-choice science education outside the classroom [16]. Although not yet accepted widely, the background philosophy of this movement is named as 'Humanistic' [17] of 'Scientific Humanism' [18].

Song & Cho (2004), based on their brief summary of the historical development of science education and science museums / centers, characterized the overall pattern of the historical development as the change of paradigms with corresponding analogies referring to the parts of human body (See Table 1.): Ears-On → Eyes-On → Hands-On → Minds-On → Hearts-On [18]. In the following sections, the importance of the context, the main focus of 'Hearts-On' science education, will be discussed, and then examples of recent development led by the author will be briefly outlined.

Table 1. The Change of the Paradigms of Science Education

Period / Aspect	**Until 18C**	**19C – Mid 20C**	**1960-70s**	**1980-90s**	**21C**
Science as	Natural philosophy	School Subject	Discovery	Personal & Social Construction	Culture & Communication
Background Philosophy	Deduction	Empiricism	Positivism	Constructivism	Scientific Humanism
Essence of Science Learning	Logic & Reasoning	Practical Knowledge	Conceptual Structure & Process Skills	Conceptual Change	Situated Understanding
Focus of Science Teaching	Philosophical Argument	Demonstrating Usefulness	Scientific Inquiry	Cognitive Conflict	Context of Science & Learning
Corresponding Analogy	Ears-On	Eyes-On	Hands-On	Minds-On	Hearts-On

3. Context and School Science

Recently the dimension of context has gathered a considerable attention from science educators. There have been a number of attempts to classify the dimension of context into its sub-categories and to understand the process of learning (e.g. [19]). For example, Flak & Dierking(2000) developed the ‘Contextual Model of Learning’ consisting of three inter-wining contexts (i.e. personal, socio-cultural and physical contexts), which was suggested for the basic platform for describing learning from museums [20]. For a more sophisticated description of the learning experience in science centers, Hong & Song(2005) developed the CoDiLE(Context Diagram of Learning Experience) in which the links and their patterns between nine contextual factors are investigated [21].

However, most studies on the context dimension have tried to classify the context dimension further into its components, with an implicit assumption that the classification of the context would be one dimensional. However, the activity of teaching and learning, not only science education but education in general, is the combination of two basic components, that is, the content to be taught and the activity of learning (or teaching). For example, the principle of energy conservation is taught with the help of a textbook. It is thus necessary to consider the issue of context in terms of these two components. In other words, the dimension of context would have two dimensions, i.e. the context of content and the context of learning.

The context of (physics) content can further be classified into its four components (i.e. physical, personal, social and global). While most of laws, principles and phenomena of physics (such as, laws of motion, energy conservation, thermal expansion and so on) belong to the physical context, a lot of the facts, phenomena and applications of physics can belong to other components. For example, personal health - related facts and information which are to be explained with physics are of the personal component, many of STS-related issues (like traffic, industry, recycling, electricity and other everyday topics) are of the social, and phenomena of a larger scale (like global warming, green house effect, air pollution, nuclear issue) are of the global contexts. It is true that we have, maybe implicitly or as a habit of mind, assumed that physics is only to do with general principles and laws, that is the physical context of the content, and the rest would be the mere application of physics to personal, social and global issues. It is however a strong belief of the author that the facts, data, instances and phenomena which are to be explained with physics are also the essential components of physics education, which also need to be taught and learned explicitly. It is quite clear, from our numerous experience and studies, that what most students really want to study are the whole contexts not just the physical context of the content of physics.

The context of learning (physics) can also be further divided into five components (i.e. textbook, laboratory, classroom, local and global). In many occasions physics is still taught mainly by means of textbooks and the textbooks are really the main platform of physics education in all countries, advanced or not. The laboratory activity would be the second most common means of physics education. The third context of learning is classroom where students are engaged in project works, group discussion, and presentation. In most cases school physics is usually confined into these three contexts of learning. However physics can also be learned through local activities (e.g. doing survey or gathering data in a community, participating in science fairs, visiting science centers) and global activities (e.g. video conferencing with students on other countries, data logging for global environmental issues, participating in international competitions and events). To the extent that school education aims to foster students as citizens with, global as well as local, scientific literacy and to make them see science from a wider perspective, school science needs to focus more on the last two contexts of learning science.

