Practical Suggestions for the Effective Use of Everyday Context in Teaching Physics −based on the analysis of students' learning processes−

Hyun Suk Jeong · Jongwon Park*
Chonnam National University

Abstract: Even though many researchers have reported that everyday contexts can arouse students' interests and improve their science learning, the connection between everyday context and physics learning is not yet clearly discussed. In our study, at first, we assumed five guidelines for helping the development of teaching materials for physics learning in everyday context. Based on these guidelines, we developed teaching materials for understanding basic optics and applied these materials to ninth grade students. From the positive responses of students and science teachers about the developed materials, we could confirm that the guidelines were reflected well in the materials. And also, it was found that students and teachers wanted to learn or teach context-based physics in future classroom learning. However, all students do not receive benefits from learning physics in everyday context. By analyzing students' actual learning processes and interviews with them, we found five potential impeding factors which could hinder students' successful learning of physics in everyday context. As a result, we suggested five recommendations for overcoming these impeding factors.

Key words: teaching physics, everyday contexts, developing teaching materials, impeding factors in learning physics, basic optics

I. Introduction

Responding to critics complaining about an over-emphasis of too abstract and too much mathematical knowledge involved in physics learning (e.g., Olsher *et al*., 1999), many studies have stressed the importance of contextualized physics learning (e.g., Campbell *et al*., 2000; Keeves and Aikenhead 1995; Mayoh and Knutton, 1997; Park and Lee, 2004). They have claimed that students' physics learning, under the slogan of "Science for All", should be relevant to their everyday life, itself, rather than professional skills and knowledge of a scientist. With this intention, a lot of new science courses introducing and applying everyday context, such as the Dutch PLON project, the Large Context Problem approach in Canada, the applications-led approach in Scotland (UK), Event Centered Learning in Brazil and the UK, the Supported Learning in Physics Project in the UK, and the Victorian Certificate of Education physics course in Australia, have been developed and implemented for schools (Wilkinson, 1999a).

Various positive effects have been reported using everyday context-based approach. Lubben *et al*. (1996) observed that the "speculation" phase where students were asked to think about the possible explanation of everyday context could improve their conceptual understanding. Ramsden (1997) found that context-based teaching using Salter's Science Course encouraged students to have interests in their studying. Baker and Millar (1999) also observed that many students' conceptual understanding was improved when they learned chemistry using the context-based course (Salters' Advanced Chemistry). There has also been a report that new courses using everyday context led more students to enroll in physics courses in Australia (Whitelegg and Parry, 1999; Wilkinson, 1999b).

However, it is also true that more detailed research for teaching and learning physics in

*Corresponding author: Jongwon Park (jwpark94@jnu.ac.kr)
**Received on 22 April 2011, Accepted on 1 November 2011

everyday context are necessary. For instance, Cajas (1999) claimed that even though the connection between everyday context and learning physics in school looks simple, plausible, and desirable, the connection is complex, difficult and rarely studied. Therefore, more concrete and practical guidelines and students' and teachers' responses-based recommendations for the effective use of everyday context in physics learning are needed.

As a guideline for developing everyday context-based teaching materials, we can consider the comment that science learning in everyday context can be effective only when teaching styles do not reflect a teacher-centered approach (Lubben *et al.*, 1996). And many educators have emphasized that teaching science in everyday context should start from a student's personal experience. However, in the previous research, it is not easy to find out more concrete and practical guidelines for teaching science in everyday context.

Therefore, our first concern is to establish a list of concrete guidelines for designing teaching materials in everyday context. And based on actual application of teaching materials using everyday context into school physics teaching, an extracting recommendations for more effective use of the everyday context is our second concern.

When investigating the effect of newly developed teaching materials on students' learning, usually overall enhancements of or changes in students' academic achievements or affective aspects such as interest and attitude are investigated. However, even though there can be overall improvement in students' interest and conceptual understanding, some students may fail to experience an interest or improvement in the provided everyday context. Thus these students may face of unexpected difficulties in achieving their learning goals. For instance, Ramsden (1994) found that, even though students enjoyed everyday contexts and showed interests on the future relevance of this kind of learning to their lives, some students felt difficulty because of performing excessive quantities of worksheets. Three years after, Ramsden (1997) again observed that the context-based approach could stimulate students' interest in science, but this new approach did not show a difference in conceptual understanding compared to a traditional approach. In the Baker and Millar's (1999) study, the researchers indicated that, after teaching a context-based program, some of the students failed to change their misunderstanding about chemistry, even though the majority of high school students benefited from Salters' Advanced Course. Campbell *et al.* (2000) obtained data showing students' low achievement in recognizing social and economical implications of science, in using experimental design skills, and in applying science to solve everyday problems. They interpreted that this result was because learning science through everyday context did not guarantee effective use of science into everyday activities.

