A PISA Paradox? An Alternative Theory of Learning as a Possible Solution for Variations in PISA Scores

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Variations in mean PISA scores have not been adequately explained to date, suggesting the limits of our current understanding of the relationship between educational practices and students’ performance. In contrast to previous research that applies existing theories to explain observed variations, this study attempts to extend our existing theoretical horizon using PISA-derived data. We first introduce findings of PISA-Science data that run counter to the fundamental assumptions of both student-centered and teacher-centered learning theories; namely, countries having lower levels of students’ initiative to design and carry out their own projects had higher scores. We then propose an alternative theory of learning (Type II learning) to explain this counterexample by rethinking the learning process at its philosophical and ontological depths. We conclude by noting a surprising paradox: the Type II learning made visible through PISA data appears to undermine the core premise of the OECD’s whole approach to PISA itself.

Introduction

The Organisation for Economic Co-operation and Development’s (OECD’s) Program for International Student Assessment (PISA) has revealed that there exists considerable variation in mean scores of students’ performance among participant countries. Explaining these variations has now become a major puzzle for educational researchers worldwide, for both those working academically and those seeking applied policy solutions (OECD 2007; Meyer and Benavot 2013). One reason that PISA has been so attractive to the latter group is that the abilities that PISA purports to measure—the ability to use curricular contents creatively in the practical context of modern society—are widely viewed as essential ingredients for innovation-cum-economic success in an era of global competition (OECD 2014; Komatsu and Rappleye 2017). In contrast to earlier large-scale international assessment exercises such as the Trends in International Mathematics and Science Study (TIMSS), the
appeal of PISA is largely founded on the belief that its test items and auxiliary student surveys more holistically assess creativity, student experiences, and independent thinking, thereby offering more accurate indices of “real learning.”

Nevertheless, the growing interest in PISA to date has not yielded richer explanations of variations in mean PISA scores. Previous studies that examined relationships of mean scores with factors long posited in the theoretical literature such as gross domestic product per capita, spending per student, and significance of equity all yielded relatively poor correlations (Wolter and Vellacott 2003; OECD 2007; Wilkinson and Pichett 2009). Such results underscore the need not only to continue to inquire more deeply into the relationship between educational practices and students’ performance but also to think beyond the usual theoretical parameters that define the field.

To that end, this study utilizes PISA data to rethink existing frameworks and propose a new theory of learning that may better explain the puzzle of PISA score variation. After briefly reviewing the leading concept of learning in the West (i.e., student-centered learning), we spotlight findings derived from PISA-Science data that cannot be understood through that lens: countries having a lower level of students’ initiative had higher PISA-Science scores. Given that PISA measures creativity, the strong correlation we have identified cannot be dismissed by reference to well-worn critiques that higher scores come at the expense of creativity, applicability, and independent thinking. We propose an alternative theory as a possible solution to this puzzle. We then confirm that, on the one hand, the new theory does not contradict additional data from PISA-Science and, on the other hand, squares with extensive qualitative research observations of teaching and learning practices in East Asia. Finally, we further clarify the alternative theory by drawing clear contrasts with existing educational theories put forth by prominent Western philosophical thinkers, including Rousseau, Oakeshott, and Dewey. In conclusion, we explicate a surprising, unexpected paradox that becomes visible from the standpoint of Type II learning: PISA data undermine the fundamental premise of the OECD and other applied researchers who seek “solutions” in the PISA data. Regardless of whether or not future studies confirm or confound the Type II learning hypothesis we propose here, we contend that the value of the current piece lies in pushing researchers in the field to think far more deeply about teaching and learning and in encouraging a move beyond the

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1 We recognize that creativity is a complex and multifaceted phenomenon and that what PISA purportedly measures is just one aspect of creativity (i.e., problem-solving ability). While we do not wholeheartedly endorse the OECD’s claims, PISA is currently the only data set that can be used for international comparison of students’ creativity. As one of the editors insightfully pointed out, our stance belies some ambivalence about what PISA actually does vis-à-vis creativity; we utilize it to challenge persistent stereotypes that Asian students lack creativity, but we also recognize that such tests cannot fully capture it.
usual theoretical horizon that defines and—we would argue—holds back the field.

Brief Background: Logic of Student-Centered Learning

Student-centered learning, a pedagogical approach that became increasingly dominant in the modern era, generally assumes a positive correlation between the level of students’ initiative to design and steer their own projects and student performance. In student-centered learning, one typical image is the student as independent experimenter (Kilpatrick 1918; Thomas 2012). The learner designs her/his own individual projects and is therefore expected to be more strongly committed, motivated, and engaged. S/he learns from the results obtained through the ongoing process and challenges of carrying out the project itself. The underpinning assumptions here are that the student learns most effectively through self-directed experiences, that motivation rises accordingly and leads to higher levels of achievement, and that the types of knowledge obtained through such experiences can be applied/deployed more creatively in other practical, nonstructured contexts in comparison to learning in “traditional” settings.

The point of student-centered learning is readily understandable when compared with its opposite: teacher-centered learning. Here the typical image of the student is a receiver of knowledge merely transmitted by the teacher (Thomas 2012). Advocates of student-centered learning criticize teacher-centered learning most frequently on the grounds that it forces students to simply reproduce knowledge received from the teacher without deeper levels of understanding or engagement. As a consequence, critics contend, the student lacks strong motivation to learn and is unable to use acquired knowledge flexibly, creatively, or synthetically in practical contexts. To what degree does this familiar dichotomy approximate the actual complexities of teaching and learning?

What the Data Show I: Students’ Initiative and PISA Scores

Data Utilized

This section examines the relationship between the level of students’ initiative to design and operate their own projects and PISA-Science scores. We use data derived from PISA 2006 (OECD 2007). PISA assessments are undertaken every 3 years, with each test selecting a particular “main” field from among science, math, and reading. The focus of PISA 2006 was science, and therefore more information about teaching and learning in science classes was available in PISA 2006 than for either PISA 2009 or PISA 2012.

