Introducing people knowledge into science learning

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Abstract: A weakness inherent in science education has been (and remains) its emphasis principally on the teaching of scientific knowledge, i.e. knowledge of the object (or the observed). Little attention has been directed to the teaching of people knowledge about scientists, i.e. knowledge of the subject (or the observer) who creates knowledge. This study explores the nature of this people knowledge and its possible effects on science learning. There are two types of people knowledge identified through this study: breadth-oriented people knowledge (BPK) and depth-oriented people knowledge (DPK). BPK profiles scientists' scientific achievements across life whereas DPK describes scientists' intellectual struggle in relation to their theory building. The findings indicate that the two types of people knowledge are fundamentally different in nature and it is only DPK that is beneficial to science learning (e.g., deepening students' understanding of scientific theories and making science learning environments more humanly interesting).

Overview

Scientific knowledge organizations in science curricula are person-neutral (AAAS, 1993; Hodson, 1998; NRC, 1996). As reflected in science textbooks, a major knowledge source in science learning (Memory & Uhlhorn, 1991), scientific knowledge is normally organized around natural objects (e.g., scientific facts, concepts, and theories). Rarely seen in any science textbooks is knowledge organized around people (e.g., scientists' intellectual struggle with theory building) (Souque, 1987; Hodson, 1998). The emphasis on object-oriented knowledge, in part, is because helping students acquire objective knowledge of nature is a central goal in science education (AAAS, 1993; NRC, 1996). Accordingly, students' cognitive learning experience in science becomes highly person-irrelevant. Some critics, however, see this kind of dualism as a severe flaw in science. For example, Snow (1965) described the distinctness between science and humanities as a gap between "two cultures" and predicted such distinctive cultures would bring more harm than good to mankind. Jenkins (1989) deemed it as a weakness as science does not tell people its humanistic components. To avoid such dualism and to increase students' person-related understanding of science, research in the past has tried to integrate the teaching of history of science (see, e.g., Brush, 1989; Jenkins, 1989; Klopfer, 1969; Klopfer & Cooley, 1963) and science-technology-society (see, e.g., Solomon & Aikenhead, 1994) into science education. Despite the fact that these alternative teaching approaches have helped students develop more informed understanding of related human, social, and cultural aspects in science, they do not necessarily provide students with the kind of cognitive learning experience that is highly person-relevant (e.g., personal history of scientists). As argued by Michael Novak, "Historical detail, if present, consists only of sprinkling of the names of great scientist with no attempt to relate the personalities and personal histories of these people to their discoveries" (as cited from Martin & Brouwer, 1991, p.716).

Recent research, however, indicates humans not only organize their knowledge around natural objects, but also have an innate tendency to organize their knowledge around people. For example, neurocognitive research has suggested that people can possess exceptional knowledge about others, such as knowledge about a famous person (Hodges & Graham, 1998; Ross & Hodges, 1997). Social cognitive research also indicates that even very young children can have a fairly sophisticated knowledge of others (Bretherton, McNew & Beeghly-Smith, 1981). More recent brain studies even suggest that humans' memory for others (person-related knowledge) is in relation to mental activities that often occurred within a specific brain region (see, e.g., Mason, Banfield, & Macrae, 2004; Mitchell, Heatherton, & Macrae, 2002; Thompson, Graham, Williams, Patterson, Kapur, & Hodges, 2004). In contrast, mental activities related to object-related knowledge and animal-related knowledge are found to be occurring more frequently in other specific brain regions (Mason, Banfield, & Macrae, 2004; Thompson et al, 2004; Caramazza & Shelton, 1998). These findings seem to suggest that knowledge organized around people may have a special status in human cognition and learning. Yet, little is known about the role of such person-relevant knowledge organization in relation to students' science learning experience.