Therefore, some science teachers think that learning science in everyday context may not be always helpful for students' learning. Wilkinson (1999b) investigated teachers' perceptions of teaching physics through everyday contexts and found that 52% of physics teachers believed that the use of contexts had improved students' understanding of physics. However, 25% thought that the contexts did not help students' understanding. Therefore, we need to identify what aspects of learning in everyday context can make students fail to achieve their learning goals.

In this study, we observed and analyzed students' actual learning processes to identify potential impeding factors which can disturb successful science learning in everyday context. Using this practical data, we suggested more practical recommendations for effective use of everyday context for physics learning. The detailed purposes of this study have been to

(1) develop teaching materials for physics in everyday context, implement the materials for students, and obtain and analyze physics teachers' and students' responses about the developed teaching materials.
(2) investigate students' actual learning processes to extract learning difficulties and unexpected impeding factors which disturb their successful learning.
(3) finally, suggest practical recommendations for effective use of the everyday context in teaching physics.

Ⅱ. Situation of Physics Learning in Korea

Many of us have worried about the decrease of students' preference in the subject of physics. Spall et al. (2004) observed that secondary school students showed less positive interest in learning about physics than biology. Osborne (2003) found that only 4% of 3,551 boys (15 years old) responded that physics was easy. In Korea also, it was found that the number of students selecting an advanced physics course in the national examination for university entrance (CSAT: College Scholastic Ability Test) was very low. Among students who selected an advance science course (Physics Ⅱ, Chemistry Ⅱ, Biology Ⅱ, or Earth science Ⅱ) in the exam, only 13.5% of them selected physics Ⅱ in 2005, 12.6% in 2006, and 10.3% in 2007, respectively (KICE, 2004; 2005; 2006). TIMSS 2003 also reported that only 9 % of Korean eighth grade students (average age=14.6) answered that they enjoyed science and 62% of them did not enjoyed it, even though their achievement in science ranked fourth in 46 countries (Martin *et al.*, 2004). According to Kim and Lee (2006), among contents indicated as being an "uninteresting unit" by seventh grade Korean students in their integrated science textbook, 32% of these units belonged to the physics part. For eighth, ninth, and tenth grade students, 42%, 56%, and 35% of uninteresting units were physics, respectively.

Ⅲ. Research Procedure

Development of learning worksheets

In this study, worksheets were developed for learning basic optics in everyday context for grade 9 students. To do this, we established following five basic guidelines for developing the worksheets:

(1) Everyday context should include context of everyday life, natural phenomena, or technological applications.
(2) Everyday context should be able to stimulate students' interests in learning physics.
(3) Everyday context, itself, should involve information and contents worthy of understanding.
(4) Everyday context should not make students' learning difficult because of additional and complex information related to the context.
(5) Everyday context should be closely related to the physics concepts to be learned.

Choi and Song (1996) ranked the order of Korean students' preferred contexts: (1) everyday life, (2) living things, (3) sports, (4) military weapons, (5) laboratory, and (6) natural phenomena. Milner (1986) suggested the use of context of technology and environment for teaching physics as well as pure scientific context. In this study, except for the context of military weapons because of its inhumanity, as the first guideline for worksheets, we regarded an everyday context as the context of everyday life, technological applications, or natural phenomena.

One of the basic reasons for introducing everyday context is to enhance, improve, or encourage students' interests and curiosity in learning physics. Therefore, learning worksheets need to be interesting to students.

As the third guideline, we required that everyday context should involve information meaningful to students. This means that everyday context is not just the only vehicle or means for enhancing students' interest and conceptual understanding of physics but also should involve contents helping students qualify their scientific literacy.

By introducing everyday context into learning physics, the amount of contents may be increased. Also, since actual situations in everyday context can be complex, it can make students feel that the contextual approach is difficult for them. For instance, when we try to explain electrostatic phenomena in a copy machine, the complicated inner structure of the machine can interrupt students' understanding of the basic concepts of electrostatics. Therefore, we suggested the fourth guideline.

The final guideline is necessary because students sometimes may fail to link the everyday context with conceptual understanding. For instance, some students think that frictionless motion in an abstract physics world is irrelevant to their everyday experiences where motion is always exposed to friction (Schecker, 1992). Therefore, we suggested the final guideline. We need to give an intentional effort for linking everyday context with a physics concept.

According to the above five guidelines, we developed the learning worksheets consisting of two parts: a context part and a concept part. The basic structure of the learning worksheets is described in Table 1.

According to table 1, learning started from introducing and exploring everyday context (everyday context part) and went through learning physics concept (physics concept part).

With this 2 stage structure, 4 topics of basic optics, including reflection of light, an image with the plane mirror, refraction of light, and concave/convex lenses were developed. And details about everyday contexts used in each topic are described in Table 2.

