Teacher views about constructivist instruction and personal epistemology: a national study in Taiwan

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This study investigated the views about constructivist instruction and personal epistemology of the secondary earth science teachers in Taiwan. Participants were assessed through a paper-and-pencil survey and a Learning environment preference questionnaire (LEP) designed to explore personal epistemology. On a five-point Likert scale, teachers, on average, showed a neutral agreement on constructivist instruction. The content analysis suggested that teachers held alternative views about the nature of the constructivist instruction. LEP scores were found to be statistically associated with gender, education, current teaching level and years of teaching; the score distribution indicated that most teachers had not developed a constructivist-compatible epistemology. By one-way ANOVA, it was suggested that views about the constructivist instruction were aligned with personal epistemology.

Keywords: constructivist instruction; personal epistemology; teacher views

Introduction

As in many countries in the world, education in Taiwan is undergoing a constructivist reform. However, the reform frequently receives objections and even doubt from many teachers who actually prefer traditional settings. Reports around the world have also revealed that the implementation of constructivist instruction is difficult and positivist pedagogy still prevails in secondary science classrooms (e.g. Windschitl 2002; Tsai 2002; Poole 1994; Hammer 1994; Lemke 1990). To understand the resistance by teachers, there is a need for an investigation on teacher perspectives about the educational reform from a psychological viewpoint. Hence, the objectives of this study were to explore teacher views about the constructivist instruction and their epistemological beliefs about knowledge and learning.

Theoretical background

With cognitive research supporting views about human knowledge construction, constructivism has become the major theoretical ground for science education (Staver 1998; Fosnot 1996). Although critics of constructivism in science education can be found in the literature (e.g. Solomon 1994; Osborne 1996; Jenkins 2000), most science educators welcome the constructivist style of teaching and learning because it matches the current consensus concerning the acquisition of human knowledge. Moreover, empirical studies have shown a positive learning effect with the instruction (e.g. Fensham, Gunstone and White 1994). In
Taiwan, a dramatic reform movement is currently taking place where the traditional teacher-centred pedagogy is being directed to the student-centred, constructivist approach. However, despite theoretical support and research evidence, many teachers in Taiwan seemingly remained unconvinced. They complained about the extra preparation load for teaching, the lack of relevant instructional knowledge and the unclear teaching and learning strategies, and they also questioned students’ readiness for constructivist learning. The implications of constructivist teaching are even more complex.

The above-mentioned situation is, in fact, a universal phenomenon, for reports from various countries have pointed out that teachers struggle with constructivist teaching (Prawat 1992; Rosenfeld and Rosenfeld 2006) and the positivist settings are still popular in secondary classrooms (e.g. Windschitl 2002; Tsai 2002; Poole 1994; Hammer 1994; Lemke 1990). Hence, to promote the Constructivist movement, it is thus necessary to examine in depth the resistances displayed by teachers who are viewed as important agents of change in educational reform. Windschitl (2002) suggested that, to understand the challenges of the constructivist reform for teachers, four dimensions of dilemma need to be attended to, including the conceptual, pedagogical, cultural and political dilemmas. In the study, the conceptual dilemma is addressed, which concerns teachers’ conceptions of and beliefs about constructivism. It was hypothesised that what teachers thought about the forms of constructivist instruction actually deviated from what the academic community would identify, consequently affecting teachers’ willingness to adopt constructivist teaching approaches.