In the present study, we refer to this phenomenon of knowledge organized around people as "people knowledge" (see, Hong, 2005; Hong & Lin, 2005; Lin & Bransford, 2005). Of minimal research in the past that investigated possible learning effects in relation to people knowledge, it is generally suggested that people knowledge is beneficial to learning. For example, Loftus and Loftus (1974) have found that college students' people knowledge—as measured by students' recall of names of psychologists—plays a key role in influencing how they memorize and retrieve their domain knowledge in psychology. Also, people knowledge—as reflected in the extent to which the author's identity and personality is revealed to its readers—is found to be useful for enhancing students' interest in reading statistical textbooks (Nolen, 1995) and history textbooks (Paxton, 1997). Lin and Bransford (2005) found that students' knowledge of their teacher can influence whether and how students would like to learn from and work with their teacher. Davis, Lee, Vye, Bransford, & Schwartz (2006) note that the addition of people knowledge to curricula can improve general class learning. Specifically in science education, Palincsar and Magnusson (2001) found young children were highly motivated to learn because of the involvement of a fictitious scientist called Lesley Park, who shared with them documented personal inquiry experiences regarding investigations of light. Hong & Lin (2005) further suggested that people knowledge about scientists can play an important role in influencing how students remember and understand certain scientific concepts. Despite the fact that increased human understanding seems to benefit learning, a critical issue that remains unclear is the exact nature of people knowledge, as knowledge organized around people can refer to any aspects of human understanding (e.g., a person's name, personalities, work experiences, etc.). A more systemic definition and investigation is thus necessary in order to better understand the nature of people knowledge and its role in relation to science learning.

Arguably, knowing a person is a continual process and can take two general approaches. It can start from, for example, knowing a target person's name, profession, job title, and physical features (superficial people knowledge), to knowing the target person's work experiences, successes, and achievements across life (in-breadth people knowledge), or to knowing the target person's underlying motives, basic values, dispositions, personality, strengths and weaknesses in learning, and recurrent patterns in emotions, thought and behavior (in-depth people knowledge). As argued above, knowledge organized around scientists is rarely seen in science curricula. If so, it is certainly not the in-depth kind of people knowledge. For example, Souque (1987) has found that scientists are all too often superficially presented only with their names and dated discoveries in the majority of science textbooks. To some degree, some textbooks may include scientists' personal profiles in a brief summary. Such profiles are however commonly presented in each chapter as supplementary learning materials, e.g. a scientist's picture with a short description of what he or she has discovered. Other times, they are presented as a part of the general introduction to the history of science in a single chapter (Brackenridge, 1989). In both cases, the presentation of scientists is highly focused on the superficiality or breadth of people knowledge, i.e., what they have discovered or accomplished in life. What is rarely seen in science textbooks is the portrayal of scientists from a more depth-oriented perspective, illustrating scientists' intellectual struggle in relation to their theory building process. Unfortunately, this is also observed in informal science learning. According to Dagher and Ford (2005), "Biographies of historic scientists were characterized by a relative absence of description of how scientists arrived at their knowledge especially in books addressing younger readers." (p.377). In short, research in the past has not systemically explored the nature of people knowledge and have not investigated to what extent can different types of people knowledge affect science learning, either. The purpose of this study is to investigate whether the two types of people knowledge (i.e., in-breadth vs. in-depth people knowledge) have any different effects on the following aspects of science learning: image of scientists, memory, problem-solving, and science learning interest.

Method

This study was conducted in a public trade school (also a senior high school) in Taipei, Taiwan. In Taiwan, students are required to take the National Basic Competence Test (NBCT) in order to enter a senior high school; and usually students who were not able to enter a college-bound general high school will enter a trade school, and those who were not able to enter a trade school may choose to go to work. Thus, trade school students tend to be academically lower-achieving. Based on the NBCT, admission requirement for this school was a percentile rank of 46th and above, and the average percentile rank for students who entered this school was 51st. For this school in particular, students were trained to be mechanics and technicians. Participants were 323 10th graders (age between 16 and 18) from nine classes, which were selected out of 20 classes using convenience sampling. The nine classes were then randomly assigned into three conditions: Breadth-oriented people knowledge (BPK) group, depth-oriented people knowledge (DPK) group, and superficial people knowledge (SPK)/control group.

This study employed a between-subject design and the intervention constitutes two major sets of learning materials. The first was three science lessons. Introduced from the first to the third lesson were the following scientific laws/theories: (1) Galileo's Law of Free Fall and Law of Inertia; (2) Newton's three Laws of Motion and Law of Gravity; and (3) Einstein's Theories of Relativity. The time needed to self-study a lesson is about 15 minutes. All three groups were required to self-study all three lessons. The second set of learning materials was concerned with people knowledge. For each scientist in each lesson (e.g., Einstein) introduced, there were two types of people knowledge materials prepared: BPK and DPK materials. BPK materials profile scientists' scientific achievements across life. Below is an exemplified excerpt: "Between 1589 and 1592, Galileo disproved Aristotle's theory that heavier objects fall faster than lighter ones, and in 1610, Galileo discovered four moons orbiting Jupiter." By contrast, DPK materials describe scientists' intellectual struggles in relation to their theory building process. As an example, here is an excerpt: "…While the famous fable suggests that Newton was inspired by seeing an apple dropped form a tree, it was actually his hard work and inquisitive nature that led to his discovery of the theory of gravity. As he said, 'I keep the subject constantly before me, till the first dawnings open slowly, little by little, into the full and clear light'." The time needed to self-study each scientist (either BPK or DPK) is about 10 minutes. Both sets of materials were adopted from various biographic or autobiographic sources (Einstein, 1956; Haven, 1996, 1997; Machamer, 1998; Schilpp, 1951; White, 1997). BPK and DPK materials were only used by the BKP and DPK groups respectively. The control group received no PK materials. All self-study activities were held in a computer-based learning environment. The PK learning materials were designed to humanize science learning and to make the online learning environment more humanly inspiring.