Subjects and Questionnaire

In this study, twenty six science teachers and twenty eight students (grade =9) participated. They were asked to answer the questionnaire developed to investigate their recognition about physics learning in everyday context. All students answered the questionnaire after learning optics for 4 hours using the worksheets developed in this study.

Science teachers were also asked to review the worksheet at first and then to answer the questionnaire. The reason that teachers were asked to answer the questionnaire was to check out whether science teachers agreed with that the developed teaching materials in this study could be actually helpful students' learning physics.

To provide sufficient time to think about the

Table 1
Two parts of learning worksheets

Part	Contents
Everyday context	E1: Introduction of the everyday context
	E2: Activities for exploring the everyday context
	E3: Summary of the main features of the everyday context
Physics concept	P1: Introduction of the basic features, definition, or related phenomena about the physics concept.
	P2: Activities to enhance understanding of the physics concept
	P3: A link between the physics concept and the everyday context
	P4: A summary and application of the learned physics concept

Table 2
Major activities in learning worksheets for each topic.

Topic	Part	Major Activities
Reflection of light	Context	Observing retro–reflection by traffic signs for night use.
	Concept	Law of reflection at a plane mirror. Explaining the retro–reflected light in 3 plane mirrors.
Image of plane mirror	Context	Taking a photo in front of the plane mirror. Observing a half mirror.
	Concept	Drawing the image formed by reflection in a plane mirror. Explaining interesting phenomena (related to the image formed) by a plane mirror.
Refraction of light	Context	Observing photos of mirage at the Arctic region and on a hot asphalt pavement. Observing a coin that lies at the bottom of a cup of water.
	Concept	Law of refraction Explaining a curved laser light by varying refraction indices of sugar solution in a water tank.
Lenses	Context	Making a convex lens camera. Exploring the structure of our eyes Identifying two types of eye–glasses.
	Concept	Drawing a refracted ray in concave and convex lenses qualitatively. Drawing a ray of light passing through eye glasses.

worksheets to the science teachers, 13 teachers among 26 reviewed only two topics and other 13 teachers reviewed the remaining two topics. Besides the four questions for students, science teachers were asked an additional two questions as shown in Table 3.

Subjects responded to each question (Table 2) by making a check on a five–point scale, comprised of −2, −1, 0, 1, and 2. The value of "−2" corresponds to "strong no"; "+2" corresponds to "strong yes". "0" indicates a neutral answer.

Table 3
Questionnaire

No.	Questions
QI.	In general, are worksheets interesting to students?
QⅡ.	Is the information about the contexts provided in the worksheets worthy of learning?
QⅢ.	In general, are worksheets easy for students?
QⅣ.	Is the teaching (or learning) physics using everyday context good and appropriate for future classroom teaching (or learning)?
QⅤ*.	Do contexts provided in worksheets include everyday life, technology, or natural phenomena appropriately?
QⅥ*.	Are contexts related well to physics concepts to be learned?

*These two questions were not asked to students.

Observation of students' learning activities and interview

Since it took about 60 minutes (including 10 minutes for a rest break) to learn each topic, it took about 4 hours to teach 4 topics. Among twenty eight students, we selected eighteen students randomly and taught them in a classroom for 4 hours.

For the remaining nine students, we taught them one by one to observe their learning activities more in depth. It took 36 hours to observe them all because nine students learned 4 topics, respectively. During the student's learning, each student was asked to express their thinking processes using the "thinking aloud" method. The teacher conducted an interview to obtain more information about student's learning activities and processes. Through this observation and interview, we explored what benefits could be obtained from and what impeding factors could act on context-based learning. Since the questions in the interview were not pre-determined and different questions were asked according to student's responses on worksheets, we present the actual interview questions in Section III, Results, with their answers.

Students' thinking-aloud reports about their thinking and answers to interview questions were audio-recorded and analyzed. From this analysis, we obtained concrete recommendations for future application of everyday context in teaching physics.

Ⅲ. Results

Teachers' and students' responses on the worksheets

In Table 4, the results dealing with students' and teachers' recognition about the developed worksheet are described.

Table 4. Students' and teachers' recognition about learning and teaching physics in everyday context

* means the statistically significant difference between students and teachers ($p<.05$)

** means the statistically significant difference between students and teachers ($p<.01$)

For question Q1, students and teachers answered that learning physics using everyday context was interesting to students. Teachers answered more positively compared to students (students' answer= 0.91, teachers' answer =1.21, and $p<.05$). Then, why did students feel the material to be less interesting than teachers? In fact, this question can be solved by more deep analysis about students' actual learning process. The result from this analysis in the later section will say that students can show less interest on the everyday context when the everyday context is not familiar to them because they did not experience the provided context at all, when it is too complex to observe directly and to understand conceptually, and when it is provided as a form of reading materials without any hands-on activities. Therefore, in a later section, besides four guidelines for developing worksheets, we suggest additional recommendations for effective use of everyday context in physics learning.

