INCORPORATING INDONESIAN STUDENTS' "FUNDS OF KNOWLEDGE" INTO TEACHING SCIENCE TO SUSTAIN THEIR INTEREST IN SCIENCE

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Abstract. The purpose of this study was to examine the effect of incorporating students' funds of knowledge in the teaching of science in sustaining Indonesian students' interest in science. The researchers employed mixed method approach in this study. This study took place within two suburban secondary schools in Indonesia. Two teachers and a total of 173 students (94 males and 79 females) participated in this study. The findings revealed that initially, most students expected that the teaching process would mainly include science experiments or other hands-on activities. Their preferences revealed a critical problem related to science learning: a lack of meaningful science-related activities in the classroom. The findings showed that incorporating students' funds of knowledge into science learning processes -and thus establishing students' culture as an important and valued aspect of science learning was effective in not only sustaining but also improving students' attitudes and increasing their interest in science.

Keywords: funds of knowledge, interest in science, teaching and learning science, Indonesia

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Introduction

There is a broad agreement that all teaching should "build on" the interests and experiences of the students. The lack of connection between students' experiences and science become increasingly as major concern for researchers in the area of science education research especially for students from marginalized groups. McNeill et al. (2005) identified that the differences between diverse students' everyday discourses versus classroom or scientific discourses may be one cause of the achievement gap.

Thus, this study was undertaken to examine the effect of incorporating students' funds of knowledge on sustaining students' interest towards science in Indonesian schools and draw some implication from findings in order to provide a valuable suggestion for developing teaching and learning science in Indonesian schools context.

Literature review

Students' funds of knowledge

González & Moll (2002) introduce the concept of 'funds of knowledge' to identify the connection between students' home experiences and their experiential knowledge, which can be valued as part of the epistemological tradition of the classroom. The authors note that funds of knowledge are based on a simple premise: that people are competent and knowledgeable and that their life experiences have given them that knowledge.

Funds of knowledge are the cultural artifacts and bodies of knowledge that underlie household activities (Basu & Barton, 2007). Funds of knowledge are knowledge and skills gained through historical and cultural interactions that are essential for individuals to have if they are to function appropriately within their communities. In addition, they also refer to experiences and knowledge that may be more particular to a family within the context of a community, such as the knowledge that a young person might have about the care of the elderly from growing up in a family and a community that includes multiple generations.

There are important cultural resources in communities surrounding schools. Funds of knowledge are grounded in the networking that communities do to make the best use of those resources. Funds of knowledge are also transmitted from one household to another or even to the greater community. Funds of knowledge therefore include knowledge, action, and disposition or habits, with the recognition of how each of these domains is culturally constructed and refined (Basu & Barton, 2007). These elements create the connections and interactions inherent in funds of knowledge.

Incorporating funds of knowledge into learning environments suggests that education should promote social relations between schools and homes, which in turn "establish and maintain necessary trust among participants [keeping] the system active and useful" (Bouillion & Gomez, 2001). These connections, established between the school and home through a ''funds of knowledge lens'', are strategic tools for teachers looking not only to incorporate into classroom work the kinds of knowledge that are used in students' homes but also to consider how that knowledge can be intentionally used to reach a set of greater goals (González & Moll, 2002).

The challenge for the teacher is to engage students from the beginning of the learning process so that the student will feel that their ideas and experiences are honored and believe that they have a chance and a hand in their own learning. When students bring their culture into the classroom, the teacher should accommodate their life experiences to ensure effective teaching and promote “connected science” (Bouillion & Gomez, 2001) whereas scientific knowledge is applied to real-life situations to which students have been exposed. However, Fraser-Abder et al. (2006) note, the literature connecting at-home culture to the science classroom is still limited.

Developing a sustained interest in science

There is widespread agreement among educators that each society has to construct its own science curricula to fit its own needs and purposes regarding schooling. Academic science is only one of the possible inputs in this process of selection and construction. The consensus is that all teaching should consider the interests and experiences of students. In particular, everybody who subscribes to (some version of) educational constructivism will take such a stance for granted. For the material being taught to be meaningful for the learner, it must have some sort of relevance for him/her and must fit into his/her personal or societal context (Barton & Yang, 2000; Sjøberg, 2000).