The PISA-Science score we use here is the arithmetic mean of the scores for the sample students of a particular country. The level of students’ ini-
iative is assessed using results from the accompanying PISA 2006 questionnaire concerning teaching and learning methods. The questionnaire includes the following six questions about “inquiry-based science teaching,” asking the students the following questions: (1) How often are you allowed to design your own experiments? (2) How often are you given the chance to choose your own investigations? (3) How often are you asked to do an investigation to test out your own ideas? (4) How often are you required to design how a “school science” question could be investigated in the laboratory? (5) How often do you spend time in the laboratory doing practical experiments? (6) How often are you asked to draw conclusions from experiments you have conducted? The first three questions, which include the term “own,” are clearly related to students’ initiative to design and operate their self-directed projects. The last three questions do not assume that students design their own projects. For each of these six questions, students are asked to select one of the following responses: “in all lessons,” “in most lessons,” “in some lessons,” and “never or hardly ever.” We use data for the percentage of students who selected “in all lessons” or “in most lessons” and recorded those as affirmative responses. Those results are shown in appendix table A1.

**Methods and Results**

We examine the correlations between the PISA-Science scores across countries and the percentage of students in those countries who responded affirmatively to those six questions. The strength of the relationships is evaluated using the Pearson’s correlation coefficient ($r$). Since $r$ value is highly affected by outliers, we calculate 95 percent confidence intervals to examine the stability of the correlation. For this, we obtain random samples from the original data with replacement using a bootstrapping method and calculate $r$ values 10,000 times (Diadonis and Efron 1983; see Supplementary Text S1 of the appendix) and then identify the range in which 95 percent of the $r$ values fall (the confidence interval, CI$_{95\%}$).

Countries whose students have low affirmative percentages for the first three questions tend to have higher average test scores than those countries whose students have higher percentages (fig. 1); such a relationship is not clear with respect to the last three questions. The correlations of average test scores with the first three questions are relatively strong according to $r$ values, while the correlations with both (i) economic status and equity factors examined by the OECD (2007) and (ii) similar other relevant indicators examined by the current authors are comparatively weak (table 1). These results imply that there exists a negative dimension to high levels of student initiative for learning; that is, the lower their initiative, the more likely that they achieve higher PISA-Science scores. A correlation does not necessarily signify a causal relationship, but our estimated correlations are so strong that
Fig. 1.—Relationships of PISA score with the percentages of students who responded affirmatively to the six questions. The solid line indicates the regression line determined using the least-squares method.
we should reflect more deeply on the underlying processes underpinning the estimates, the task we undertake in the latter part of this paper.

**What Explains the Negative Correlation? Negative Dimensions of a High Level of Students’ Initiative**

What are the negative dimensions in demanding that students show a high level of initiative for learning? We offer a possible explanation for this finding. Our explanation begins with distinguishing between two different types of learning, termed Type I and Type II. We propose that encouraging high levels of students’ initiative could make Type II more difficult. This section first describes the distinction between Type I and II learning and then details what makes Type II learning possible. We suggest, in turn, that the difference between Type I and Type II learning is deeply rooted in divergent conceptualizations of learning and self.

**Type I and II Learning**

What makes Type I and Type II learning distinct? Following philosophers such as Wittgenstein ([1921] 1961) and Husserl ([1927] 2015) among others, as well as seeing some similarities with social theorists such as Schutz ([1932] 1967), we suppose that individuals see the world through an implicit “frame.” This frame becomes the horizon within which one can “understand” (fig. 2a). Unknown facts exist both within and beyond the horizon but are distinct in that the former are known unknowns, while the latter are unknown unknowns. We define learning of facts within the established horizon as Type I learning and learning of facts beyond the horizon as Type II learning.
But what does the term “frame” mean? To make this key term as accessible as possible, we use the image of a six-sided die found in figure 2a. Why do we perceive the image in this way? This question is more interesting than it initially appears: not only can we see only three of the six sides of the die, but the image is printed on paper and therefore is only two-dimensional. Why does it not strike us as, say, a two-dimensional coat of arms of a distinguished feudal clan? What allows us to perceive it as a die is precisely our frame. This frame comprises a set of knowledge implicitly used to “see” objects. Several simple examples of the knowledge we use to see a die are that (1) dice are usually cubic in shape, (2) dots are drawn on each side of a die, (3) the number of the dots denotes a corresponding number, and (4) dice are often used.

Fig. 2.—a, Schematic drawing of the horizon of understanding. b, Picture of something.
in a game. Importantly, one is rarely aware of such knowledge because frames operate below the level of consciousness. Nonetheless, most readers would agree that one could not see a die in figure 2b if one did not have such an implicit frame.

The differences between Type I and II learning revolve around this idea of frame. Type I learning does not require changes in the learner’s frame. Within Type I learning, questions undoubtedly arise in the learner’s mind when faced with an unknown, but such questions arise from the learner’s understanding that there is missing information within the horizon embedded in a particular frame. In contrast, Type II learning requires changes in the learner’s frame itself. Within Type II learning, questions cannot arise in the learner’s mind because the learner cannot see the areas beyond the horizon of the existing frame. For example, one who does not see a die in figure 2b cannot raise questions about which numbers might be on the other sides of the die. Such questions arise only after understanding what a die is, that is, after obtaining new knowledge that constitutes the new frame. Similarly, and more seriously, one who does not have the knowledge that the earth rotates (and other related knowledge), for example, cannot come up with questions such as, say, why do humans not “fall off” as the earth spins around in space? Here we begin to see how learning that is fully based on the learner’s initiative may make Type II learning impossible, although it might well be useful in encouraging and motivating Type I learning.

What Makes Type II Learning Possible?