Table 2 shows the author’s personal opinion about the situation of school physics education in terms of the two dimensions of the context. The number of stars in each cell represents the relative frequency of school physics in the particular combination of the two dimensions of contexts. This is, of cause, just for illustrating how much the current situation (particularly in Korea) is biased in favor of the physical and personal contexts of content and the textbook and laboratory contexts of learning. If we want to have more student-friendly and scientific literacy-oriented physics, not only everyday life stuff with traditional science but also modern life stuff with modern science and technology, we do need to pay much more attention to the personal, social and global contexts of content and to classroom, local, and global contexts of learning.

Table 2. The Contexts of Content and of Learning in School Physics

Context of Content / **Context of Learning**	**Physical**	**Personal**	**Social**	**Global**
Textbook	*****	***	***	**
Laboratory	****	***	**	*
Classroom	***	**	**	*
Local	**	*	**	*
Global	*	*	*	*

The * represents the relative frequency, from ‘almost none’(*) to most frequently(*****).

4. SNU Community-Based Science Programs

For the last four years or so, a team of science educators at SNU (Seoul National University), Korea has carried out a series of community-based science programs for local area, with a special attention to ordinary housewives. Table 3 outlines the three projects (2002-2005). As citizens, housewives play important roles in society as well as in home. They take care of family health, purchase household goods, and help their children's study. Along with these roles of managers, consumers, and educators, they also have responsibility as citizens in democratic society to make personal decisions and sometimes voluntary participation in relation to S&T-related controversial issues. For these roles, housewives are expected to be scientifically literate and to be provided with various opportunities for improving their scientific literacy. However they have been the subjects of only a few studies (e.g. [22]).

Table 3. Summary of the SNU Community-Based Science Programs (2002-2005)

Projects	1st Project	2nd Project	3rd Project
Period	Feb. – Nov. 2002	Oct. 2004 – Mar. 2005	Feb. – Jun. 2005
Titles	*A Development of the Programs for Improving Housewives' Understanding of ST in Korea*	*Development of Programs and Activity Manual for Regional Science Class*	*Kwanak-Gu Science Classes for Housewives*
Participants	2 professors 2 PG students	2 professors 4 PG students	2 professors 8 PG students 6 local groups
Funding	KSF	KSF	KSF
Budget	about 10,000 USD	about 30,000 USD	about 30,000 USD
Main Activities	- Survey of Housewives - Sample Materials	- Activity Manuals - Group Work Program - Career Program	(for each group) - 10 lessons - 2 public lectures
Nature	A research project with a development of sample materials	A development of programs and activity manuals	A community-based science program

4.1 (1st Project) Basic Survey and Developing Sample Materials

In 2002, a team of science education specialists from Seoul National University (SNU) undertook a project, titled 'A Development of the Programs for Improving Housewives' Understanding of Science and Technology in Korea', with a grant from Korea Science Foundation (KSF). The research team carried out a survey to find out their attitudes toward S&T, interests about S&T-related issues, school science experience, preferred formats of science culture programs, etc. Based on the results of the survey, a program and a set of samples of educational materials for housewives' understanding of S&T were developed.

The SNU team consisted of two sub-groups, physics and biology, each of which consisted of one professor and one postgraduate. This small scale research project was offered as one of the projects in 2002 Funding Scheme of the KSF. The duration of the project was just 10 months Feb. – Nov., 2002, and its theme was given by the KSF.