To evaluate whether teachers’ views about constructivist instruction were different from those identified by the academics, a clear definition of constructivist teaching is required. Nevertheless, an explicit definition is hard to find in the literature because there exist various forms of constructivism (see Kelley 1997; Matthews 2000; Green and Gredler 2002). Richardson (2003) mentioned that the elements of constructivist teaching could not be defined because constructivism is a theory of learning, not a theory of teaching. Although a universal definition of constructivist pedagogy is difficult, then, there are commonly accepted characteristics about constructivist pedagogy among scholars. According to Richardson (2003), these characteristics include: (1) attention to the individual and respect for the learner’s background and generation of meanings in a domain; (2) facilitation of group dialogue that leads to the creation of shared meanings; (3) introduction of formal domain knowledge into conversation through various means, such as direction instruction, exploration of a website, and so on; (4) provision of opportunities for students to determine, challenge, change or add to existing beliefs and understandings through engagement in structured tasks; and (5) development of the students’ metacognition. Thus, one of the objectives of this study was to ascertain whether teachers recognised these characteristics as the significant elements of constructivist instruction.

That teachers hold various views concerning the constructivist instruction may be a well-recognised fact, but why they should have different views is a question that needs to be discussed. This study further proposed that, in addition to the unclear definitions in the literature that may result in confusion, teachers’ views about the most effective forms of instruction are actually mediated by their personal epistemology. In other words, their epistemological beliefs would determine whether teachers agreed with the constructivist pedagogy and they would attempt to implement it. Cognitive research has pointed out that thinking and reasoning are regulated by metacognition. Recent psychological research further suggests that higher than the metacognitive level is the epistemic level, where epistemological beliefs influence the practice of metacognition and instigate different reasoning consequences (Perry 1970; King and Kitchener 1994; Kuhn 1991; Belenky 1986; Kitchener
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1983; Yang 2005; Yang, Chang and Hsu 2005). Hence, it was hypothesised in this study that teachers’ personal epistemology would determine, to some extent, their views about teaching and learning processes.

By definition, personal epistemology concerns teacher beliefs about knowledge and knowing. Epistemological studies concerning teaching have discovered that teachers’ instructional strategies and decision-making are associated with their epistemological beliefs (e.g. Hashweh 1996; Kember and Gow 1994; Yerrick, Pedersen and Arnason 1998). As far as learning is concerned, students’ academic performances and learning strategies have to do with their epistemological perspectives (e.g. Schommer 1993; Roth and Roychoudhury 1994; Yerrick, Pedersen and Arnason 1998). Accordingly, for educational practice, personal epistemological belief is a fundamental element that shapes classroom behaviours. Bell and Pearson (1992) have argued that in order to change what teachers do in the classrooms, their epistemology must be transformed to the relevant status. Hence, another purpose of the study was to examine teachers’ epistemological beliefs in the expectation this would provide explanatory information on teachers holding alternative views (if any) about constructivist instruction.

Among various models about personal epistemology in the literature (e.g. Hofer and Pintrich 2002), this study employed Perry’s model of epistemological development (Perry 1970). The Perry scheme of intellectual development was constructed based on interview data concerning college students’ experiences regarding elements of learning, including knowledge content, instructors, peers, classroom atmosphere and evaluation. There are basically four forms of personal epistemology in the Perry scheme, namely dualism, multiplicity, contextual relativism and commitment within relativism, each being further divided by various developmental positions. Individuals in the different epistemological positions would exhibit different perceptions towards the elements of learning mentioned above. According to Perry (1970), personal epistemology evolved from dualism to relativism. It was found that the more years and higher levels of education one receives the higher epistemological stage the person can develop. Although other studies inspired by Perry’s work proposed different epistemological constructs, the developmental nature of personal epistemology was widely accepted (Perry 1970; Belenky et al. 1986; King and Kitchener 1994; Kuhn 1991; Hofer and Pintrich 1997, 2002).

As mentioned above, perspectives of the Perry Scheme include knowledge, learning and assessment. The emphasis on learning process is supported by constructivism that addresses an epistemology focused on not only the nature of knowledge but also how people learn and approach learning (Moore 2002). Hence, from the philosophical point of view, the higher the position in Perry Scheme, the more resemblance the views of knowledge and learning to constructivism, and the lower to positivism. It was thus hoped that examining teachers’ personal epistemology would provide in-depth information, from a psychological perspective, regarding their resistance to the constructivist pedagogy.