Type II learning is possible when a student faces something that s/he finds neither understandable nor interesting and yet brackets her/his existing frame, while continuing to struggle, long enough until the frame itself changes. Type II learning thus requires enforcement and/or guidance—either explicit or implicit—by a teacher (or equivalent others) as an essential factor for making such learning possible. This contrasts sharply with Type I learning, which attempts to utilize a student’s interest to promote learning (table 2). Certainly Type I learning is also possible under conditions of enforcement and/or guidance of the teacher, but our primary point here is that a teacher’s enforcement or guidance is not essential for Type I learning. Type II learning requires that students trust in their teacher, which in turn leads to obedience to the teacher’s guidance, persistence in the task assigned by the teacher, and deference for what the teacher is trying to communicate, even if not immediately understood. Again, this contrasts with learning allowing a high level of students’ initiative, which presumes the student to be an independent experimenter. One corollary of this difference in the expected attitude and locus of emphasis, authority, and deference: it lies with the teacher in the Type II model, while it lies in the student for student-centered learning.
To further clarify the main features of Type II learning and illustrate these points, let us take another example from the realm of science: learning the fact that the earth rotates. The student needs to initially simply accept this fact, which is taught by the teacher. The student cannot initially understand the meaning of learning such an odd fact. To understand the meaning, s/he must further accept many other facts, again those provided by a teacher, until s/he understands the whole picture of the universe. Examples of these “other facts” include such notions that the place we live in is a tiny part of the whole vast universe, that the solar system exists within that universe, that the earth is one of the planets constituting the solar system, and that rotation of the earth causes the experience of the oscillation between day and night. Only after learning such facts can the student finally understand the relationship between the fact of earth’s rotation and her/his daily experience.

One might argue that the student could learn this fact while critically engaging with the validity of the facts presented by the teacher, not simply accepting it. However, to consider the validity of the fact in any meaningful way, the student would need to know the other facts and the whole picture in advance. This is a logical consequence of the fact that the validity of a fact is examined by comparing it with other facts and the whole picture of the universe. In other words, s/he can be critical only after s/he finishes learning how to see existing experience within a new frame and horizon—only after Type II learning has occurred. Critical engagement before such learning occurs is, at best, an ill-fated attempt to apply the existing frame to facts that cannot fit. At worst, it reinforces the horizon of the existing frame and prevents the acceptance of facts vital for the emergence of a new frame itself.

**Concept of Learning and Self**

Above we have shown that Type II learning is clearly distinct from Type I. We argue here that this difference lies not merely at the pedagogical level,

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Type I</th>
<th>Type II</th>
</tr>
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<tbody>
<tr>
<td><strong>Pedagogical level:</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in learners’ frame</td>
<td>Not required</td>
<td>Required</td>
</tr>
<tr>
<td>Enforcement or guidance</td>
<td>Not essential</td>
<td>Essential</td>
</tr>
<tr>
<td>Expected attitude</td>
<td>Independence(^a)</td>
<td>Trust, obedience, and persistence</td>
</tr>
<tr>
<td>Authority</td>
<td>Learner(^a)</td>
<td>Teacher</td>
</tr>
<tr>
<td>Key to achievement</td>
<td>Innate ability</td>
<td>Persistence</td>
</tr>
<tr>
<td><strong>Philosophical and ontological levels:</strong></td>
<td></td>
<td></td>
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<tr>
<td>Knowledge</td>
<td>Finite</td>
<td>Infinite</td>
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<tr>
<td>End of learning</td>
<td>Exists</td>
<td>Does not exist</td>
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<tr>
<td>Self</td>
<td>Consistent</td>
<td>Changing</td>
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\(^a\) This is the case when learners are given a high level of students’ initiative. Note that Type I learning is also possible under teacher’s enforcement and guidance.
but deeper at the philosophical and ontological levels, that is, that Type I and II learning are founded on different concepts of learning and self.

Type I learning assumes that learning is the acquisition of a finite quantity of information (and/or skills), while Type II learning assumes that learning is a continual process of altering the learner’s frame (table 2). Consequently, Type I learning has an end in sight, while Type II learning does not. Type I learning ends when the student has acquired all the relevant information within a given horizon or frame. Type II learning continues without end, for two reasons. First, in Type II learning the student presupposes the potential for another world existing outside the horizon of the present frame. As such, the present frame appears not essential, but merely temporal and temporary. Second, a change in the frame requires that the student “learn again” the information within the horizon of the original frame, because the significance and interrelationships within this information change along with the changes in the wider frame.

To elaborate this point, we return to the example of learning to conceptualize the universe. Even before learning the whole picture of this universe, one normally knows the word and concept of “human beings.” Suppose that a student, one who possessed these concepts, now learns the whole picture of this new universe, discovering that human beings and living organisms have not been discovered anywhere else in this vast universe except on earth. In such cases, the student’s concept of human beings would be forced to change. After this shift, the student would know that human beings and living organisms are apparently alone in the universe, leading the student potentially to raise questions about the conditions that give rise to and support human existence. This change in the frame then changes the information that was once “obvious” in the horizon of the original frame, converting it again to something unfamiliar or incomplete, requiring the learner to contemplate it again within the horizons of the new frame.

Corresponding to the difference in the concept of learning between the two types of learning, Type I and Type II learning also assume different concepts of the learner’s self. Type I learning assumes that the self is consistent throughout the learning process. Namely, the self after learning is qualitatively the same as the self before learning. The only difference is a quantitative one; that is, the coverage of the student’s knowledge in areas within the horizon is greater after learning than before learning (fig. 2a), that is, knowledge has been accumulated.

In contrast, Type II learning assumes that the self is inconsistent throughout the learning process. The self after learning is different from that before learning, because the student’s frame changes through the learning process. One might argue that despite changes in Type II learning, there is still a consistent someone who “sees” or holds both selves. We would counter that this assumption of a consistent watcher or holder is also given new meaning within
Type II learning, although readers who have not personally experienced this sort of transition would have considerable difficulty in understanding this point (and arguably the existence of Type II learning itself). The difference in the concept of self between Type I and Type II learning leads to crucial differences in a student’s assumption about the key to academic achievement, as already noted by some leading psychologists (Dweck 2015). In Type I learning, the key to academic achievement is understood as innate ability, while in Type II learning the key is persistence (table 2).

What the Data Show II: High-Achieving Countries Have Low Levels of Interest

We now examine whether data for students’ attitudes toward science learning, collected as part of PISA, are consistent with the alternative theory proposed above. According to our empirical results (fig. 1), students in countries that outperform others have lower levels of initiative. On the basis of the theory, students in these countries face tasks that are unfamiliar to them. These students presumably feel that their classes are uninteresting, not enjoyable, and difficult to understand. However, this would not necessarily mean that the students do not value their classroom work; thus they continue to stay committed to the learning process. This mismatch is the wellspring from which persistence emerges. Here we examine whether such features can be detected in PISA-Science data exploring students’ attitudes toward science learning.