Not only do learner experiences and interests vary, but it is also evident that there are similar variations in what can be said to be relevant and useful knowledge for students with such different life situations. Sjøberg (2000) argues that learning needs to be resilient to daily challenges and prepare students for a meaningful life, the definition of which will vary based on the different backgrounds of the students.

According to Sjøberg (2000) students' ideas about the nature of science, the personalities of scientists and the purpose and meaning of their activities may have different sources. They may emerge from the media and influences outside school, or they may arise from students’ encounters with school science and science teachers. Some student ideas may arise from their own culture and the prevailing world-views, ideologies, and religious or other sorts of beliefs associated with that culture. These factors are of a more affective nature; they are related to feelings, ideals and values. They may influence students' level of eagerness, motivation or interest in learning science.

Basu & Barton (2007) argue that science curricula are a key factor in developing and sustaining students' interest in science. There seems to be a broad agreement about the shortcomings of the traditional curricula that still exist in most countries. In that context, science is still mainly seen as a massive body of authoritative and unquestionable knowledge. Consequently, students may become disengaged from school science because their funds of knowledge are not incorporated into the science curriculum (Basu & Barton (2007)

Basu & Barton (2007) and Sjøberg (2002) further argue that to build on the interests and experiences of the learner, it may be necessary to abandon the notion of a common, more or less universal, science curriculum in favor of curricula and teaching materials that are more context-bound and that take into account for both gender and cultural diversity. It has also been argued that the problems related to interest in and attitudes about science cannot be regarded as solely educational but rather need to be understood and addressed in a wider social, cultural and political context (Sjøberg, 2002).

Based on Basu & Barton (2007) research findings, it is quite clear that the main reason for the decline in students' interest in science is not merely gender differences or the new approach to teaching and learning science. To develop and sustain students' interest in science, one should consider the entire interrelationship between curricular, behavioral, and organizational changes, the development of the interests and experiences of students, and an emphasis on students' funds of knowledge.

Methodology

This study employed a mixed-method design involving both quantitative and qualitative methods (Brewer & Hunter, 1989), aimed to examine the teaching of science which incorporated students' funds of knowledge on students' interests towards science. This study took place in two sub-urban Junior High Schools in Indonesia.

Participants

Students at St. George and St. Paul Secondary Schools (both school names are pseudonyms) formed the sample for this study. There were 173 students, 94 males and 79 females, most of whom were 13–14 years old. The students were from various socio-cultural backgrounds. A total of 79% of the students were Javanese, 17% were Chinese and the rest from the Batak, Papua, Melayu, Betawi, and Flores ethnic groups. There were no Chinese students in St. Paul. Almost all students in St. Paul were Javanese. However, in St. George, 40% of the students were Chinese. Two science teachers, one teacher from each school involved in this study.

A workshop for teachers

Prior to the teachers planning for instruction, a workshop facilitated by the researchers was conducted. During the workshop, the teachers were trained to incorporate students' funds of knowledge into their teaching. The elements of science learning that tend to make science foreign to students were discussed. To provide teachers with a clear understanding of the concept of funds of knowledge, a discussion session was established during the workshop. This session presented the means which teachers should investigate students' funds of knowledge. Finally, curricular design was also discussed; and an example of a lesson plan was introduced to the teachers.

Initially, the teachers maintained an explicit mode of instruction to promote student engagement. Because we were building on the strengths of teachers and on those of students with shared cultures, the researchers did not direct the teachers how to teach. However, the researchers did encourage the use of activities that gradually transitioned toward exploration as students gained experience with modes of inquiry. The teachers maintained structured classroom environments and were aware of difficulties that could arise if students were given tasks of which they had limited understanding and over which teachers exercised limited control.

Data collection and analysis

There were two questionnaires used in this study, *The changes in attitude about the relevance of science questionnaire* developed by Siegel & Ranney (2003) and *Students' Interests Questionnaire* developed by Trumper (2006).