Design and procedure

Subjects
Initial subjects of this study included some 1000 earth science teachers from a total of approximately 1000 secondary schools in Taiwan, with 70% junior and 30% senior high levels. In general, each school had one to two earth science teachers. Since the names of teachers were difficult to track, the instruments of the study – i.e., a survey sheet concerning the constructivist instruction and the Learning environment preference questionnaire (LEP) – were sent to each participating school administration who then appointed an earth science
teacher to complete the survey. The return rate of the questionnaire was about 75%, with about 690 valid samples.

Instrument

To investigate teachers’ collective views regarding constructivist instruction, instead of giving definite definitions for the instruction, an indirect approach was employed. Teachers were asked to supply their own image of the constructivist practice: a survey sheet was developed including one multiple-choice and one open-ended question, and a Likert scale. In the multiple-choice question teachers were asked to choose the instructional styles they believed most matched the constructivist characteristics. Teacher agreement on the constructivist instruction was assessed with the five-point Likert-scale. In the open-ended question teachers were required to provide reasons why they supported, or objected to, the constructivist instruction. These questions are listed in Appendix 1.

As listed in question 1 (Appendix 1), there were 13 options describing common instructional settings in the Taiwanese classroom. The 13 options were examined by three content experts of science education, who reached a consensus that excepting options 8, 9 and 11, all selections could be regarded more or less as constituting the constructivist style, according to the list of common characteristics illustrated in the previous section. Options 1 and 5 were considered as the traditional, non-constructivist instruction. Nevertheless, from a radical-constructivist viewpoint (Von Glasersfeld 1995), the content experts agreed that those two options also had some constructivist nature, in that the descriptions emphasised learners’ comprehension over concepts. As previously mentioned, since there was no unified definition for the constructivist instruction, questions posted in the survey were employed mainly to explore teachers’ collective views about constructivist instruction, rather than to test whether they had a proper understanding.

Various instruments measure the epistemological perspective (e.g. Hofer and Pintrich 1997; Duell and Schommer 2001); most of the instruments employ interview methods and/or written measures for data collection. To relate the research issue to teaching and learning, and for a large-scale survey, this study used the Learning environment preference questionnaire (LEP), developed by Moore (1989) to assess the Perry scheme. The five sections in the questionnaire are each attributed to the five specific domains related to epistemology and the learning elements: (a) view of knowledge and course content, (b) role of the instructor, (c) role of the student and peers in the classroom, (d) the classroom atmosphere and (e) the role of evaluation. Subjects were asked to rate the significance of each statement on a Likert scale to reflect their own ideas about the ideal learning environment. The results of the questionnaire were then transformed into LEP scores, as authorised by Moore (1989), ranging from 200 to 500 and indicating the Perry scheme continuum from position 2 to position 5. The LEP measurement has a ceiling effect which cannot go beyond Perry position 5; therefore, according to Moore (1989), this questionnaire might not be appropriate for older graduate students and/or faculty members. The LEP questionnaire was translated into Chinese and had several pilot tests. The internal consistencies (alpha values) of the final Chinese version reported here were found to be higher than 0.8 by position.

According to Hofer and Pintrich (1997), the most reliable method in the Perry scheme is the written measure, such as the MID (“Measure of intellectual development”). However, since the written measure requires trained raters for scoring purposes, the extent to which the method can be used is limited to small-scale investigation. Although the LEP questionnaire found only a median correlation between the LEP scores and the MID scores, the
association between LEP subgroups and MID positions was significant (Moore 1989). In other words, there was a conceptual overlap between constructs assessed by the LEP and MID methods; hence, the LEP scores and positions were used in the study to suggest the trend of epistemological development – i.e., the higher score/position, the higher epistemological development.

Data collection and analyses
The instruments were mailed to selected schools and completed by an earth science teacher in each school; participants were asked to return the survey within two weeks. As previously mentioned, the questionnaire return rate was about 75%, with some 690 valid samples for analysis.