Major dependent variables in this study include the following instruments (all pilot-tested with demographically similar students): (1) A "specific image of the three scientists survey" (three open-ended questions, e.g., "Could you describe three things about Einstein that impress you the most?), employed as a post-survey to assess students' specific image of the three scientists, Galileo, Newton, and Einstein; (2) A "general image of all scientists survey" (18 Likert-scaled items, e.g., "Scientists takes his/her work seriously.", Cronbach Alpha reliability 0.74), used as a pre-post-survey to assess students' image change of all scientists in general; (3) The "memory retention test" (three 20-item multiple-choice questions, Cronbach Alpha reliability 0.70), used as a post-test and was administered twice to measure students' immediate and delayed (after a week) memory retention of the key terms/concepts learned in the three science lessons; (4) A "well-structured problem-solving test" (30 multiple-choice questions, e.g., "Which of the following situations Newton's First Law of motion does not apply?", Cronbach Alpha reliability 0.81), employed as a post-test to evaluate students understanding of textbook problems; (5) An "ill-structured problem-solving test" (seven open-ended questions, e.g., "Could you describe the relationship between Galileo's law of inertia and Newton's First Law of Motion? Is there anything in common between these two laws?", content-validated by science experts), a post-test to evaluate students understanding of the relationships between different scientific laws/theories studied in the lessons; (6) A "interestingness of the three online science lessons survey" (14 Likert-scaled questions, e.g., "I enjoy learning the laws or theories described in the lesson", Cronbach Alpha reliability estimate was 0.93), used a post-survey to assess to what extent students think the online science lessons as interesting. In addition, a "personal information sheet" was used to collect additional data, e.g., whether students are personally interested in science and whether they already possess extensive knowledge about the three scientists under study. The section chief of Research Division, Mr. H, at the subject school was the sole experimenter for this study to ensure the same experiment procedures were applied in every class.

Results and discussion

To ensure the validity of the study, students who already possess extensive knowledge of the three scientists (N=8) and those who did not complete the surveys or tests (numbers vary) were excluded for further analysis. As a baseline comparison, students' final science grades from the previous semester were compared. A one-way ANOVA showed no significant difference ($F_{(2,320)}=2.97$, $p>.05$) between the three groups (N=106, M=66.8, SD=11.3 for the DPK group; N=110, M=67.1, SD=11.4 for the BPK group; and N=107, M=63.3, SD=15.2 for the control group).

1. Impact of people knowledge on students' specific and general images of scientists

First, two specific kinds of images—achievement-oriented vs. inquiry-oriented—emerged from the open coding of data based on the grounded theory method (Strauss & Corbin, 1990). Inter-rater agreement between two researchers who coded the two images was 0.96. As a result, it was observed that students tended to possess a much stronger achievement-oriented image than an inquiry-oriented image, towards the three scientists (Galileo, Newton, and Einstein) introduced in the lessons (t=20.37, df=291, p=.0000). This is to be expected as these three scientists are well-known for their scientific achievements. To explore group differences in terms of these two specific kinds of images, one-way ANOVAs were conducted. First, a significant difference was observed between groups in terms of inquiry-related image ($F_{(2,289)}=39.91$, $p<.001$). A post hoc analysis showed the DPK group scored higher than both the BPK group (post hoc, p<.001) and the control group (post hoc, p<.001). As it appears, DPK students' perceived image of the three scientists tended to be more inquiry-related. For example, many DPK students mentioned Galileo never gave up and kept experimenting. Second, in terms of the achievement-related image, it was found that the pattern was quite contrary. There is a significant difference between groups ($F_{(2,289)}=30.71$, $p<.001$) in that the BPK group scored higher than the DPK group (post hoc, p<.001) and the control group (post hoc, p<.001). That is, the image of the three scientists perceived by the BPK students tended to be more achievement-related. For example, many BPK students mentioned that Newton was a genius. In terms of general image of all scientist, within-subject analysis (i.e., pre-post t-tests within each group) revealed no significant differences in the DPK group (t=.548, df=94, p>.05, two-tailed) and the control group (t=1.492, df=101, p>.05, two-tailed). However, there was a significant difference found in the BPK group (t=.3053, df=93, p<.01, two-tailed), suggesting that introducing scientists' achievements and successes to students seem to reinforce a less realistic general image of all scientists among students. Table 1 summarizes the findings regarding students' specific and general images of scientists.