Data Utilized

We use data of students’ attitudes for science learning from PISA 2006 (OECD 2007) and data for the level of how classrooms are conducive to learning from PISA 2009 (OECD 2012). Note that the latter data are not available in PISA 2006, so we use PISA 2009 data. To measure aspects of students’ attitude, we use data from the 2006 and 2009 PISA databases. Students were asked sets of questions pertaining to five measures of attitude (general level of interest in six subjects, instrumental motivation, enjoyment, general value) and the classroom’s conduciveness to learning (see Supplementary Text S2 of the appendix).² We use the arithmetic means of these variables in our analysis; see table A3 for the country average percentages of students who responded in the affirmative to the questions.

Methods and Results

We examine the relationship between the PISA-Science scores and measures of student attitude (general interest, instrumental motivation, enjoyment,

² The percentages of students reporting medium or high levels of interest for each component are shown in table 3.8 of OECD (2007).
general value) and classroom conduciveness. We expect that high-achieving countries have low levels of general interest, instrumental motivation, and enjoyment, while not always having low levels of general value and classroom conduciveness.

We observe lower levels of general interest, instrumental motivation, and enjoyment for high-achieving countries (fig. 3). The $r$ values (CI$_{95\%}$) for the relationships are $-0.697 (-0.876, -0.287)$, $-0.602 (-0.802, -0.224)$, and $-0.596 (-0.861, -0.0134)$, respectively. The correlations of the score with the levels of general value and classroom conduciveness are not clear: $r = -0.213 (-0.547, 0.290)$ and $-0.0785 (-0.487, 0.340)$, respectively. The slopes of the regression line for the relationships are small ($-0.0304$ and $-0.0172$, respectively). These negative correlations in figure 3a-c are consistent with expectations based on the concept of Type II learning.

Comparison with Previous Studies

In light of these findings, the section below briefly compares and contrasts our argument with those of previous studies, both empirical and philosophical works, to articulate clearly the contribution and implications of our findings.

Empirical Studies

Empirical studies made by research scholars (Stevenson and Stigler 1992) and popular writers alike (Ripley 2013) have reported findings in congruence with some of our findings. These studies compared education in the United States with that in several high-performing countries, such as Japan, Taiwan, South Korea, and Finland. At the risk of oversimplification, these studies point out that countries that lead the league tables of international student assessment generally have (1) outlooks or mind-sets that promote students’ persistence to improve their performance and (2) a pervasive belief that learning in schools matters. The first point overlaps with our theory concerning Type I and II learning, while the second point is consistent with our findings of relatively high values for general value and classroom conduciveness for high-scoring countries (fig. 3).

Concerning the first point, both Stevenson and Stigler (1992) and Ripley (2013) discovered that Japanese, Taiwanese, and Koreans tended to explain students’ high performance mostly as a product of persistence than of innate ability, while the opposite is the case for the United States. This finding is consistent with anthropological observations of Japan’s classrooms (Tsuneyoshi 1992), as well as psychological studies of Korean students (Kim and Park 2006). In societies that assume students’ performance is a product of persistence, students who score low on tests are expected to work harder than they did before. In a society assuming that students’ test performance is a product of innate ability, students who score low tend to attribute their
performance to low innate ability and therefore give up on (quit) learning (Dweck 2007). According to the latter belief, studying is a waste of time because of the lack of innate ability.

In regard to the second point, Stevenson and Stigler (1992) and Ripley (2013) find that the belief that learning matters is more pervasive in Japan,
Taiwan, South Korea, and Finland than in the United States. Such a belief is culture based and therefore is woven into people’s daily lives, routines, and educational practices. Indeed, Stevenson and Stigler (1992) note that more than 98 percent of Japanese parents and 95 percent of Taiwanese parents buy their fifth graders a desk to study on, while only 63 percent of US parents do. These authors also find that Japanese and Taiwanese parents regularly convey the message to their children that school learning matters. Ripley (2013) reports that in Korea, even planes are grounded during the English listening session of the national college entrance exam. This widespread belief in the importance of schooling might be a factor in maintaining general value and classroom conduciveness in Japan and Korea relatively high despite students reporting low interest, motivation, and enjoyment in their lessons (fig. 3). In finding clear correlations across 30 countries, this study offers evidence to suggest the wider applicability of the findings by Stevenson and Stigler (1992) and Ripley (2013), who examine the cases of only a few countries.

Philosophical Studies

Philosophical studies (e.g., Polanyi 1958; Standish 1992; Uchida 2008) have long noted the pitfalls inherent in pedagogy that encourages a high level of students’ initiative, as we have done in this article. Those studies have argued that such pedagogy could “fix” or harden students’ present frame and make subsequent change in frame more difficult. Standish (1992) and Uchida (2008), in particular, note that such pedagogical approaches implicitly assume that self is temporally consistent. Our own theory is inspired by these studies, but our study explicitly links theory with empirical and quantitative data and suggests that philosophically derived theories can partly explain the difference in the students’ performance in PISA across countries. As such, we take up a fuller philosophical discussion further on in this piece.

Other Explanations? Stereotypes of Japan and South Korea

Our explanation has been supported by empirical findings. However, critics might contend that it is possible to explain these empirical findings in another way. One could argue that some of PISA’s top-performing countries subject their students to rote learning, memorization, and strict discipline because of pressure from fierce competition to get into university. Accordingly, these students lack the ability to use the curricular contents creatively, even while they have little interest in learning and rarely enjoy school. This is a now familiar, stereotypical explanation for the reason why Japan and South Korea score high in international tests, as detailed by Park (2013).