Based on the survey results ([22]), the researchers recommended the implementing methods of the program in the following order: firstly, TV program; secondly, Internet service; thirdly, books; fourthly, the programs of cultural/local centers. However, it turned out to implement the programs through the forth way, because MOST(the Ministry of Science and Technology) suddenly launched a national project called 'Science Korea' which included 'Classes for Science and Life' Project to be implemented through local town offices across the country. The 'Science Korea' project is a government-driven project for establishing a nationwide infrastructure for enhancing science culture. In June, 2005, under the umbrella of 'Science Korea' project, there were 19 Science Culture Cities, 350 Classes for Science and Life, 2,427 Youth Science Clubs, and 1,042 Science Ambassadors.

4.2 (2nd Project) Developing Activity Manuals

In 2004, a group with the same team leaders carried out the next project, titled "A Development of Programs and Activity Manual for Regional Science Classes", which included the development of programs (1) for people's recognition of the importance of S&T, (2) for the students' positive attitude toward S&T career pursuit, and (3) the development of Activity Manuals specially for community-based science lessons for local housewives as a part of 'Classes for Science & Life' Project. For the third, two kinds of Activity Manuals (one for instructors and one for housewives) were developed with 10 topics.

The SNU team again consisted of two sub-groups, physics and biology, each of which consisted of one professor and two postgraduate students. This project was suggested by the KSF to the SNU team because after the launching 'Classes for Science & Life' Project the KSF needed to have some programs and materials to be distributed to local town offices across the country. Since everything had been decided so quickly, the duration of the project was given just 6 months, Oct. 2004 - March 2005.

4.3 (3rd Project) Implementing the Programs and Manuals

In 2005, the SNU team started to implement their programs and materials to the groups of housewives in local community, Kwanak-Gu ward in Seoul, where the university is located. Kwanak-Gu is largely considered as an area of relatively low socioeconomic status and educational prospects. At the beginning stage, six groups (i.e. six local town offices) of full-time housewives with a maximum of 20 in each group were formed with a help from the local government. The program lasted 6 months (Feb. – July, 2005), and each group was given 10 two-hours' classes (of a mixture of practical work, discussion and lecture) once a fortnight in addition to two times of public lecture. This was a corporative science program for local citizens of Kwanak-Gu, developed and implemented by a SNU team, with an administrative support from Kwanak-Gu local government and with a financial support from the central government through the KSF.

For this first round of implementation, the SNU team with the same team leaders as the previous two projects consisted of two sub-groups, physics and biology, each of which consisted of one professor and four postgraduate students. Although the planning and preparation of the classes were done as a work of the whole SNU team, the actual classes are mostly delivered by the postgraduate students. The fund from the KSF was assigned according to the number of participating local town offices to the program. For the evaluation of the first implementation process, a small scale survey and interviews with three participating groups (Kwanak-Gu, SNU, and KSF) and with course attendees (i.e. local housewives) were carried out throughout this implementation process.

After the evaluation of the first round, the second round of the implementation was carried out starting from on July 25, 2005 for another eight months. This time the program was delivered to the students of grade 4 to 6 and their mothers. Due to the change of the attendees from housewives to children and mothers, the contents of the biology team had to be changed into more inquiry-oriented topics not necessarily directly related to housewives' interest and concerns. The results, especially the turnout rate of the attendees which had gradually decreased with the housewife-only groups of an earlier trail, showed a great success. The presence of their children made them to concentrate on the programs and there were active interactions between mothers and children.

In summary, the SNU group acquired a considerable amount practical experience of running community-based programs with which the group had no previous experience, and so as to the local government (Kwanak-Gu). Through the continuous communication and cooperation with other participating groups, each participating group (SNU, Kwanak-Gu, and KSF) was able to reduce to a considerable degree the gaps which had been naturally imposed by their lack of interaction in the past. Nevertheless, as shown in Figure 1, since each participating group has their own expertise as well as weakness and is implicitly and explicitly controlled by corresponding central governmental organization, there are still mismatches of desires and opinions which are to be resolved through future collaborations.