In summary, the findings indicate that the two types of people knowledge have caused different imagery effects on science learning. The question is "Why?" One possible explanation is that these two types of PK represent two very different kinds of personal history. First, DPK represents a more process-oriented kind of personal history, which highlights a scientist's intellectual struggle in relation to the development of particular scientific theories. Understandably, one's image of a certain person is largely shaped by one's understanding of that person. So introducing to students the scientists' knowledge-seeking process should help students gain a deeper knowledge of how a scientist works with knowledge, thus a more inquiry-related image. By contrast, BPK represents a more outcome-oriented kind of personal history, which profiles a scientist's major scientific successes throughout life. Knowledge organization, as such, gives an overview of a person in a relatively thorough, nevertheless superficial, manner. And when over-exposed to scientists' achievements and successes (breath-oriented people knowledge), an unrealistic image of all scientists (e.g. all scientists are genius) is likely to take shape. The findings basically confirm the current research on image of scientists. As science education continues to promote person-neutral knowledge (i.e. BPK), not DPK, it is not surprising that students' unrealistic or stereotypical image of scientists continue to persist as a long-standing issue (see e.g., Barman, 1997; Chambers, 1983; Beardslee & O'Dowd, 1961; Souque, 1987; Brush, 1979; Kirschner, 1992; Driver, Leach, Millar & Scott, 1996).

Table 1: Impact of people knowledge on students' general and specific image of scientists.

	Groups								
	DPK		BPK		Ctrl				
Variables	M	SD	M	SD	M	SD	df	F	Scheffe test
Specific Image	(N=89)		(N=102)		(N=101)				
Inquiry-related	1.74	1.66	0.55	0.75	0.48	0.63	2, 289	39.91	DPK>BPK*** DPK>Ctrl***
Achievement-related	3.47	2.07	5.84	2.09	3.97	2.50	2, 289	30.71	BPK>DPK*** BPK>Ctrl***
General image	(N=95)		(N=94)		(N=102)				
Pre-post change (pretest)	-0.03 (4.27)	0.45 (0.45)	-0.18 (4.17)	0.56 (0.55)	-0.08 (4.00)	0.51 (0.56)	n.a.	n.a.	

**p<.01 *** p<.001

2. Impact of people knowledge on science content knowledge

Regarding the immediate Memory Test, first, the overall average scores of the three lessons revealed a significant difference between the three groups ($F_{(2,312)}$=3.952, p<.05), in which the control group outperformed the DPK group (post hoc, p<.05). Second, regarding the delayed memory test, the overall average scores of all three lessons also revealed a significant difference between groups ($F_{(2,312)}$=9.966, p<.001), with the DPK group outperforming the control group (post hoc, p<.001). The pattern observed here is totally opposite to that observed from the immediate Memory Test. Third, in terms of well-structured (textbook) problem-solving, the overall average scores of all three lessons have revealed that there was no significant difference existing between groups ($F_{(2,312)}$ = 1.626, p = 1.98). Finally, in terms of ill-structured problem-solving test (i.e., test on students' understanding of the relationships between different scientific laws/theories), the results showed that there was a significant difference between the three groups ($F_{(2,312)}$=29.349, p<.001). Post hoc analyses revealed that the DPK group outperformed both the BPK group (post hoc, p<.001) and the control group (post hoc, p<.001). As an example, in answering the question, "Could you describe the relationship between Galileo's law of inertia and Newton's First Law of Motion?", most DPK students (and few BPK students) were able elaborate that a commonality between these two laws were the concept of inertia and that Newton further improved Galileo's theory. Table 2 summarizes the results.