(1) The changes in attitude about the relevance of science questionnaire

This questionnaire was designed to evaluate the developing changes in students' attitudes. The questionnaire consisted of 59 items separated into three partially redundant final scales (pretest, posttest, and delayed posttest) with 25 items each. The extreme categories of students' attitudes questionnaires in the Likert scale was labeled from *strongly disagree* (coded 1) to *strongly agree* (coded 5) Other questions had a list of statements, and the students were asked to indicate in a 5-point Likert scale whether they were *very not interested* (coded 1) or *very interested* (coded 5). The questionnaire was a reasonably reliable instrument, as indicated by the internal consistency of each scale being above 0.80, and for all 59 items it was 0.91.

(2) Students' Interests Questionnaire

This questionnaire was part of whole questionnaires developed and validated by Sjøberg during The Relevance of Science Education (ROSE) comparative project in 2003. The extreme categories of students' interests questionnaire in the Likert scale was labeled from *very not interested* (coded 1) to *very interested* (coded 5). This instrument consists of four domains as follows: a) students' interest in science (22 items with Cronbach's $\alpha = 0.88$), b) students' attitude towards their science classes (13 items with Cronbach's $\alpha = 0.89$), c) students' opinion about science and technology (16 items with Cronbach's $\alpha = 0.79$), and d) students' interest in out-of-school experiences in science (17 items with Cronbach's $\alpha = 0.84$). Only one domain (students' interest in science) was used in this research. Only 15 (out of 22) items relevant to the topics covered in the science curriculum at Grade VII and VIII Junior High School in Indonesia was selected.

This instrument has not been used in any Indonesian school before. The questionnaires were first translated into the Indonesian language. The instruments (the Indonesian version) had been used in a pilot study involving 79 Grade VII students in St. George. The results of the pilot test indicated that reliabilities of instruments (15 selected items) of students' interest in science was $\alpha = 0.78$, indicating that the questionnaire is acceptable. Semi-structured interviews using open-ended questions were conducted to explore students' funds of knowledge. To develop rich, meaningful portraits of the students, they were invited to elaborate and expand their answers. There were 20 students involved in this interview process: 11 females and 9 males. The interviews lasted a half-hour to an hour depending on the amount of time allotted to the process by their schools. Students' responses to the questionnaire and their commentary in the interviews were considered in developing lesson plans that would incorporate their funds of knowledge. Interviews were also conducted with teachers to determine their insights into and experiences implementing the lesson plans developed. To keep track of students' experiences, each student was given a task of journal writing in which to write about his/her experiences during the lesson. Students were also asked to keep track of their learning experiences in this journal. At the end of the study, the journals were collected as part of the data.

Additionally, questionnaires inquiring about student interests and attitudes were administered to examine changes in both of those areas. These questionnaires were administered before implementation (as a pre-test), after implementation (as a post-test) and at the end of the semester (as a delayed post-test). To facilitate the data analysis, all qualitative data collected were organized carefully. This process involved 'tidying up' data, organizing them into files, labeling the files, transferring them into an electronic format, putting them into directories, and organizing and reducing data according to ideas, themes, units, patterns, and structures that are visible within them. This involves some forms of coding and categorizing data. Participants' words as included in the following section are edited and translated as all participants use colloquial language (the Indonesian language).

Findings

Supportive learning environment

Specific students' responses stressed the learning process. Students felt that learning was exciting, interesting and even challenging. Using a teaching process in which students' funds of knowledge were incorporated made the concepts being learned seem more relevant and made them easier to understand. Table 1 shows the students' experiences with the learning process in terms of learning environment.

Table 1. Students' experiences in learning process

	Total (N=151)	St. George (N=65)	St. Paul (N=86)	Male (N=78)	Female (N=73)
Learning is exciting and interesting	60 (40%)	11 (17%)	49 (57%)	36 (46%)	24 (33%)
Learning is challenging	28 (19%)	8 (12%)	20 (23%)	18 (23%)	10 (14%)
Topics are relevant	29 (19%)	15 (23%)	14 (16%)	15 (19%)	14 (19%)

Forty percent of 151 students considered learning to be a complete process that was also exciting and interesting. Twenty-three percent of 65 students from St. George felt that topic they were learning about was relevant versus 16% of 86 students. The students from St. Paul felt that learning was challenging. The strategies for teaching science developed in this study helped the girls to understand science. More girls had experience that made the topics easy to understand.