For question Q2, students and teachers responded that the content and information involved in the everyday context was worthy of learning in a physics classroom. Here, the rate of teachers' responses was higher than students (students' answer = 1.36, teachers' answer =1.69, and $p<.01$). This may be because teachers more realized that there were connection between the everyday context and a physics concept compare to students. That is, it can be inferred that teachers thought that understanding the information of everyday context could help students' physics learning. This interpretation is supported by the following result about Q6 (teachers' answer about the link between the two=1.58).

In the results about Q3 in Table 4, because

Table 4

Students' and teachers' recognition about learning and teaching physics in everyday context

Question	Topic	Student	Teacher	Average
Q1. Interest in the worksheet	Reflection of light	1.18	1.69	1.44
	Image in the plane mirror	0.89*	1.38*	1.14
	Refraction of light	0.86	0.92	0.89
	Lenses	0.71	0.85	0.78
	Average	0.91*	1.21*	1.06
Q2. Information concerning context	Reflection of light	1.54*	1.92*	1.73
	Image in the plane mirror	1.32*	1.85*	1.58
	Refraction of light	1.25	1.69	1.47
	Lenses	1.32	1.31	1.31
	Average	1.36**	1.69**	1.52
Q3. Difficulty of the worksheet	Reflection of light	1.04*	0.38*	0.71
	Image in the plane mirror	0.82*	0.08*	0.45
	Refraction of light	0.29	0.15	0.22
	Lenses	0.54	−0.08	0.23
	Average	0.67**	0.13**	0.40
Q4. Appropriateness for future teaching (or learning)	Reflection of light	1.75	1.85	1.80
	Image in the plane mirror	1.64	1.92	1.78
	Refraction of light	1.25	1.38	1.32
	Lenses	1.25	1.31	1.28
	Average	1.47	1.62	1.54
Q5. Appropriateness of the contexts	Reflection of light	•	1.77	•
	Image in the plane mirror	•	1.62	•
	Refraction of light	•	1.38	•
	Lenses	•	0.92	•
	Average	•	1.42	•
Q6. Link between context and concepts	Reflection of light	•	1.85	•
	Image in the plane mirror	•	1.38	•
	Refraction of light	•	1.54	•
	Lenses	•	1.54	•
	Average	•	1.58	•

*means the statistically significant difference between students and teachers ($p<.05$)
**means the statistically significant difference between students and teachers ($p<.01$)

response of 1 means that the worksheet is easy to study and 2 means "very easy", we can say that students thought that learning "reflection of light" in everyday context was easy (students' answer = 1.04). Because it is well known that students are reluctant to study science if they perceive it as difficult (Dlamini et al., 1996), the students' response to Q3 indicates that the new worksheets are appropriate for their learning. Another interesting result is that students recognized that the worksheets are easier than the teachers acknowledged (students' answer = 0.67, teachers' answer = 0.13, and $p<.01$). Usually, students tend to feel the difficulty of a learning topic or materials as compared to the science teacher. Therefore, from this result, we can infer that everyday context can affect students' recognition about the difficulty of learning material more positively beyond the expectation of the science teacher.

It was reported that Korean students wanted to learn science in everyday context such as everyday life, living things, and sports (Choi and Song, 1996). In Q4, students and teachers also answered that students highly wanted to learn physics in everyday context in future classrooms. There was no statistical difference between students' and teachers' responses (students=1.47, teachers=1.62, and $p>.05$). Therefore the two stages-structure of the worksheet and four guidelines suggested in this study can be useful approach for developing teaching materials for physics in an everyday context.

Q5 and Q6 were asked to only science teachers because these questions were about the structure of the worksheets. In Q5, science teachers highly agreed that the provided contexts as shown in Table 2 were appropriate as everyday context (average=1.42). In Q6, teachers said that the everyday contexts were connected to the physics concepts well (average=1.58). These results means that the developers' intention of teaching materials in everyday context was reflected well into the worksheets.

From the positive responses on questionnaire, we could confirm that five guidelines for developing teaching materials using everyday context reflected well into the worksheets, because the first guideline corresponded to Q5, the second guideline corresponded to Q1, the third to Q2, the fourth to Q3, and the fifth guideline corresponded to Q6. Q4 was used to obtain students' overall responses on the new approach by asking whether they wanted to learn physics in everyday context in a future class.

Recommendations for more effective physics teaching in everyday context

In the previous section, we found that students and teachers, who participated in this study, generally thought that the provided worksheets were not difficult to study and were interesting and involved valuable and meaningful contents in contexts. These worksheets were recommended as a future teaching or learning materials in the physics classroom. Moreover, science teachers responded that the contexts in the worksheets were appropriate as everyday context and also connected to physics concepts well.