3 In the case of Japan specifically, we maintain that there is a relatively widespread belief in learning, despite recent critiques that increasing social stratification has led some students to turn away from learning (e.g., Kariya 2012).
This explanation is tempting because Japanese and Korean students are engaged in rote learning and memorization, particularly in cram schools, and because the competition to get into university is surely fierce in Japan and Korea. However, we find several phenomena that cannot be explained in this way. First, our analysis used PISA data. PISA, unlike TIMSS (Mullis and Martin 2015), assesses students’ ability to use curricular contents creatively in practical contexts resembling those found in contemporary society. This suggests that rote learning and memorization observed in these countries are not antithetical to the creative use of curricular contents, as also noted by LeTendre (1999) and Park (2013). Second, significant differences in students’ performance among these countries are apparent even at the elementary school stage (Stevenson and Stigler 1992). In this early period (roughly ages 7–11), students’ attendance at cram schools is not so pervasive, and the pressure from the exam competition is not fierce in these countries. In addition, the rates of students’ attendance at supplementary education outside school for these countries are not exceptionally higher than those for other developed countries (Leung 2006; Park 2013). It is thus difficult to explain the high performance of Japan and South Korea only from the pressure generated by fierce competition over entrance exams. Instead, we propose explaining the fierce competition over university admissions in Japan and South Korea as a consequence of the widespread “adoption” of Type II learning, echoing a prominent education scholar in Japan (Tsujimoto 2012). Where Type II learning is prevalent, learners feel compelled to continue learning even if they have learned much more than laid out in the official curriculum. Although Tsujimoto does not elaborate this concept of learning in as much detail as we do here, he does highlight that entrance exams in Japan are designed to measure how much students learn on their own above and beyond what was taught in school; that is, exams evaluate how much a student internalized the concept we are calling here Type II learning.

Above we hypothesized that Japan and South Korea “adopt” Type II learning, but how do we support that case? Multiple sources, both historical and contemporary, confirm that one typical concept of learning in Japan is indeed Type II. We have too little data to discuss Korea at this time. This

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4 One might still argue that the PISA-Science test actually measures students’ knowledge of content (“facts”) rather than their ability to creatively use it. Indeed, the PISA-Science includes several questions that examine students’ basic knowledge. However, in addition to science, mathematics, and reading, PISA recently began another test focusing on assessment of the ability to problem-solve in 2012 (OECD 2014b). This supplement does not require, for the most part, any prior factual knowledge. We observed a clear correlation ($r = .908$) between the science score and this problem-solving score. This result supports our claim that the PISA-Science score reflects the ability to creatively utilize knowledge. See also fn. 1 concerning our stance on PISA.

5 We want to clarify that we do not mean that Type II learning is the only concept of learning currently found in Japan. The Western progressive concepts of learning proposed by Rousseau and Kilpatrick have also been popular in Japan, particularly in recent decades (Nakamasa 2005). Yet, Type II learning is still found widely across Japan (Cave 2004, 2007) but is virtually absent in the West.
concept of learning in Japan might date back to the seventeenth and eighteenth centuries, since there are similarities in the concept of learning between then and the present (Tsujimoto 2012). Many schools (or jukus and han schools) were established during the Tokugawa Shogunate period, and most children from samurai families learned Confucianism. The process of learning in those schools included typical features of Type II learning. Students who had enrolled at age 7 or 8 were expected to start learning classical Chinese texts. These texts were the same as those that learned scholars of Confucianism also studied, not “child-friendly,” simple versions. Students were not expected to understand them, but they were required to read them aloud and memorize them without understanding (Tsujimoto 2012), an exercise in expanding and redefining the learner’s frame.

Such a concept of learning was not limited to the samurai class alone, however, but was shared across other classes in premodern Japanese society. We can see evidence of this in a book entitled Wazokudojikun (How to teach children in nonsamurai classes) written by Kaibara Ekiken in 1710 (Tsujimoto 2012). Kaibara argues in that treatise that a child does not initially have wisdom, but starts to mimic and learn from the speech and behaviors of intimate others. What the child has mimicked and learned becomes the master of the child’s mind and forms the child’s new frame. Learning without understanding the meaning of the content is the only way to bring about a change in the student’s frame. Moreover, such a concept of learning is still observable in that the Japanese word manabu (“to learn”) derives from the root word manebu or mimic (Yamada et al. 2012). This contrasts with educere, one of the Latin root words for education (Bass and Good 2004), which means to “lead out” the inner talents, thus suggesting that there is something like a consistent seed (or soul) unchanging, albeit potentially growing, through the course of a student’s life.

Moreover, this traditional concept of learning is still alive in modern educational settings in Japan, not only in the minds of masters of traditional arts and martial arts and Zen Buddhists (Hori 1994; Tsujimoto 2012; Nishihira 2016), but also among many regular school teachers. For example, Suwa Tetsuji, a recently retired middle-school teacher, describes his teaching and learning in the following way: “It is impossible to teach only knowledge. A teacher teaches not only knowledge but the underlying frame of the knowledge. Learning thus is not accumulation of information in the student, but changes in ways of thinking, feeling, and organization of the student” (Suwa 2014, 82). Suwa’s description of learning is also consistent with quantitative research results from US researchers Stigler and Hiebert (1999), who find that “73 percent of Japanese teachers said that the main thing they wanted their students to learn from a lesson was to think about things in a new way” (89).
Comparisons with Dominant Western Education Theories

What is the relationship between Type II learning and existing educational theories? Type II learning resists simple classification into the usual either/or of student- or teacher-centered learning. To make this clear we show that Type II learning differs from the concept of learning proposed by progressives Rousseau and Kilpatrick, on one side, and conservatives Burke and Oakeshott, on the other side (table 3). In the following, we describe differences in learning recommended by these four prominent Western philosophers and Type II learning. For simplicity of explanation, we focus on two characteristics among the six raised in table 3: (1) necessity of enforcement or guidance and (2) the concept of self. We note in passing that the differences found here are reasonable in light of the fact that progressive/conservative cleavage that continues to shape pedagogy globally originated from the rupture caused by the European “Enlightenment,” not from the historical context of East Asian countries, where Type II learning still arguably retains a large following.