The students felt that the classroom atmosphere was supportive and that this made them enjoy carrying out the activities. The lessons were both fun and challenging. Additionally, the teachers' support was effective and made lessons easy to understand. As for the media used by teacher, they made the topics and activities presented even the discussion interesting. The following excerpts are some examples of comments that demonstrate students' interest in this manner of learning.

> It is easy to learn and fun (Student Journal_1, line 473)
>
> Both teacher and friends are exciting (Student Journal_2, line 486)
>
> I can understand movement as discussed (Student Journal_2, line 1080)
>
> Fun in terms of classroom atmosphere and a good teacher support (Student Journal_2, line 65)
>
> I can ask friends and answer the questions of friends and lessons today is exciting (Student Journal_2, line 1268)
>
> Interesting because of the teacher's explanation (Student Journal_1, line 98)

The supportive environment led students to feel challenged and made them feel quite positive. Hence, the students' desire to ask their friends questions related to the subject at hand increased. Most of the students' responses noting that the lessons were also challenging indicated their curiosity about the topics, their wanting to know how things work, their wanting to know more about science, their wanting to know how to do experiments and how to formulate questions, and their wanting to understand more about daily life as it relates to science.

> There is new equation, I was curious of sound and others. (Student Journal_1, line 884)
>
> The examples of resonance phenomena motivate me to learn more on resonance (Student Journal_2, line 737)
>
> I want to understand more about daily life that related to science (Student Journal_2, line 545)
>
> I want to know how to do resonance experiment (Student Journal_2, line 618)
>
> I want to know how things work (Student Journal_2, line 15)
>
> I want to know more deeply about science (Student Journal_2, line 256)

The students responded that the topics being discussed were also relevant to everyday life. *"Teacher explained using story that related to topics and it could be applied in daily life"* (Student Journal_2, line 554). Moreover, the relevance of topics for discussion was also considered. "*In discussion of topics that usually be done in daily life"* (Student Journal_1, line 1126) Students' experiences as relevant to science teaching in this way increased their awareness about the relation between science and human life. The following excerpts are examples that demonstrate this.

> The phenomena that already happened actually related to science (Student Journal_2, line 596)
>
> The activities in science influence the daily life (Student Journal_2, line 627)

> Science is closely related to daily life (Student Journal_1, line 224)
>
> Science is important for people in daily life (Student Journal_2, line 114)

Even though incorporating students' funds of knowledge had an impact on student learning, there was also evidence that there were students who still did not find learning interesting when the material was presented in this way, as they explicitly expressed in their journals. The data also shows that only a small number of students were receptive to particular tasks, such as observing and designing experiments. For instance, 9% of 115 students were interested in designing experiments.

There is also evidence that being curious during learning activities has led students to develop awareness that these modes of learning could enable them to *"learn how to be a scientist"* (Student Journal_2, line 338). Furthermore, the students commented that during the activities, they felt like young scientists. The activities *"could make a child like a scientist"* (Student Journal_2, line 286).

Sustaining students' interest

The data above indicate an increase in students' interest in learning. The increase in students' curiosity is one of these indicators. The teachers' interviews also included similar evidence. The teacher from the lower-performance school (St. Paul) was very happy to discover that her students' behavior had changed for the better. This change was visible in their dedication to learn and improvement in their level of interest. The following excerpts provide specifics.

> In fact, they were happy with the lessons. Their interests emerge and one that I always feel was there was a smile. Moreover, after leaving the class they always asked "Miss, what else will we learn for tomorrow?" That made me challenging. It appeared that they were interested in the learning process that had been done. (Teacher Interview_2, line 204-209)

> I observed, they were much more different, which used to shout or say “bad” words in the learning activities. It had been reduced even in outside the classroom, or when they passed me on the road. They were more polite, and I felt very happy with all this. Students now liked to ask me question in outside class. "Miss … so … it should relate to the science" "Then, what about this …? … That was great, so their interest in learning was increased. (Teacher Interview_2, line 378-386)
>
> They were very open. They showed happiness on their face, not feeling bored. They welcomed me and looked happy with saying me “good morning Miss”. They were always curious. Their curiosity was growing. (Teacher Interview_2, line 402-405)

Similarly, the teacher from St. George found that his students showed greater interest in their learning. They were eager to attempt the activities and specifically expressed that they had achieved what they had expected. The following excerpts indicate as much.