In order to present the results of the study, responses to the survey questions regarding the constructivist instruction were analysed by the content analysis method. LEP scores were cross-examined by one-way ANOVA with subjects’ background characteristics, including gender, age, education, major in college, and so on. To find associations, if any, between agreement on the constructivist instruction and LEP scores, one-way ANOVA and the correlation analysis were conducted.

Results
Teacher views of constructivist instruction
As presented in Table 1, most teachers (over 80%) regarded options 2, 3 and 4 in question 1 of the survey, where the main emphasis was on student participation in learning activities, as constructivist instruction. Over 60% of teachers thought that options 6 and 7, where the focus was on teachers’ role(s) in promoting cooperative learning and individual opinions, were constructivist orientated. However, only about half of the teachers agreed that incorporating social issues and/or issues that students were familiar with (option 10) belonged to the constructivist style. As anticipated, less than 25% of teachers regarded the option of using multimedia and/or computers in teaching as a constructivist design. Also, barely 7%
of teachers felt that doing paper-and-pencil exercises intensively was constructivist oriented. Disappointingly, only 45% of teachers considered students’ involvement in the instructional plan or design (option 11) as constituting the constructivist approach.

The result of the survey implied that, for secondary earth science teachers in Taiwan collectively, the most important aspect about the constructivist instruction was student participation in the learning activities. Less emphasis was placed on the role of the instructor in promoting constructivist learning. The student participation in the instructional design, however, was least appreciated.

When teachers were asked if they agreed with the constructivist instruction on a five-point Likert scale (1 = Strongly disagree to 5 = Strongly agree), 298 displayed a neutral feeling (scored 3), while 283 agreed (scored 5 and 4). Some 86 teachers disagreed (scored 1 and 2) with this type of instruction. The average score was 3.33 (SD = 0.84), which reflected a neutral feeling. Since participants were not obliged to answer the third question in Appendix 1, about 450 teachers provided reasons why they supported or objected to the constructivist instruction. Among the respondents, 188 teachers agreed with the constructivist style, 73 disagreed and 193 gave neutral views. The content analyses over teacher responses are presented in the following sections.

Responses from teachers who agreed with the constructivist teaching

Table 2 presents the content and frequencies of the teacher responses. Since some teachers gave more than one opinion, there were 209 responses in total.

According to the table, teachers in this category thought the constructivist approach had the advantages of promoting thinking, knowledge construction, in-depth understanding of concepts, development of cognitive ability, creativity and motivation. Some teachers (n = 22), while agreeing with the constructivist style, recorded concerns about the time constraint, curriculum stress and the status of cognitive development of students.

Responses from teachers with neutral views about the constructivist instruction

Table 3 displays concerns about the constructivist instruction as expressed by teachers who showed a neutral attitude towards it. As shown in the table, the most talked about problem was the time issue. Under the current educational system in which standardised examinations lead teaching and learning, many teachers cannot afford to spend too much time on facilitating knowledge construction. Some teachers thought that constructivist teaching can be applied only to certain topics, and that the constructivist process was not the only way of acquiring knowledge. Some teachers thought that the constructivist process actually needs a strong knowledge/skill base. Moreover, the success of the strategy might depend on learner characteristics and pupils’ cognitive development. Overall, teachers in this group believed that the constructivist instruction should be used under specified conditions.

Responses from teachers who disagreed with the constructivist instruction

Some 105 negative opinions about the constructivist instruction were collected, as displayed in Table 4. Similar to the neutral group, the time constraint was the issue of most concern. In this group, many teachers thought the constructivist instruction could be successful only when students already had a strong knowledge and/or skill base. For many the priority of teaching was to meet the National Curriculum standards. Some teachers questioned students’ readiness for student-centred learning; in addition, some even expressed doubts
over the instruction because students’ performance in schools, evaluated via the traditional way, was not significantly enhanced.