Jean-Jacques Rousseau ([1762] 1979), in his seminal work *Emile*, recommends that a teacher “do nothing at all and allow nothing to be done” in the educational process. Rousseau held that if the teacher followed these recommendations, “the eyes of his [the pupil’s] understanding would from the very first open to reason.” Rousseau rejected the necessity of enforcement

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>Rousseau/Kilpatrick</th>
<th>Burke*/Oakeshott</th>
<th>Dewey</th>
<th>Type II</th>
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<tr>
<td>Pedagogical level:</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Change in learners’ frame</td>
<td>Not requiredb</td>
<td>Occurs once</td>
<td>Occurs continually</td>
<td>Occurs continually</td>
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<tr>
<td>Enforcement or guidance</td>
<td>Not essential or should be minimized</td>
<td>Essential</td>
<td>Essential</td>
<td>Essential</td>
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<tr>
<td>Expected attitude</td>
<td>Independence</td>
<td>Obedience</td>
<td>Independence and obediencec</td>
<td>Trust, obedience, and persistence Teacher</td>
</tr>
<tr>
<td>Authority</td>
<td>Learner</td>
<td>Teacher</td>
<td>Teacher and learnerc</td>
<td>Teacher</td>
</tr>
<tr>
<td>Key to achievement</td>
<td>Innate ability</td>
<td>Persistence</td>
<td>?</td>
<td>Persistence</td>
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<tr>
<td>Philosophical and ontological levels:</td>
<td></td>
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<td></td>
<td></td>
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<tr>
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<td>Finite</td>
<td>Infinite</td>
<td>Infinite</td>
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<td>End of learning</td>
<td>Exists</td>
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<td>Consistent</td>
<td>Changes once</td>
<td>Changes continually</td>
<td>Changes continually</td>
</tr>
</tbody>
</table>

* Burke does not explicitly mention the pedagogical level.

b Might change, but the change occurs naturally without the influences of learning/teaching.

c Dewey emphasizes the interaction between students and the teacher, not on either students or teacher.
(table 3) and assumed the consistency of the child’s self. Or at least he believed that the child’s self might undergo change, but that change would occur spontaneously without the influence of teaching. Rousseau clearly assumed something consistent within the child, something akin to a seed that, as it grows in the light of reason and unobstructed by tradition, induces development in the child’s mind.

William Heard Kilpatrick (1871–1965) was a modern Rousseau, although he is most often regarded as a successor of John Dewey. Kilpatrick was a professor at Teachers College, Columbia University, who wrote extensively on the philosophy of education and was highly influential in laying the intellectual groundwork for the progressive education movement. Kilpatrick was the chief proponent of the now famous Project Method (Kilpatrick 1918) that recommended children undertake any self-initiated project, as long as it is performed purposefully. Kilpatrick recommended the teacher allow or facilitate the child in this work, but the authority for decision would come from the child and would develop according to what the child her/himself wanted to do (Knoll 1997). This recommendation was rooted in Kilpatrick’s specific concept of self. Like Rousseau, he assumed that personality is innately endowed, producing specific wants and desires within individuals; therefore, education should be “designed to free the whole personality of the learner for the fullest living” (Kilpatrick 1951, 121). The assumption of a self that moves through the learning process, directing and steering that process, is evident throughout Kilpatrick’s writings.

Edmund Burke (1730–97) was the conservative counterpart of progressive Rousseau. Burke was primarily a politician and political thinker and did not refer explicitly to education and pedagogy. However, his views became the cornerstone of later conservative thought extended to education. Specifically, Burke rejected the idea that there is something akin to a seed that induces spontaneous development in a person’s mind. He believed that human beings and human society are not primarily the products of reason, but of custom, tradition, and “long and prescriptive usage” (Norman 2013). By extension, a child thus needs to be initiated to the custom and tradition in order to change or remake her/himself to live in this world, to become fully human. In this sense, Burke’s ideas were similar to Type II learning (table 3). However, Burke assumed that the change in the child’s self ends when the child is civilized (fully socialized or initiated into that cultural tradition) and that further changes are not preferable. He sought a one-off change in self, terminating in a civilized end prescribed by custom.

Michael Oakeshott, inspired by Burke, was a philosopher who dealt more explicitly with educational issues and pedagogy. At the pedagogical level, the concept of learning championed by Oakeshott bears some similarities to Type II learning (table 3). He rejected Rousseau’s idea that learning proceeds spontaneously and advocated the necessity of enforcement and guid-
ance by teachers. For example, Oakeshott held that “if a human life were a process of growth in which a potential became an actual, or if it were a process in which an organism reacted to its circumstances in terms of a genetic equipment, there would be no room for transaction [education] between generations” (2001, 65). He believed instead in the necessity of education initiated by a teacher with “something to impart.” However, despite such similarities, Oakeshott’s ideas differ from Type II learning when we move to the philosophical and ontological levels (table 3). Echoing Burke, Oakeshott assumed a one-off change in learner’s self. Oakeshott (1976) stated that “to be conservative, then, is to prefer the familiar to the unknown, . . . fact to mystery, the actual to the possible, the limited to the unbounded, the near to the distant, the sufficient to the superabundant” (168–69). Oakeshott here reveals that he does not expect that the learner changes continually. He expects learners to stay within the horizon of the familiar. A close and favorable reading of Oakeshott’s project suggests that he did not see existing tradition as necessarily better than other modes of being, but instead just one possible way of living among many alternatives. But tradition was “better” in the sense that it had stood the test of time and it provided the background on which to make all subsequent judgments of right and wrong (here we note affinities with the later Wittgenstein; Palmer et al. 2001). This is the reason why learners needed to accept the specific beliefs under the guidance of a representative of the previous generation who “imparts” (i.e., the teacher; Oakeshott 2001, 71).

When viewed from the standpoint of Type II learning and the divergent philosophical and ontological foundations (table 3) it rests on, these well-known progressive and conservative philosophers appear to be far more similar than is commonly portrayed: all attempt to describe teaching and learning from a rather narrow range of possibilities of self. Self is either a unique seed (soul) or a tabula rasa.