In summary, there are two major findings in the memory test. First, DPK seems to have generated two interesting opposite effects. That is, in the immediate memory test, the DPK group was outperformed by the control group, but in the delayed memory test, the DPK group outperformed the control group. Second, the BPK seems to have generated no effect on both immediate and delayed test results as compared with the control group. Why? It is conjectured that as compared with BPK, there are relatively stronger emotional components embedded in the storyline of the DPK. Emotions (such as scientists' passion and love for science, unrelenting spirit in experiments, and deep commitment to knowledge advancement) are a natural part of DPK when scientists were portrayed through their intellectual struggle of theory-building. It is believed that such embedded emotion has influenced how students remembered the key terms in the lessons. As recent emotional research in cognitive neuroscience suggests, emotionally arousing events are more likely than more neutral events to be recalled later (Labar & Cabeza, 2006; see also Hamann, 2001, for reviews). But this does not explain why the same effect was not attained in the immediate memory test. Perhaps this can be accounted for also by an emotional factor called "emotion-induced forgetting". According to this theory, "emotionally arousing stimuli can lead to retrograde amnesia for preceding events and anterograde amnesia for subsequent events." (e.g., Hurlemann, Hawellek, Matusch, Kolsch, Wollersen, Madea, et al. 2005). By contrast, BPK seems to have less to do with emotions, as compared with DPK, because emotions were less highlighted when profiling scientists' objective scientific discoveries and achievements in life. Therefore, it appeared to demonstrate relatively neutral effect on students' memory retention, regardless of immediate and delayed memory tests.

In terms of findings for ill-structured problems, an important factor that makes DPK useful (and BPK less useful) may be its capacity to make scientists' thinking or theory-building process more transparent. Clearly, when scientists' intellectual struggle (DPK), is made visible to students, it also makes clearer how a scientist thinks during an inquiry (e.g., how he/she formulates and continually improves his/her theory) or how a theory generated by one scientist is further improved by another scientist. On the other hand, when PK presented by means of scientists' achievements and successes (BPK) or in a superficial manner (i.e., the control group), it misses the opportunity for students to learn from (e.g., modeling) and learn through (e.g., perspective-taking) scientists' thinking processes. This may explain why DPK was able to deepen students' understanding of relationships between scientific laws/theories as the context of scientists' thinking or theory-building processes are more accessible. These findings are in agreement with literature regarding the importance of making expert thinking visible for modeling learning and problem solving (see, e.g., Collins, Brown & Holum, 1991; Dunbar, 1995; Dunbar, 2000; Rahm & Downey, 2002; Williams, Papierno, Makel & Ceci, 2004; Schoenfeld, 1985). On the other hand, the reason why both types of people knowledge have no impact on well-structured (textbook) problem-solving may have to do with the nature of problem types. Textbook problems are usually designed with certain recipes or obvious formula as answers or solutions, which are naturally part of the content knowledge contained in the three science lessons. Thus, both types of people knowledge provide little help in solving such problems.

Table 2. Impact of people knowledge on science content knowledge.

	Groups								
	DPK		BPK		Ctrl				
Variables	M	SD	M	SD	M	SD	df	F	Scheffe test
Immediate memory test									
Overall effect (all 3 lessons averaged)	11.2	1.5	11.7	2.1	11.9	2	2, 312	3.957	Ctrl >DPK*
Delayed memory test									
Overall effect (all 3 lessons averaged)	12.9	1.9	12.2	2.1	11.6	2	2, 312	9.966	DPK> Ctrl***
Well-structured problems									
Overall effect (all 3 lessons averaged)	4.7	1.7	5	1.5	4.6	1.9	2, 312	1.626	
Ill-structured problems	1.9	1.7	0.7	1.1	0.7	0.8	2, 312	29.349	DPK>BPK*** DPK> Ctrl***

* $p<.05$ **$p<.01$ *** $p<.001$

3. Impact of people knowledge on interestingness of science lessons

Overall analysis. First, a one-way ANOVA has revealed no significant difference between the three groups ($F_{(2, 293)} = 1.895$, $p = .152$ for all lessons combined). To explore further, all above participants (n=296) were further divided into two groups: those with high individual interest in science (High-II, n=135) and those with low individual interest in science (Low-II, n=151), based on their self report on a question, "Are you interested in science?" surveyed in the Personal Information Sheet. Ten students who did not provide answers were excluded from further analysis. As a baseline, these two groups were first compared; and it was found that there was a significant difference between these two groups in their rating as to how interesting the three online science lessons were to them (t=-4.207, df=284, p<.001, two-tailed). Students with Low-II (N=151) rated the three science lessons as much less interesting (M=129.17; SD=25.77) than students (N=135) with High-II (M=145.39; SD=25.47). An additional comparison between these two groups further indicated that there is also a significant difference (t=3.311, df=300, p<.01) in terms of students' science grades in the previous semester

(N=140, M=68.7, SD=13 for High-II students; and N=162, M=63.8, SD=12.2 for Low-II students), suggesting that students with Low-II tend also to be the low science achievers. The baseline comparison suggests that students' self report in individual interest was a reliable data for the following analysis.