In short, regardless of the time issue, teachers who disagreed with the instruction seemed to care more about whether an alternative instruction could result in a quick effect on school performance. They were also reluctant to delegate the responsibility of learning to students.

Other views about the constructivist style
Among the respondents, seven teachers selected opinion 13 that asked whether there were other styles regarding constructivist instruction not included in the survey. From the written responses, it was evident that the active participation of learners was the most recognised trait of the constructivist instruction:

(M1) [The constructivist instruction] let students freely explore information and then construct a report … allow time for students to experience the process.

(M2) [The constructivist instruction] let students prepare subject-related reports.
Field observation, explanation, discussion, any processes that can properly transmit concepts to students can be considered as constructivist instruction, for these approaches can enhance motivation and promote the in-depth understanding of the content.

Field observations, group discussions and problem-solving activities are constructivist.

On-line learning and discussion is also constructivist.

Two teachers recognised the advantage of reflection and individualisation in the approach:

[Constructivist instruction] allows reflection and comparison over past and current experiences …

[Constructivist instruction] allows individual pace in learning.

Despite the positive aspects, students’ ability and readiness were again raised by some teachers:

However, free exploration might not be constructivist because students might construct misconceptions.

Not all students are suitable for the constructivist style.
Teachers’ personal epistemology

Teachers’ LEP scores ranged from 203.2 to 447.5, with the mean score locating at 337 (SD = 47.9). The score distribution in Table 5 showed that the majority of teachers (68.3%) had scores between 300 and 400, indicating the early multiplicitist (position 3) in the Perry scheme. More than 20% of teachers with scores less than 300 could be characterised as the dualist (position 2), while less than 10% of teachers had scores higher than 400 suggesting the later multiplicitist (position 4). The score distribution suggested that the personal epistemology possessed by most teachers in the study was not aligned with the constructivist epistemology which, according to Moore (2002), should be more compatible to the Perry position 5 or higher.

One-way ANOVAs for LEP scores and teachers’ background characteristics showed that background factors, such as gender, years of teaching, education and the current school level, were statistically associated with the LEP scores. According to Table 6, female teachers had higher LEP scores, while in general the higher degree of education, the higher LEP score, and the more teaching experiences, the lower LEP scores. In addition, teachers in senior high schools had higher LEP scores compared to those in junior high schools. Noticeably, teachers

Table 4. Responses from teachers who disagreed with the constructivist instruction.

<table>
<thead>
<tr>
<th>Reasons for opposing the constructivist instruction</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Under the current schooling system, time is not allowed for the instruction</td>
<td>24</td>
</tr>
<tr>
<td>Students need to have strong knowledge and/or skill base for constructivist learning</td>
<td>9</td>
</tr>
<tr>
<td>It’s not effective (as far as school performance is concerned)</td>
<td>8</td>
</tr>
<tr>
<td>Effective only for some students</td>
<td>6</td>
</tr>
<tr>
<td>There is the curriculum issue</td>
<td>6</td>
</tr>
<tr>
<td>There is the issue of national standardised examinations</td>
<td>4</td>
</tr>
<tr>
<td>It’s too complicated for students and would cause confusion</td>
<td>4</td>
</tr>
<tr>
<td>It’s an ideal theory but not in practice</td>
<td>3</td>
</tr>
<tr>
<td>Students are passive</td>
<td>3</td>
</tr>
<tr>
<td>It depends on topics; not all topics can be designed accordingly</td>
<td>3</td>
</tr>
<tr>
<td>It lacks higher-order thinking</td>
<td>2</td>
</tr>
<tr>
<td>It is only one type of teaching strategy</td>
<td>2</td>
</tr>
<tr>
<td>Students lack motivation for this type of instruction</td>
<td>2</td>
</tr>
<tr>
<td>Teachers lack instructional knowledge</td>
<td>2</td>
</tr>
<tr>
<td>Parents disagree with the instruction</td>
<td>2</td>
</tr>
<tr>
<td>Not compatible in the current environment</td>
<td>2</td>
</tr>
<tr>
<td>It should not be overly used</td>
<td>2</td>
</tr>
<tr>
<td>Other opinions (which appeared once only)</td>
<td>17</td>
</tr>
</tbody>
</table>

Table 5. LEP scores distribution by Perry positions.