> The first, their interests were excitement. That was something that.... (who) initially did not know.... through activities and found out by themselves ... that was something made them happy. They expressed with the expression "YES" loudly. (Teacher Interview_1, line 160-163)
>
> It is more interesting. Yes, I was pleased them to find out for their own, and they did successfully, and then they expressed. That was later on,… if I made an evaluation ... ... the result was extraordinary. (Teacher Interview_1, line 174-176)

To find the level of students’ interests and attitudes towards science, questionnaires were administered on three different occasions. The first questionnaire (Pre-test) was administered before the implementation of the new mode of instruction (at the beginning of the semester). The second questionnaire (Post-test) was administered right after implementation. The third questionnaire (Delayed post-test) was administered at the end of the semester. Fig. 1 shows the times when the questionnaires were administered and the results from the questionnaires. The findings from the three tests showed increasingly positive views toward science. The attitudes and interest of the students from St. George were scored on a 1–5 continuum, from ‘‘strongly disagree’’ to ‘‘strongly agree’’, with regard to the relevance of science. The scores averaged between 3 and 4 (neutral and agree) at every point in time. The average scores are shown in Fig. 1.

Time (Week)	Teaching Method	Questionnaires	Result: Mean Score (1-5 scale)			
			Attitudes		Interests	
			St. George	St. Paul	St. George	St. Paul
1	Traditional teaching	➢ Pretest	3.61 (.35)	3.60 (.33)	3.55 (.42)	3.70 (.42)
2						
3						
4						
5						
6	**Teaching which incorporating students’ Funds of Knowledge**					
7						
8						
9						
10						
11						
12						
13						
14						
15	Traditional teaching	➢ Posttest	3.66 (.28)	3.70 (.30)	3.73 (.40)	3.80 (.44)
16						
17						
18		➢ Delayed Post-	3.77 (.25)	3.80 (.28)	3.84 (.36)	3.91 (.43)

Fig. 1. Mean score of students’ attitudes and interests

Discussion

During the implementation phase, the students found that they were interested in learning when they were engaged in doing science. Hence, the students felt that the lessons were more interesting. They also noted that successfully performing an experiment or other activities helped to sustain their interest.

Students felt that the type of learning exercised was exciting, interesting and even challenging. Incorporating students’ experiences into teaching as funds of knowledge made the concepts learned more relevant and easier to understand. The classroom atmosphere was supportive, and as a result, the students became involved and enjoyed the activities. Additionally, teacher guidance made the lessons easy to understand. The supportive environment made students feel less challenged so that they could instead see science as something exciting; in other words, it stimulated their curiosity.

Even though taking into account students' funds of knowledge had an effect on student learning and engagement, there was also evidence that certain students remained disengaged from the material. Furthermore, there was evidence that classrooms were often noisy and chaotic, and such teaching practices were sometimes labeled as unsound. For example, Ms. Martha found it difficult to help her students engage in science in meaningful and empowering ways at the beginning.

> In fact, the first has not been successful. The latter have not yet increased as well. Just the third and fourth they would have to open their mind, reveal the ideas they want to, want to ask, appreciate a friend, and like to think .... (Teacher Interview_2, line 119-122)

> However, I have a problem, some students who tend to be less active in the classroom or students who like to ridicule friend when she revealed opinions. Indeed, it is not easy to change it in one or two days of teaching. Therefore, it is their basis and become part of their culture. (Teacher Interview_2, line 214-219)

Even though student-to-student communication did occur, there were many students who explained their thoughts to their friends in response to the questions posed by their teacher but did not want to share their opinions in front of the class. This showed that their engagement in discussions about science was still limited. They had begun to feel more willing to participate, but they failed to move beyond simply participating in those particular ways that would advance their science learning.

Meaningful engagement in discussion might propagate the notion that differences of opinion are important for discussion in science-learning settings; students need to appreciate that debating contentious matters can facilitate learning for all group members without compromising social harmony and friendships if undertaken properly, and they should grasp that science itself proceeds on the basis of conjecture and debate between scientists (Scott et al., 2006). Thus, the notion of social harmony needs to be considered as an aspect of student culture.