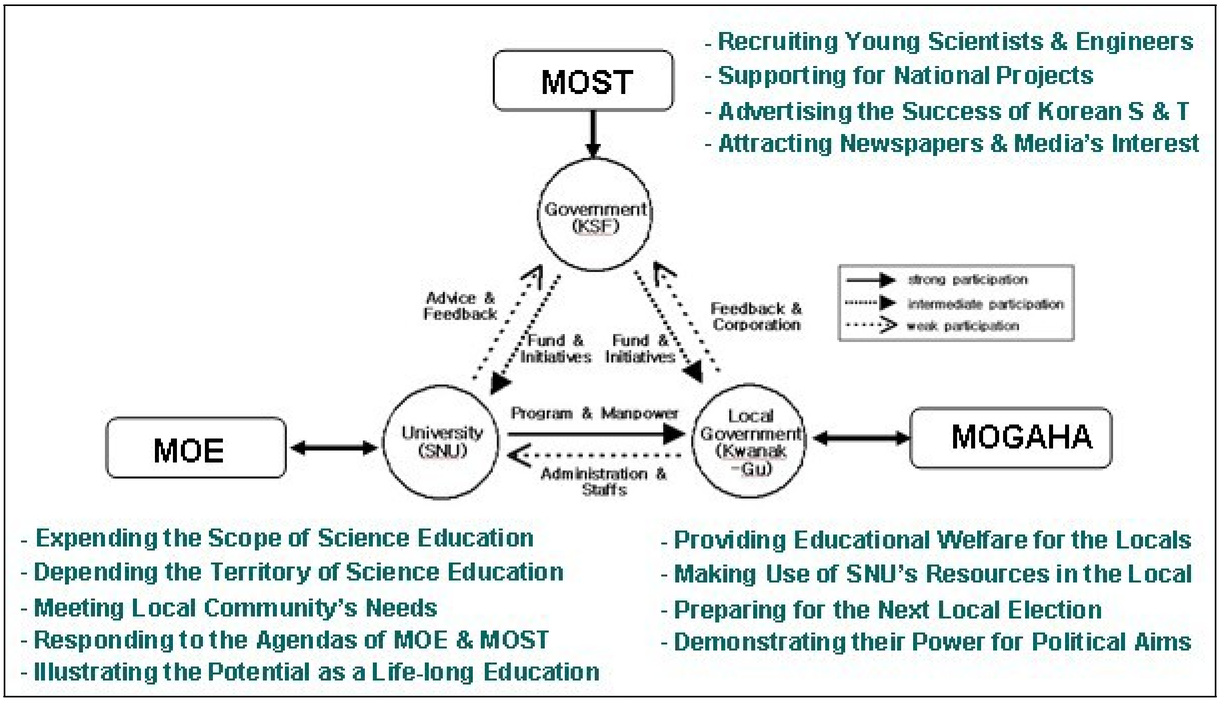

Figure 1. The Network of Participating Groups for SNU Community-Based Science Programs
(MOE: Ministry of Education & Human Resources Development, MOST: Ministry of Science & Technology, MOGAHA: Ministry of Government Administration and Home Affairs)

5. Context-Rich Approach: Contextual Physics

In addition to community-based science programs, the EPIC(Education of Physics In Context) group of SNU, as one of the context-rich approaches, is developing so-called 'Contextual Physics' series of which main audiences are middle school students. At the moment the series consists of four books (Body Physics, Wearing Physics, Dining Table Physics, and Sports Physics) covering various aspects mainly of the personal and social contexts of physics contents. Each book is aimed to deliver distinctive positive messages of physics and learning physics. The mysterious & amazing, charming and convenient, healthy & useful, and powerful & exciting (supposed) features of physics and physics learning are to be delivered as the intended messages: through Body Physics, Wearing Physics, Dining Table Physics and Sports Physics, respectively. These features and intended messages are hoped to convert the common negative images of physics and physics learning (that is, boring, distant, difficult, irrelevant, only for the talented etc.) into more humanistic and easy-to-access images.