<table>
<thead>
<tr>
<th>Perry position</th>
<th>LEP mean</th>
<th>Frequency</th>
<th>%</th>
<th>Cumulative %</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>269.11</td>
<td>155</td>
<td>22.5</td>
<td>22.5</td>
</tr>
<tr>
<td>3</td>
<td>340.21</td>
<td>471</td>
<td>68.3</td>
<td>90.7</td>
</tr>
<tr>
<td>4</td>
<td>411.75</td>
<td>64</td>
<td>9.3</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td>337.02</td>
<td>690</td>
<td>100.0</td>
<td></td>
</tr>
</tbody>
</table>
who had attained the teacher enrichment programmes in recent (five) years seemed to have higher LEP score, even though the significant level was at 0.1. In summary, there was a trend that the more personal education, the higher LEP scores. However, years of teaching seemingly did not contribute to the development of the personal epistemology.

Association between LEP scores and agreement on the constructivist instruction

By one-way ANOVA, it was found that there was a significant difference of LEP scores between those teachers who agreed with the constructivist instruction and those who did not. The result is shown in Table 7. In addition, those teachers who gave alternative views about the constructivist instruction were found to have higher LEP scores (mean = 372.93), and their degree of agreement with the constructivist style (mean = 3.62) was also higher than the average (mean = 3.33).

To explore whether teachers with different epistemological beliefs would have selected differently about the styles of constructivist instruction, one-way ANOVA was conducted in each survey option. It was found that there was a significant difference between LEP scores and whether options 1, 3, 4, 6, 10, 11 and 13 were selected. As displayed in Appendix 1, these options (except option 1) actually represent the commonly accepted, constructivist
teaching style. The statistical result is displayed in Table 8. In general, teachers who selected the above-mentioned options, except option 1, tended to have higher LEP scores.

### Discussion

The investigation on teacher views concerning constructivist instruction showed the following facts. First, the average score on agreement was 3.33 on a five-point Likert scale, which implied an overall neutral attitude towards this type of instruction. Secondly, the percentage of selections in each survey option revealed that the focus of constructivist instruction expressed by the teachers mainly concerned learner participation, while the teachers’ role in facilitating knowledge construction and learner autonomy were neglected. Thirdly, content analyses of 544 collected written responses revealed that more than 65% (n = 357) were actually negative to a greater or lesser extent. Many teachers recorded doubts about the effectiveness and feasibility of the constructivist approach, and questioned whether students possessed enough knowledge and skills to engage in constructivist activities. Some of them even thought that students were passive by nature. Only a few teachers in the neutral group recognised that teachers themselves lacked relevant instructional knowledge. The findings suggest that teachers’ ideas actually deviated from what is commonly held regarding constructivist instruction in academic circles, as described in the literature. One may say that teachers’ alternative conceptions of constructivist instruction originate from lack of training or relevant information; however, studies have shown that teacher education programmes incorporating the constructivist teaching model have not successfully realised pre-service teachers actually teaching in a constructivist way (see Mintrop 2001). Moreover, since the educational reform in Taiwan is a national issue and numerous workshops have been held

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### Table 7. One-way ANOVA for teachers’ agreement on the constructivist instruction and LEP scores.

(a) One-way ANOVA for 5 scales. (b) One-way ANOVA for 3 scales.