Interestingly, we find that the concept of learning advocated by Dewey may carry closer affinities with Type II learning. Dewey, in contrast with Rousseau and Kilpatrick, advocated the necessity of enforcement and guidance by teachers. Moreover, it is often forgotten that Dewey was strongly critical of concepts of pedagogy permissive of high levels of students’ initiative, even taking explicit aim at Kilpatrick’s project method (Knoll 1997). At one point late in his career, Dewey went so far as to write that “above all let us not suggest any end or plan to the students; let us not suggest to them what they shall do, for that is an unwarranted trespass upon their sacred intellectual individuality since the essence of such individuality is to set up ends and aims. Now such a method [as this one] is really stupid. For it attempts the impossible, which is always stupid. . . . Without some guidance from experience these reactions [of the students] are almost sure to be casual, sporadic and ultimately fatiguing, accompanied by nervous strain” ([1926] 1981, 58).
Dewey even explicitly rejected the idea that a child’s learning is like a seed naturally germinating and growing up into a rose: “there is no spontaneous germination in the mental life. . . . If he does not get the suggestion from the teacher, he gets it from somebody or something in the home or the street” (1981, 58–59). More deeply, Dewey explicitly rejected the consistency of the learner’s self and frame during the learning process, stating, “There is no more fatal flaw in psychology than that which takes the original vague fore-feeling of some consequence to be realized as the equivalent of a thought of an end, a true purpose and directive plan. . . . In the full sense of the word, a person becomes aware of what he wants to do and what he is about only when the work is actually complete (1981, 60; italics added).

Dewey clearly recognized that the self and learner’s frame change during the course of the learning process. Tellingly, this quote resonates strongly with what Uchida (2013, 11), a well-known Japanese philosopher, writes about learning: “the learner cannot explain what he is learning until he finishes learning it.”

The clear similarities in Dewey’s concept of learning and Type II learning suggest that, although Type II learning is rooted deeply in concepts of self and might thus be more commonly available, accessible, or visible within a specific cultural tradition, Type II learning cannot be reduced to a culturally specific position. Instead, it is essentially a philosophical position or—better yet—an ontological disposition. It is specific to certain cultural traditions in the sense that those places embed these dispositions within culture, largely through teaching. Yet, anyone in any culture can adopt Type II learning if s/he arrives at a corresponding concept of self in some way. Indeed, Dweck (2007), a mainstream US psychologist, has long suggested the necessity of changing the basic concept of self from consistent to changing in order to open the door for continual growth. Such resonances across disciplines, through time, and across space confound attempts to reduce our arguments to cultural essentialism and reification.

Although the learning recommended by Dewey is indeed very close to the Type II learning found in Japan (table 3), we do find a subtle but highly significant difference between these two. In contrast to Type II learning in Japan, which emphasizes change itself, Dewey puts the primary emphasis on the outcome of the change. The self and frame after the change are often presented, usually implicitly, to be better than those before the change. Dewey

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6 See also Odin (1996) for a deeper discussion on similarities and differences between Japanese traditional thought (e.g., Zen) and American pragmatism, including founding assumptions about the self. For another rich contemplation of self in the American pragmatist tradition, see the work of Saito (2005).

7 Our argument is lent further support by the fact that the Suzuki violin method (Mehl 2009), originated in Japan, incorporated a Type II concept of learning and nevertheless has been widely accepted and utilized in the United States.
frequently appears to offer a similar description of learning but then subtly places the whole process on a teleological trajectory. We question the assumptions deeply embedded in such a view. Comparing the selves and frames before and after the change is logically impossible without the presence of a consistent holder who can “see” both selves. It also requires a consistent set of values to underpin claims that conditions after change are “better.” We infer that Dewey did not compare these two; nonetheless, he believed that the latter state is better than the former, somehow arriving at that position without comparison. We base our interpretation on a similar belief about the nature of the truth itself that can be found running through Dewey’s writing. Dewey (1938), following Peirce (1878), states that the truth is “the ideal limit” of our “endless investigation.” He thus simply believes that one improves his or her understanding and approaches the truth through investigation. Such a belief is, however, arbitrary and is thus subject to considerable critique by Quine (1960) among others in subsequent decades.

Conclusion: The “PISA Paradox” Made Visible by Type II

This study sought to explain better the variance in mean PISA scores, centering a counterintuitive negative correlation between levels of students’ initiative and PISA-Science scores among OECD countries as a way to think beyond our usual theoretical horizons. By examining pedagogical processes (e.g., attitudes, authority, achievement) at a deeper philosophical and ontological level (e.g., nature of knowledge, self), we proposed an alternative concept of learning—Type II learning—as a possible means of explaining the score variation observed in the data.

What novel conclusions emerge from these results? Or, what becomes visible from a Type II learning perspective? Here we focus on just two major points, the first related to academic research and the second related to PISA itself.

As pointed out in the introduction, despite much interest in understanding the reasons behind variations in mean PISA scores, academic research to date has largely failed to yield adequate explanations. The problem is not insufficient data, as the presence of the negative correlation we observed within the existing data demonstrates. Instead, the major reason for this is the limited range of theoretical possibilities that most researchers use to interpret data. In other words, the impasse emerges more from a limited, bounded, and static theoretical horizon (i.e., student-centered vs. teacher-centered).

As such, the pressing priority for educational researchers at present is to set to the task of developing new theories. In doing so, however, it is crucial to avoid relying solely on abstract philosophical and ontological contemplations, as so much educational philosophical-cum-theoretical work of
the past has tended to do. The new strategy is to renew the dialogue between empirical data and philosophy, not least because philosophical contemplations alone will continue to die a slow death in the emerging world of big data.

A crucial point here, however, is that Type II learning is merely a starting point for further investigation rather than a final solution to the PISA puzzle. “Starting point” carries a twofold meaning for us. The first is that our conceptualization of Type II learning needs to be subject to validation processes in future work. Such validation processes should examine whether or not results from other components of the PISA student questionnaire help confirm the theory of Type II learning.

The second meaning of “starting point” is that the theory of Type II learning itself is something that eventually needs to be overcome in the future. Here is a surprising self-contradiction embedded at the very heart of Type II learning: given that the theory rejects the very premise of a “final solution” to learning, the more Type II learning is utilized and elaborated by subsequent research, the harder we must struggle to find counterexamples against it. It is only when we continue to face uncomfortable counterexamples and persist in trying to understand them that the implicit frame through which we understand educational phenomena can continue to grow. Real learning is necessarily a process of continual self-overcoming. To locate such educative counterexamples, data collected from large-scale international assessment such as PISA offer enormous resources.