Table 4 summarizes the main contents and features of the series. The sequence of the series is arranged along the outward direction starting from myself. In order words, the Body Physics is to do with the human body which concerns biological and physical features of my own body, the Wearing Physics with something put on the body, the Dining Table Physics with food and eating which are essential for our life and something inside home, and the Sports Physics with the activities which can be enjoyed outside home.

The books are being developed with a common structure. Each book contains about twenty topics specific to its title. Each topic starts with a diary either written by a boy or a girl, main characters of the books, and is of the length of about 6-10 pages. The diary describes an interesting happening of the day and is followed by the main text which progresses in a form of dialogue along the storyline following the happening of the diary. The dialogue is set between a famous scientist (such as, Newton) and his young and somewhat naughty (of similar age with the expected audience) assistant (such as, U-turn). The names of the assistants of the scientists are matched in pronunciation with their masters but with a rather amusing meaning imbedded in Korean pronunciation. Through the lively dialogue between a scientist and his assistant, the main concept and contents are introduced with some detailed explanations here and there along the dialogue. Each topic contains several special sessions, called 'Wisdom Box from History' and 'Wisdom Box for Life', and at least one hands-on activity related to the main concept of the topic.

The first book, Body Physics, is dealing with the physical and biological functions and features of the parts of human body. The basic idea of this book is that the human body which has been usually considered to be the subject of biology can also be an extremely interesting topic for teaching & learning of many physics concepts. For instance, the structure of bone and muscle provides very good examples of the principle of lever (i.e. moment and torque). The topic of Breath can be used to explore the concept of isothermal expansion. Through this book, it is hoped that students realize that physics is useful to understand my own body and has a strong relationship with biology.

The second book, Wearing Physics, is dealing with things that we wear or put on our body, such as cloths, helmet, accessories. The cosmetics and suntan cream are also included as topics in this book. Some more complex devices, such as headphones and mobile phones are included too. The message to deliver through this book is something like, 'science/physics is charming and convenient'. Physics would help you to be more comfortable as well as looking good.

The third book, Dining Table Physics, is dealing with topics of food, cooking and cookery which can be found on dining tables and in the kitchen. The basic message of this book is 'physics can be healthy and useful'. This book is expected to bring physics closer to the housewives who are usually unfriendly with science and physics in particular. If housewives are equipped with scientific knowledge or at least familiar with scientific phenomena related to cooking and kitchen, there would be more active interactions with their children who are studying science in school.

The fourth book, Sports Physics, is to do with various sports which is most favorite activity among youngsters. The main message to deliver through this book is 'science is powerful and exciting'. Although science is in fact somewhat serious and abstract, it is hoped to tell the readers that science is everywhere, especially in sports, as underlying principles and as applied concepts. Most of the activities and their devices of different kinds of sports can be explained and understood on the basis of the concepts of mechanics.

Besides the books above under development, the EPIC group is also hoping to expand the scope of the Contextual Physics series. There are several titles being considered for future publication: for example, Classroom Physics (explaining physics of the things and phenomena which students can meet everyday inside the classroom, such as, whiteboard and marker, books and pencils, window glass, fluorescent lamp, beam projector, screen, table and chairs etc.), Street Physics (explaining physics of the things and phenomena which you can meet in the street, such as, traffic light system, street mirrors, bus card, road signs, vending machines, escalator, mirage on the asphalt, air pollution etc.) and others (like, Safety Physics, Unit Physics).

Although we have taught physics in schools for more than a century, we are not perfectly prepared to teach physics. Physics education specialists as well as physics teachers, although they are equipped with theories and knowledge, are often lack of practical knowledge on how physics is actually used or on how we can explain things around us. And this seems to be one of the very reasons of students' turning away physics. What we need to teach through physics is not only the contents of physics itself but also the contexts (in other words, the application or instances) of physics. The contexts, together with the content itself which we science educators have exclusively focused on, of physics are one of the two key components of physics education. The assumption, of our traditional practice of teaching science, that the knowledge of the contexts can either be delivered automatically or learned by students themselves is now to be reconsidered.