Specific analysis on High-II vs. Low-II students. First, for the High-II group (N=48 for the DPK group, N=51 for the BPK group, N=41 for the control group), a one-way ANOVA has showed a significant difference between groups ($F_{(2,132)}$=4.091, p<.05). A further post hoc analysis showed that the control group scored higher than the BPK group (p<.05). Second, for the other Low-II group (N=50 for the DPK group, N=51 for the BPK group, N=53 for the control group), a one-way ANOVA showed that a significant difference exists between groups ($F_{(2,148)}$=5.20, p<.01) in which the DPK group outperformed the control group (post hoc, p<.01). Table 3 summarize the results in this section.

According to Hidi and Anderson (1992), there are two fundamental kinds of interest: individual and situational interest. Individual (or personal) interest basically means interest that students bring to some learning environment. For example, typically some students will come to a science classroom already interested in the subject while others may not (Mitchell, 1993). On the other hand, situational interest means interest that students acquire by participating in a learning environment. In summary, there are two major findings in this aspect of science learning: (1) for students with low individual interest, DPK appeared to have a positive effect on how they perceived the interestingness of the online lessons (i.e., situational interest due to environment); and (2) for students with high individual interest, BPK appeared to have a negative effect on situational interest. For the first finding, one possible explanation may be when students' individual interest is low, situational interest due to environment becomes more important. According to Kintsch (1980) there are two types of text-based situational interest: cognitive and emotional interest. It is possible that the two types of text-based situational interest were aroused by scientists' visible thinking and emotions embedded in DPK; therefore situational interest due to the environment was raised. For the second finding, when students' individual interest is high, it is relatively more difficult to get them even more interested in the lessons. And the reason why the BPK group perceived the interestingness of the online lessons (situational interest) as less interesting may be because information about scientists' achievements and successes is less relevant to the overall understanding of the three science lessons.

Table 3. Impact of people knowledge on science learning interest.

	Groups								
	DPK		BPK		Ctrl				
Variables	M	SD	M	SD	M	SD	df	F	Scheffe test
All students									
Overall effect (all 3 lessons averaged)	143	19.4	136	24.9	138	29.6	2, 293	1.895	
High-II Students only									
Overall effect (all 3 lessons averaged)	146	19.6	141	22.9	155	24.7	2, 132	4.091	Ctrl>BPK*
Low-II Students only									
Overall effect (all 3 lessons averaged)	139	19	132	23.8	124	25.1	2, 148	5.200	DPK>Ctrl**

* p<.05. **p<.01. *** p<.001.

Conclusions

The findings in the present study have suggested that providing students with a more person-relevant science learning experience can benefit their science learning. But more importantly, the findings also revealed that in order for people knowledge to be beneficial, it is essential to distinguish between *knowledge about* scientists (breadth-oriented people knowledge) and *knowledge of* scientists (depth-oriented people knowledge) when introducing people knowledge into science learning. As assessed in the present study, it is only the in-depth kind of people knowledge that will help students develop a more realistic image of scientists, better understand the evolutionary nature of scientific theories, and shape a more humanly inspiring science learning environment. Unfortunately, the kind of people knowledge being introduced in science education tends to be the superficial and in-breadth kinds. As argued by Hodson (1998), "The school science curriculum continues to promote some grossly distorted views of scientists" (p.191). In concluding, we would like to cite what I. I. Rabi, a Nobel Laureate in Physics, cogently proposed as an alternative to science teaching and learning:

Science is an adventure of the whole human race to learn to live in and perhaps to love the universe in which they are. To be a part of it is to understand, to understand oneself, to begin to feel that there is a capacity within man far beyond what he felt he had, of an infinite extension of human possibilities…I propose that science be taught at whatever level, from the lowest to the highest, in the humanistic way. It should be taught with a certain historical understanding, with a certain philosophical understanding, with a social understanding and a human understanding in the sense of the biography, the nature of the people who made this construction, the triumphs, the trials, the tribulations. (Holton, Rutherford, & Watson, 1970).

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