However, these findings do not guarantee students' successful learning because some students may fail to understand physics concepts or the context itself correctly in certain aspects, may not feel any interests in the provided contexts, or may show any other unexpected cognitive or affective difficulties.

Therefore, we observed students' individual actual learning activities and conducted interviews to find out any difficulties or factors impeding effective and successful physics learning in everyday context. From an analysis of teacher's observation and interviews, we found five aspects:

> *1st finding: Some of the everyday contexts are not experienced by or familiar to the students. In that case, some students showed indifference to the context or even disbelieved it for the reason that the students had not experienced the context.*

1st recommendation: *Because everyday contexts may be unfamiliar and uninteresting to students if they have not experienced these contexts, we need to give opportunities to students for exploring or experiencing the context itself.*

When preparing everyday contexts, we expect that the contexts will stimulate students' interests. However, we found that some contexts provided in the worksheets were neither experienced nor familiar to some students. For instance, some students who did not have an experience of observing mirages at all showed indifference to the mirage and, in some cases, thought that the mirage was not real.

Some students: (after reading the description about the mirage at the Arctic area) It cannot be real. Isn't it computer graphics?
Teacher: Can you believe this (mirage) if it is a real photo?
Student HM*: (I don't think so) It must be a composite picture. The oasis in the desert also may be imaginational.
Student B*: I did not see the mirage on the asphalt pavement. It (indicating the photo) must be nonsense! If it is true, this may be because the some components like oils from the asphalt are dissolved due to the hot sunlight.
* A capital letter is used instead of a student's real name

Therefore, we prepared and showed a simple demonstration (as shown in Figure 1) that laser light is curved like the situation that mirage is formed in the Arctic region. In Figure 1, there is more concentrated sugar water in the lower part of the water tank, but thin sugar water in the upper part. Since the density of sugar water is changed gradually, laser light can be refracted smoothly and, as a result, be curved.

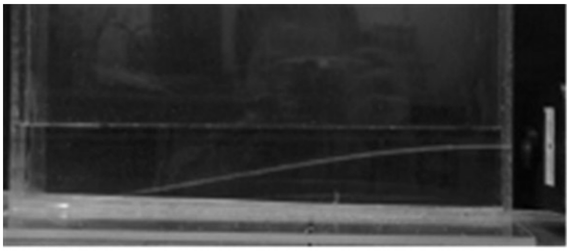


Fig. 1 *Curved laser light inside the sugar watered tank.*

In this case, after exploring the phenomena of the curved light in Figure 1, they agreed that a mirage could be possible.

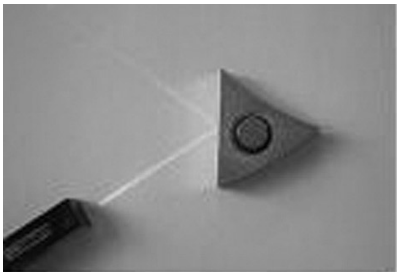
(after observing the curved laser light inside the sugar water tank as shown in Figure 1)
Teacher: Can you believe the mirage?
Student H: Yes, the mirage is a possible phenomenon in nature!

Therefore, based on this work, we suggest the first recommendation that 'We need to give opportunities to students for exploring or experiencing the context itself.' This recommendation is the same as with the Ramsden's (1994) note that "(learning science in everyday context should) start from personal experience".

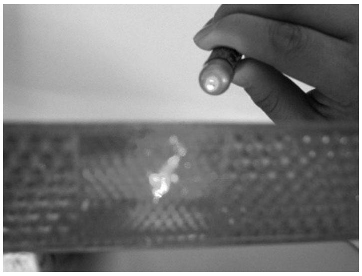
2nd finding: *Sometimes it is not easy to understand main features of everyday context in the case that the context is complex compared to an abstracted situation.*

2nd recommendation: *We need to simplify everyday contexts especially when the context is complex.*

When using everyday context, we observed that some everyday contexts might hinder students' direct observations because the structure of everyday context is often very detailed or complex. For instance, students could easily envision the reflected light from a single plane mirror as shown in Figure 2(a). However,



(a) reflection in a single plane mirror



(b) reflected light from an actual traffic sign for night

Fig. 2 *Reflected light from the plane mirror and the actual traffic sign (All theses figures were used in worksheets) (In the photo (b), the reflected lights are spreading out around fingers)*

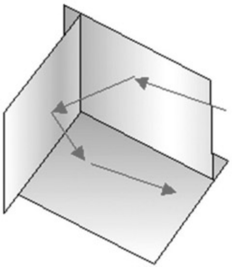
when they tried to observe the retro-reflected light from an actual traffic sign in the night (see Figure 2(b)), some students complained that 'The light (reflected from the traffic sign) looks like it is spreading out, so I can't see ... (where the reflected light goes on)'.