<table>
<thead>
<tr>
<th>Agreement</th>
<th>N</th>
<th>LEP mean</th>
<th>SD</th>
<th>F</th>
<th>Post-hoc analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strongly agree</td>
<td>39</td>
<td>353.46</td>
<td>46.51</td>
<td>2.82*</td>
<td>Strongly agree &gt; disagree (p &lt; 0.1)</td>
</tr>
<tr>
<td>Agree</td>
<td>246</td>
<td>341.20</td>
<td>45.28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>295</td>
<td>335.40</td>
<td>49.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>69</td>
<td>325.07</td>
<td>47.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Strongly disagree</td>
<td>18</td>
<td>330.34</td>
<td>57.03</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>667</td>
<td>337.20</td>
<td>47.94</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(b) Agreement

<table>
<thead>
<tr>
<th>Agreement</th>
<th>N</th>
<th>LEP mean</th>
<th>SD</th>
<th>F</th>
<th>Post-hoc analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agree</td>
<td>285</td>
<td>342.8</td>
<td>45.26</td>
<td>5.02**</td>
<td>Agree &gt; disagree (p &lt; 0.05)</td>
</tr>
<tr>
<td>(Strongly agree + agree)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral</td>
<td>295</td>
<td>335.4</td>
<td>49.49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>87</td>
<td>325.1</td>
<td>48.98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Strongly disagree + disagree)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>667</td>
<td>337.20</td>
<td>47.94</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Notes: *Indicates significant association at the 0.05 level. **Indicates significant association at the 0.01 level.
over the past 10 years, lack of training and information alone cannot fully explain the discrepancy.

In order to obtain an in-depth understanding of the teachers’ views, their personal epistemology was examined through the LEP questionnaire. Teachers’ views concerning constructivist instruction were consistent with their epistemological beliefs towards knowledge and learning. As indicated in Table 5, in terms of Perry’s epistemological development, most secondary earth science teachers in Taiwan were at the stage of “dualism” or at the “early multiplicist” stage. According to Perry, the latter – while starting to sense the existence of an uncertainty concerning knowledge – believes nevertheless that there is a “right” way to find such knowledge. The role of the instructor is to model the right process, while the students’ role is to learn and apply that process. Also, as far as evaluation is concerned, a primary issue at this stage is “How is my answer judged?” Above multiplist views are not consistent or compatible with constructivism. Instead, these teachers’ epistemological stand might be judged philosophically as more like that of the positivist. Furthermore, if the majority of teachers in the study are indeed characterised as dualists or multiplicists, it is reasonable to suppose that these teachers would not completely welcome the constructivist instruction. The association between the teachers’ views of the constructivist instruction and their epistemological beliefs were further strengthened by the one-way ANOVA for the two variables; as indicated in Table 7, those teachers who agreed with the instruction had higher LEP scores than those who did not.

As presented here, background characteristics such as gender, education, years of teaching and current level of teaching were found to be associated with the LEP scores. Since epistemological development was the result of educational experiences (see Perry 1970), it was expected that education had an effect on the LEP scores, and the study results supported the claim. As for years of teaching, the overall trend was that the more years of teaching, the lower the LEP scores. The post-hoc analysis indicated a significant difference for LEP scores between teachers with 10 and 21 years of teaching experience. The findings suggest that teaching experience might bring a more negative effect on the development of a personal
epistemology. Since teaching and learning are two sides of the same coin, it is very likely that the form of knowledge transmission in the secondary schools – mostly non-constructivist – will gradually affect a teacher’s epistemological belief. Another finding was that teachers who taught in senior high schools received higher score on the LEP than those in junior high schools, and also spoke for the assertion, for in Taiwan education at the senior high school level is more open and flexible compared to that at the junior high school. Noticeably, teachers who had attained teacher enrichment programmes tended to have higher LEP scores, although the association is only approximately significant; hence, maintaining self-development and seeking constantly for professional enrichment could be critical.