This brings us to our second point, what we term the “PISA Paradox.” The raison d’être of the OECD’s PISA program is to find the “secrets of success” of high-performing systems and translate those factors into a package of policy solutions (OECD 2012; Ripley 2013). The OECD envisages a team of “experts” possessing adequate data to identify success and propose solutions. However, the results of our study suggest that the students who perform best in the PISA-Science tests approach learning in a way that is at odds with the OECD’s approach. What the Type II theory of learning unexpectedly makes visible about the OECD’s approach is that its concept of learning is synonymous with Type I learning: its horizon is fixed and its efforts are directed entirely to understanding “unknown facts” within that static frame. There is scant evidence that any alternative data, theory, or experience could induce a substantive change in the OECD’s horizon or that the OECD might be willing to “learn” from equivalent others, say, academic researchers. From a Type II perspective, such a learner would be among the lowest performing, the least creative, and one most lacking in the persistent self-overcoming needed for growth. The PISA Paradox then is that PISA data suggest that the premise

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8 Here we would like to acknowledge Euan Auld, whose critical comments on an earlier draft sparked elaboration of the PISA Paradox idea (see Auld and Morris 2016).
of PISA as a platform for OECD experts to identify and deliver “solutions” runs counter to the aim of improving the quality of learning.

One final note. We are fully aware of the critiques of the international testing infrastructure, in particular, the underpinning ideology that drives it (Meyer and Benavot 2013; Seller and Lingard 2014). We are not naïve to the possibility that some readers might contend that using PISA data in whatever form helps legitimate the OECD’s whole exercise. Yet, such critiques are valid only when researchers utilize data derived from large-scale international tests to identify “secrets of success” with an eye toward disseminating “best practice” globally. We emphasize that the same data can be utilized to challenge the very ideological-cum-theoretical foundations of the growing international testing infrastructure (see Komatsu and Rappleye 2017). This study is one example. On a deeper level still, rejecting out of hand anything beyond our existing frame hardens the consistency of the self, returns us to the realm of Type I learning, and relieves us of the burden of persistence—all of which makes more difficult the overcoming of our existing frame and thus the continuation of learning.

Appendix
Supplementary Text S1
We do not use the analytical equation to calculate confidence intervals (e.g., Peck and Devore 2011), because the analytical equation makes assumptions about the distribution of data, and therefore confidence intervals calculated in this way are strongly affected by outliers.

Throughout this study, we do not perform hypothesis testing to examine statistical significance of any relationships. Statistical significance is not always meaningful in a practical context. Even very weak relationships can be found to be statistically significant if sample sizes are sufficiently large. For example, a relationship having \( r \) of .00620 is found to be statistically significant if the sample size exceeds 100,000. This problem has already been duly identified for decades (Berkson 1938; Bakan 1966; Carver 1978) and echoed by many contemporary researchers (Thompson 1996; Lambdin 2012; Komatsu et al. 2015). As such, many researchers recommend reporting confidence intervals and effect sizes (e.g., \( r \), Spearman’s \( \rho \), Cohen’s \( d \), and Glass’s delta) instead of statistical significance (Johnson 1999; Thompson 2002; Hubbard and Lindsay 2008). Readers who are interested in statistical significance of the relationships examined in this study may infer the significance on the basis of the confidence intervals and effect sizes (see Ellis 2010).

Supplementary Text S2
We compiled data derived in PISA 2006 in the following way. In terms of data for general interest, PISA asked students a set of eight questions on their level of interest in six different subjects (table A2), about their general interest in the ways in which scientists design experiments, and about what is required for scientific explanations. The percentages of students reporting medium or high levels of interest for each component are shown in table 3.8 of OECD (2007). We calculated the
arithmetic mean of the percentages for the components and use of the mean value for analysis (see table A3). In a similar manner, we also prepared data for instrumental motivation, enjoyment, and general value.

We also prepared data for the level of classroom conduciveness. PISA asked students a set of five questions listed in table A2. Students were requested to select one of the following responses: “in all lessons,” “in most lessons,” “in some lessons,” and “never or hardly ever.” The value for each component is the percentage of students who reported “in some lessons” or “never or hardly ever.” We calculate the arithmetic mean of the percentages for the five components and then use the mean value for analysis.

### TABLE A1
Percentage of Students Who Responded Affirmatively to the Six Supplementary Survey Questions and PISA-Science Score for OECD Countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Design Experiments</th>
<th>Choose Investigations</th>
<th>Test Ideas</th>
<th>Design How</th>
<th>Spend in Lab</th>
<th>Draw Conclusions</th>
<th>PISA Score</th>
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<td>26</td>
<td>28</td>
<td>25</td>
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<td>20</td>
<td>16</td>
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<td>14</td>
<td>11</td>
<td>12</td>
<td>49</td>
<td>510</td>
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<td>29</td>
<td>33</td>
<td>28</td>
<td>66</td>
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TABLE A2
COMPONENTS FOR EVALUATING THE LEVELS OF GENERAL INTEREST, INSTRUMENTAL MOTIVATION, ENJOYMENT, GENERAL VALUE, AND CLASSROOM CONDUCIVENESS

Components
General interest:
- Human biology
- Astronomy
- Chemistry
- Physics
- Biology of plants
- Geology
- The ways in which scientists design experiments
- What is required for scientific explanations

Instrumental motivation:
- I study school science because I know it is useful for me.
- Making an effort in my school science subject(s) is worth it because this will help me in the work I want to do later on.
- Studying my school science subject(s) is worthwhile for me because what I learn will improve my career prospects.
- I will learn many things in my school science subject(s) that will help me get a job.
- What I learn in my school science subject(s) is important for me because I need this for what I want to study later on.

Enjoyment:
- I enjoy acquiring new knowledge in science.
- I generally have fun when I am learning science topics.
- I am interested in learning about science.
- I like reading about science.
- I am happy doing science problems.

General value:
- Science is important for helping us to understand the natural world.
- Advances in science and technology usually improve people’s living conditions.
- Science is valuable to society.
- Advances in science and technology usually help to improve the economy.
- Advances in science and technology usually bring social benefits.

Classroom conduciveness:
- Students don’t listen to what the teacher says.
- There is noise and disorder.
- The teacher has to wait a long time for the students to quiet down.
- Students cannot work well.
- Students don’t start working for a long time after the lesson begins.

TABLE A3
DATA FOR STUDENTS’ ATTITUDES AND CLASSROOM CONDUCIVENESS

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References


POSSIBLE SOLUTION FOR VARIATIONS IN PISA SCORES