From the perspective of culture, it should be noted that harmony has real importance in Javanese culture but might be differently stressed. Javanese culture values those qualities in an individual that contribute to harmonious social integration. Ideal Javanese virtues include obedience to one's superiors (*manut*), generosity, conflict avoidance, understanding others' perspectives, and empathy (Koentjaraningrat, 1985; Magnis-Suseno, 1988). Thus, a teacher must facilitate better learning and encourage students to keep an open mind, helping them to engage in meaningful ways without compromising social harmony and friendships (Anderson, Thomas & Nashon, 2008). This is particularly so because in Javanese culture, students tend to be encouraged to live in harmony with others, develop a consensus, and sustain mutual loyalty (Koentjaraningrat, 1985; Magnis-Suseno, 1988) rather than engaging in criticism, practicing critical and independent thinking, and tolerating ambiguity. Social harmony and security must be maintained (Mulder, 1992). Very often, conflict cannot be prevented or avoided due to objective interest constellation, but what the Javanese want is for such conflict not to be manifested disruptively (Magnis-Suseno, 1988). Furthermore, open confrontation in the form of emotional behavior is regarded as undesirable and as endangering the lives of individuals in a society; therefore, it must be prevented.

However, attempts to maintain social harmony are often made at the expense of rigorous critical thinking and critiques, the consideration of multiple perspectives, and the development of alternative ideas, all of which are recognized as precursors and/or pathways to meaningful science learning and the use of higher-order thought processes (Anderson et al., 2009). By listening to their own discourse in groups, students were able to begin clearly articulating their roles and thought processes within the group and explain in detail the extent to which and manner in which such roles and functions contributed to group activity. Moreover, they were able to identify and influence the deliberate social and cognitive strategies that they employed to maintain group harmony and managed their learning and task functions.

Conclusion

The findings revealed that incorporating students' funds of knowledge in teaching science not only sustained but also improved students' interest in science. Students felt that approaching science concepts in the context of their everyday life made those concepts more understandable and interesting. Examining the changes on students' interests and attitudes about science show that this teaching strategy helps to develop and sustain students' interest.

The most interesting activities during group work and or discussion were those that were relevant to everyday life and required student conclusions regarding or explanation of a topic. These sorts of activities helped students to better understand the concepts being discussed and encouraged them to engage in problem-solving for activities that they felt were not interesting before this teaching method was first applied. For students to acquire more complete knowledge in this way they are better able to verify equations and understand how to use such equations in solving problems.

Some students who articulated a wish for more discussions during science lessons may be communicating something more fundamental than a preferred approach to teaching science. Opportunities for discussion could actually represent a challenge to authority, with students insisting that their voices be heard. This could be seen as a particular manifestation of broader intellectual changes under the rubric of constructivism.

Teaching methods that incorporate students' funds of knowledge made students feel engaged, excited, and even challenged. This teaching process made the concepts being taught seem more relevant to everyday life and made them easier to understand. Students' experiences showed them the relevance of the topic at hand and increased their awareness about relationship between science and human existence.

Sustained interest in learning science emerged during this study; the results show increasingly more interest and more positive attitudes towards science by the students, with a significant difference over time in mean scores for interests and attitudes. These findings indicate that there was an improvement in students' attitudes and an increase in students' interest during the period of this study.

In summary, teachers used students' accumulated funds of knowledge, themselves culturally anchored (González & Moll, 2002), to encourage them to truly engage in science learning. The teachers are valuable resources for the schools that participated in this study because they have the ability to connect their teaching with the social and cultural resources of their students (González & Moll, 2002) and utilize those resources to support their students, who themselves embody diversity. The findings of this study reveal that the "compatibility" between students' lived experiences, their funds of knowledge, and science concepts can be a major factor in sustaining science learning in school. Once students experience science instruction in this fashion, they are more likely to think critically about science and shared experiences because they can discuss their experiences in an environment that supports their input.

The results of this study indicate the complexity of learning environments and indicate that students' interest levels can be influenced by their surroundings, including household, social, and community culture. These results indicate that science education needs to shift and become more contextual and relevant, so students can have the opportunity to understand and appreciate what they are learning about, thus develop and sustain an interest in science.

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