Table 4. The Series of Contextual Physics being developed by EPIC group

Book Titles	**Intended Message**	**Examples of Units Included**	**Common Features**
1. Body Physics	Mysterious & Amazing	Achilles' Tendon (Principle of Lever) Arm-wrestling (Torque) Turning (Angular Momentum) Impossible Posture (Center of Mass) Arthritis (Friction) Floating (Specific Gravity) Fatness (Electric Resistance) High Blood Pressure (Pressure, Bernoulli's theorem) Lung & Skin (Elasticity, Hook's Law) Eye (Light Spectrum) Skin Care (Electromagnetic wave) Vocal Cords (Sound Wave, Vibration) Inner Ear (Inertia) Breath (Isothermal Expansion) Magic Eye (Light Reflection)	**(Series Constitution)** - 4 Books (or more) - about 20 Units / Book **(Structure of a Topic)** Diary of a Student + Conversation between a Scientist and His Assistant + Introduction of Physics Concepts + Wisdom Boxes (History & Life) + Hand-on Activity **(Characters)** Diary (Several Teenagers) + Conversation btw. Scientist & Assistant (e.g. Newton & U-turn)
2. Wearing Physics	Charming & Convenient	Suntan (Ultra Violet Light) Mobile Phone (Electromagnetic Wave) Gore-Tex (Phase Transition, Water & Vapor) Headphones (Hz, dB, Wave Interference) Ice Vest (Thermal Transfer) Masks (Order of Size) Backpack (Balance of Forces, Torque) Safety Helmet (Momentum & Impulse) Hair Band (Elasticity) Spectacles (Refractive index, Aberration) Diamond (Reflection, Refraction) Watch (Fluorescence, Phosphorescence, Energy Level)	
3. Dining Table Physics	Healthy & Useful	Kimchi Refrigerator (Change of State, Latent Heat) Hot Pot (Conduction & Convection of Heat) Eggs (Laws of Motion) Dish Dryer (Ultra Violet Light, Fluorescence) Egg Bomb (Electromagnetic Wave,) Cookery (Lever) Diet Cock (Calorie, Density) Boiling Water (Boiling & Sound) Spoons (Lens & Reflection) Gas Cooker (Piezoelectricity) Instant Noodles (Air Pressure) Pizza (Falling & Circular Motion)	
4. Sports Physics	Powerful & Exciting	Bicycle (Center of mass, Work & Power) Badminton/Tennis (Trajectory, Sweet Spot) Snow Board (Terminal Speed, Circular Motion) Skating (Angular Momentum, Friction) Soccer (Bernoulli's theorem, Restitution, Spin) Basketball (Spin, Balance of Forces) Martial Art (Momentum, Impulse, Torque) Marathon (Velocity, Acceleration, Action-Reaction) Sports on the Moon (Gravity, Trajectory)	

(EPIC: Education of Physics In Context, a research group in Seoul National University)

6. Conclusion

The curriculum of science, national or local, usually contains four common goals (that is, scientific knowledge, scientific inquiry, scientific attitudes, and relationship between science and society). But it is often lack of the ultimate goal of studying science, that is, for what we need to study science after all. It could be a highly value-added statement which tends to be avoided by science educators, maybe based on the common belief that science should not be value-biased. However the author strongly believe that we need to address the valued-added goals and pursue more explicitly them and that the goal of science education needs to be something to do with 'science serving for human welfare'. Particularly, in this high technology-driven society in which human being as a whole is much dependent on science, school science must share the spirit (or philosophy) of humanism. It is thus argued that the philosophical background of science education needs to be 'scientific humanism'.

As shown in Table 1, with this stance, the issue of context becomes important. The context brings us the questions of 5W1H (i.e. who, what, when, where, why, and how) and thus the meaning of science learning. In order to achieve this, once again we need to pay more attention to the contexts to which we have not been attuned so far, as illustrated in Table 2. That is why informal (or free-choice) science education and science culture activities, beyond the boundaries of curriculum and school, are highly demanded these days.

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