In summary, from a developmental viewpoint, the secondary earth science teachers in Taiwan mostly had not developed an epistemological perspective compatible with constructivism. Their views about the constructivist instruction also deviated from what theorists have defined. Most important, the association between their personal epistemology and views about the constructivist instruction was evident; hence, to facilitate the constructivist reform in education, more attention should be placed on advancing teachers’ epistemological beliefs. On the other hand, if teachers’ personal epistemology is a result of years of education, then the research findings place an urgent call for a serious re-examination of higher education in Taiwan, for the current system seemingly had not advanced the epistemological status of the subjects in the study.

**Implications**

Although this nationwide investigation was limited to earth science teachers, as indicated in Table 7, a majority of participants (58%) were actually trained in various science disciplines. Accordingly, teacher views revealed by the study would be representative of science teachers in general. The study was conducted in Taiwan, and with many studies reporting similar problems about teacher views and classroom practices (e.g. Prawat 1992; Rosenfeld and Rosenfeld 2006; Windschitl 2002; Tsai 2002; Poole 1994; Hammer 1994; Lemke 1990), it offers a different angle on the interpretation of teachers’ resistance as found in many countries to adopt the constructivist teaching approach.

The results of the study indicated the reality that teachers’ personal epistemology conflicts with the philosophy of constructivist instruction, which could be a key cause for teachers’ reluctance to implement the constructivist-oriented instructions in their classrooms; in order, then, to change the conventional educational practice to a more constructivist style, greater attention needs to be placed on transforming teachers’ personal epistemology.

Simply changing the classroom settings or classroom activities cannot produce an authentic constructivist learning environment, in that it is teachers who mediate the learning process. Based on our finding that those who have experienced in-service training programmes had higher epistemological scores, a way to start the transformation of teacher beliefs could be a re-focusing of teacher preparation and training programmes. More effort should be directed at helping prospective or in-service teachers to reflect on their ideas about educational practices, and opportunities provided for teachers to experience the authentic processes of knowledge construction, so that they may be stimulated to rethink their personal epistemologies concerning knowledge and knowing.

On the other hand, from a developmental perspective, it takes time and relevant educational experience to adapt or change one’s personal epistemology. That change is more complicated if, as Schommer (2004) proposed, personal epistemology is considered as a system of more or less independent beliefs where cultural factors also mediate its formation.
Hence, while re-examination of teacher preparation programmes or systems is important for promoting the constructivism-compatible personal epistemology, another issue should be reconsidered by researchers and educators. That is, how far constructivist teaching and learning should go at the pre-college level where the personal epistemological status of both teachers and students is not constructivist orientated. Based on the findings of this study, it is suggested that the constructivist instruction should not be regarded as a “final solution” for teaching and learning. Educators might need to advance instructional designs that are congruent with, or at least not too far removed from, existing epistemologies of both the teachers and students.

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References


Appendix 1. The survey questions about the constructivist instruction

1. Which classroom settings in the following can be characterised as “constructivist instruction”?
   (1) Teachers give comprehensive lectures
   (2) Students participate in hands-on experiments or learning activities
   (3) Students participate in group discussions, reports and presentations
   (4) Students participate in information search activity and complete a relevant report
   (5) Teachers demonstrate experiments and explain thoroughly the process and the result to students
   (6) Teachers design a collaborative activity which allows students to explore a concept or an issue in groups
   (7) Teachers post in-depth questions in the classroom and allow students to respond according to their own opinions
   (8) Teachers use multimedia materials in the classroom
   (9) Teachers use computers to assist teaching
   (10) Teachers incorporate social issues or issues that students are familiar with in the instructional design
   (11) Students do the paper-and-pencil exercises intensively
   (12) Students take part in the instructional plan or design
   (13) Others (please give examples).

2. Do you agree with the constructivist instruction?
   (1) Completely agree
   (2) Agree
   (3) Neutral
   (4) Disagree
   (5) Completely disagree.

3. Please indicate reasons for your answer to question 2, above.