In fact, everyday context tend to be more complex than the idealized situations provided in ordinary science textbooks (Cajas, 1999). Therefore, we need to be concerned about how we can simplify the complex everyday contexts. Regarding complex situation mentioned in Figure 2, in this study, we provided figure indicating the path of retro-reflected light in three mirrors (Figure 3(a)), and prepared a simple demonstration designed to help students observe simply the path of retro-reflected light by submerging three large plane mirrors into a water tank as shown in Figure 3(b).

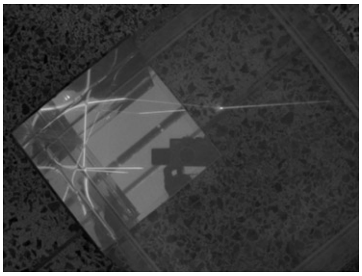
3rd finding: Simply reading materials about everyday context may not draw students' attention.

3rd recommendation: We need to develop specific teaching strategies for helping students' reading comprehension of science text.

Even though reading comprehension is important in learning science (Darian 2003; Lemke 1990; Otero, *et al.* 2002), many students mainly have focused on mathematical problem solving processes, information including graphs or diagrams, and practical activities rather than reading text (Koch, 2001). As a result, many students are often reluctant to read the



(a) Three plane mirrors and the path of the reflected light



(b) retro-reflection in three plane mirrors submerged in a water tank

Fig. 3 *The retro-reflected light from the three plane mirrors* sentences in physics textbook. For instance, Lee and Park (unpublished) observed that students often fail to capture the important information in textbooks when they tried to understand a major physics concept from a text explaining the relationship between force and motion deductively. Park and Lee (2004), in the process of solving physics problems in everyday context, found that some students missed important information in the text useful in problem solving because the problem, as described in the text describing everyday context of the problem, was usually long and complex.

Likewise, in this study, we also observed that many students read texts without specific concern or interest when everyday contexts were provided just as a form of reading material. In this case, even immediately after reading the materials, some students often did not give correct answers to the questions regarding the everyday context. They responded, 'I just read it without any imagination (thinking)'. This was not because reading materials were written badly and in a difficult way but because students read the texts without any concern.

Student HM: How do I have to answer here (indicating the direction in the worksheet)?
Teacher: Can you read it again carefully?
Student HM: (after reading it again and completing the answer in the worksheet) It is not difficult compared to the first reading.

Therefore, as a 3rd recommendation, we need to develop specific strategies for helping students' reading comprehension of science text.

4th finding: Some students had misconceptions about the given everyday context. In this case, students may interpret or understand the everyday context differently than the teacher's intention.
4th recommendation: We need to investigate and identify students' alternative ideas about the everyday context.

In this study, we also observed that some students had misconceptions or alternative ideas about some everyday contexts. For instance, in the first topic about an image by a plane mirror, after taking a photo in front of the large plane mirror (Figure 4), a student could identify where the image was formed by measuring the telemeter of the camera operated in a manual mode. That is, if a student took a photo 2 meters in front of the mirror, the telemeter of the camera indicated 4 meters because the image by the mirror was formed 2 meters in back of the mirror.

Fig. 4 *Taking a photo in front of the mirror*

The above activity of taking a picture in front of the mirror was designed to help students to realize that the image of a plane mirror was formed in the back of the mirror; however, some students insisted that the image in the mirror by the plane mirror is made on the surface of the mirror:

Teacher: Where is the image produced by the plane mirror?
Student E: On the surface of the mirror.
Teacher: You read 4 meters in the telemeter of the camera.
Student E: Even though the image is established in the back of the mirror, I know that this image is not real but a virtual image.

Therefore, the image is (actually) formed on the surface of the mirror.

Also, some students said that the mirage was a kind of an optical illusion; 'This phenomena (mirage) is an optical illusion made by a deep wish of the man (searching for water in the desert)'. When teaching the refraction of light (the third topic in Table 2), students were asked to explain why the depth of the creek looked shallow, and some students answered, 'This is because water acts like a convex lens, so if water acts like a concave lens, the creek will look deep' This may be because students know that the enlarged image through the convex lens looks closer.

As a result, we need to understand students' various and different ideas or interpretations about everyday context for effective teaching of science in everyday context.

5th finding: Some students start to have interests in everyday context after understanding the physics concepts.

5th recommendation: In some cases, it can be helpful to provide everyday context after the physics concepts because understanding physics concept can arouse students' interests in everyday context.

In this study, worksheets were developed with two stages: the everyday context in the first stage and physics concepts in the second stage. The reason that the everyday context was introduced at first was because it was expected that the everyday context could stimulate students' interest before understanding the abstract physics concept. However, we observed that some students showed low interests in the everyday context, because they could not understand why and how some phenomena in everyday context could happen. In this case, understanding the physics concept at first could help students realize that the context was interesting. For instance, we mentioned that some students rejected the mirage as virtual phenomena in the first stage of learning. However, after understanding the basic idea about the refraction of light in the second stage of the worksheet, they responded that the mirage was really interesting and curious.

(After learning about the refraction of light in the second stage of the third topic)
Teacher: Will you read again explanation about the mirage here (indicating the first part of the worksheet)?
Student YJ: (after reading it a little) I know the mirage now! Because the sunlight is too strong (hot), a mirage can be made by refraction (of light).
(after reading it more)
Student YJ: Oh! Mirage. It is interesting, mirage….

In the second topic (in Table 2) about the image of the plane mirror, student "HG", who answered that 'I think the image is formed on the surface' in the first stage of worksheet, showed interest in the everyday context after drawing an image of the plane mirror by applying the law of reflection in the second stage:

Teacher: Which is the most interesting?
Student HG: Taking a photo with camera (taking a photo in the front of mirror as shown in Figure 5) and …. It becomes interesting to me because I know now that the image is formed behind the mirror!"

From these observations, we can recommend that everyday context need not be introduced at first necessarily, but can be explored after learning basic concepts or treated in a cyclical manner with concepts. As results, the five recommendations are summarized in Table 5.

Table 5

Five recommendations for more effective physics teaching in everyday context

Recommendations
1st: Because everyday contexts may be unfamiliar and uninteresting to students if they have not experienced these contexts, we need to give opportunities to students for exploring or experiencing the context itself.
2nd: We need to simplify everyday contexts especially when the context is complex.
3rd: We need to develop specific teaching strategies for helping students' reading comprehension of science text.
4th: We need to investigate and identify students' alternative ideas about the everyday context.
5th: In some cases, it can be helpful to provide everyday context after the physics concepts because understanding physics concept can arouse students' interests in everyday context.

Ⅳ. Conclusions

In this study, at first, we developed teaching materials for teaching physics in everyday context using five practical guidelines. Even though there have been many efforts for developing new context-based curriculum, it is very strange that no one has suggested concrete and practical guidelines for helping our development of teaching materials in everyday context. In this aspect, this study confirmed, based on teachers' and students' responses about the developed materials, that five guidelines were helpful and practical for developing teaching materials for teaching physics in everyday context. Of course, the guidelines in this study cannot be complete. These guidelines need more refinements and improvements based on future research actions.

Classically, when we develop new teaching approaches, we have tested these approaches' effects or benefits by comparing initial states of students' attitude, conceptual understanding, or other affective and cognitive features with the final states of these aspects after complementing new approaches. However, in these situations, we cannot obtain more detailed information on what aspects of the new approaches actually take on an important role in students' learning and what kind of potential impeding factors can hinder their learning. In fact, in many cases, even though there are overall improvements in students' learning, there are inevitably some students who fail to get benefits from new approaches.

Therefore, secondly, in this study, we found these impeding factors by observing students' actual learning processes and by having interviews with them. As results, we extracted five impeding factors.

And thirdly, we could suggest five practical recommendations for more effective teaching physics in everyday context by getting over above finding impeding factors. We hope that the suggested recommendations should be tested and revised based on future research.

Finally, it is worth noting that there should be additional studies to generalize and confirm the results of this study. For example, we need to obtain more data from more students and teachers in different subject matters such as chemistry, biology, or earth science.

In fact, examples of everyday contexts are very diverse, for instance, home appliances including remote control, touch screen of the mobile phone, digital camera, etc, health care including X-ray, CT, artificial joint, etc, and leisure life including yachting, taking pictures, climbing mountain, etc. Besides these examples, there should be so many everyday contexts related to learning science. If then, important question is that which everyday contexts need to be introduced in science curriculum in each grade. If we cannot determine the basic items of everyday context as minimum but essential materials for learning science, this means that any everyday context can be used in teaching science. Then, emphasis of learning science in everyday context may give a heavy burden on students' science learning. Therefore, in the further study, we need to have concern about this.

References

Baker, V., and Millar, R. (1999). Students' reasoning about chemical reactions: what changes occur during a context-based post-16 chemistry course? *International Journal of Science Education*, 21(6), 645-665.

Cajas, F. (1999). Public understanding of science: using technology to enhance school science in everyday life. *International Journal of Science Education*, 21(7), 765-773.

Campbell, B., Lubben, F., and Dlamini, Z. (2000). Learning science through contexts: helping pupils make sense of everyday situations. *International Journal of Science Education*, 22(3), 239-252.

Choi, J., & Song, J. (1996). Students' preferences for different contexts for learning science. *Research in Science Education*, 26(3), 341-352.

Darian, S. (2003). *Understanding the Language of Science*. (Austin: University of Texas Press).

Dlamini, B., Lubben, F., & Campbell, B. (1996). Liked and disliked learning activities: Responses of swazi students to science materials with a technological approach. *Research in Science & Technological Education*, 14(2), 221-235.

Keeves, L., & Aikenhead, G. (1995). Science curricula in a changing world. In B.J. Fraser & H.J. Walberg (Eds.), *Improving Science Education* (pp. 13-45). Chicago: The University of Chicago Press.

Kim. H., & Lee, B. (2006). Why do secondary students perceive physics is uninteresting and difficult? *Sae Mulli (The Korean Physical Society)*, 52(6), 521-529.

Koch, A. (2001). Training in metacognition and comprehension of physics texts. *Science Education*, 85, 758-768.

Korean Institute of Curriculum and Evaluation [KICE] (2004, December 14). *2005 the results of scoring the CSAT (College Scholastic Ability Test)*. Retrieved February 10, 2007, from http://www.kice.re.kr/kice/article/news/bidinfo/list

Korean Institute of Curriculum and Evaluation [KICE] (2005, December 19). *2006 the results of scoring the CSAT (College Scholastic Ability Test)*. Retrieved February 10, 2007, from http://www.kice.re.kr/kice/article/news/bidinfo/list

Korean Institute of Curriculum and Evaluation [KICE] (2006, December 14). *2007 the results of scoring the CSAT (College Scholastic Ability Test)*. Retrieved February 10, 2007, from http://www.kice.re.kr/kice/article/news/bidinfo/list

Lee, H., & Park, J. (unpublished). Helping Students' Conceptual Understanding about the Relationship between Force and Motion Using Deductive Explanation Tasks in Classroom.

Lemke, J.L. (1990). *Talking Science: Language, Learning, and Values*. (London: Ablex Publishing).

Lubben, F., Campbell, P., & Dlamini, B. (1996). Contextualizing science teaching in Swaziland: some student reactions. *International Journal of science Education*, 18(3), 311-320.

Martin, M.O., Mullis, Ina V.S., Gonzalez, E.J., and Chrostowski, S.J. (2004). *TIMSS 2003 International science Report*. Retrieved February 10, 2007, from http://isc.bc.edu/PDF/t03_download/T03INTLSCIRPT.pdf.

Mayoh, K. and Knutton, S. (1997). Using out-of-school experience in science lesson: reality or rhetoric? *International Journal of Science Education*, 19(7), 849-867.

Milner, B. (1986). Why teach science and why to all? In J. Nellist & B. Nicholl (Eds.), *ASE Science teachers' Handbook* (pp. 1–39). London: Hutchinson.

Ministry of Education & Human Resources Development. (1997). *High School Curriculum (1): Report No. 1997–15*. Seoul, Korea: DaeHan Textbook, Inc.

Olsher, G., Doar Beit Berl, and Dreyfus, A. (1999). Biotechnologies as a context for enhancing junior high–school students' ability to ask meaningful questions about abstract biological processes. *International Journal of Science Education*, 21(2), 137–153.

Osborne, J. (2003). Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education*, 25(9), 1049–1079.

Otero, J., Leon, J.A. & Graesser, A.C. (2002). *The Psychology of Science Text Comprehension*. (London: Lawrence Erlbaum Associates, Publishers).

Park, J, & Lee, I. (2004). Analyzing cognitive or non–cognitive factors involved in the process of physics problem–solving in everyday context. *International Journal of Science Education*, 26(13), 1577–1595.

Ramsden, J. (1994). Context and activity–based science in action. *School Science and Review*, 75(272), 7–14.

Ramsden, J. (1997). How does a context–based approach influence understanding of key chemical ideas at 16+. *International Journal of Science Education*, 19, 697–710.

Schecker, H. (1992). The paradigmatic change in mechanics: Implications of historical processes for physics education. *Science & Education*, 1(1), 71–76.

Spall, K., Stanisstreet, M., Dickson, D. & Boyes, E. (2004). Development of school students' constructions of biology and physics. *International Journal of Science Education*, 26(7), 787–803.

Whitelegg, E., & Parry M. (1999). Real–life contexts for learning physics: meanings, issues and practice. *Physics Education*, 32(2), 68–72.

Wilkinson, J.W. (1999a). The contextual approach to teaching physics. *Australian Science Teachers Journal*, 45(4), 43–50.

Wilkinson, J.W. (1999b). Teachers' perceptions of the contextual approach to teaching VCE physics. *Australian Science Teachers Journal*, 45(2), 58–65.