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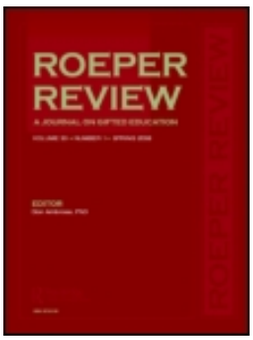

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CRITICAL THINKING

Effects of a Critical Thinking Skills Program on the Learning Motivation of Primary School Students

Weiping Hu, Xiaojuan Jia, Jonathan A. Plucker, and Xinxin Shan

Learning motivation has a significant effect on student learning, which is a key determinant of academic performance and creativity. It is increasingly popular and important to cultivate learning motivation in schools. To consider this trend, a long-term intervention program named "Learn to Think" (LTT) was designed not only to improve students' thinking ability but also to improve their learning motivation. The present study explored the effects of the LTT curriculum on primary school students' learning motivation. The sample consisted of 158 Chinese primary school students, who were randomly assigned to experimental and control groups. Experimental students participated in the LTT curriculum for 4 years, with data collected via pretests, annual end-of-year assessments, and a delayed posttest administration 1 year after terminating the training. The results suggest that LTT had long-term transfer effects on the development of primary school students' learning motivation, especially on deep motivation.

Keywords: critical thinking, deep motivation, delayed effects, "Learn to Think" intervention program, learning motivation, long-term intervention, primary school students, thinking ability

Martin (2008) defined motivation as "students' energy and drive to engage, learn, work effectively, and achieve to their potential at school and the behaviors that follow from this energy and drive" (p. 239). Not surprisingly, it has also been identified as a key predictor of student academic performance (Linnenbrink & Pintrich, 2002; Steinmayr & Spinath, 2009) and creativity (Amabile, 1985; Plucker, Runco, & Lim, 2006). However, educators in China routinely encounter two common motivational problems: On the one hand, Chinese students study hard and have solid basic knowledge, but they lack an innovative spirit and practical ability; on the other hand, the emphasis on grades and tests, increasing onerous levels of assignments and homework, and pressure from parents and teachers result in an increase in student weariness, a dislike of school, and a lack of learning motivation (Lin, 2007; Wang, 2003; Wu, 2013). Therefore, facilitating and cultivating motivation for learning is a key objective of Chinese education.

Many psychologists and other scholars put forward different perspectives on the composition and classification of learning motivation. In this study, learning motivation is divided into three categories (Biggs, 1987a, 1987b, 1987c): surface motivation (SM), deep motivation (DM), and achieving motivation (AM). SM is to meet requirements minimally, a balancing act between failing and working more than is minimally necessary, and it is maladaptive; DM is intrinsic interest in what is being learned, to develop competence in particular academic subjects; AM enhances ego and self-esteem through competition, to obtain the highest grades, whether or not the material is interesting. Both deep and achieving motivation are considered to be adaptive.

Research has shown that both internal and external factors impact students' motivation. For example, internal factors include gender (Maubach & Morgan, 2001; Meece, Glienke, & Burg, 2006), age (Martin, 2001), personality characteristics (Busato, Prins, Elshout, & Hamaker, 1998; Komarraju & Karau, 2005; Komarraju, Karau, & Schmeck, 2009; Tempelaar, Gijselaers, Loeff, & Nijhuis, 2007), thinking

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and learning styles (Atkinson, 1998; Busato et al., 1998; Fan & Zhang, 2009), learning attribution (Lei, Zhang, Hou, & Zhou, 1998), and self-efficacy (Chi & Xin, 2006), among others. External factors include characteristics of the school and classroom (Urdan & Schoenfelder, 2006), ability grouping and students' perceptions of their learning (Brown & Fletcher, 2002), classroom climate (Stevick, 1980; Urdan & Schoenfelder, 2006), social relationships with teachers and peers (Urdan & Schoenfelder, 2006), parents' attitudes toward and expectations for their children (Dandy & Nettelbeck, 2000), and culture (Fisher & Evans, 2000).

Perhaps more important, facilitating and cultivating motivation is one of the major research foci in education and psychology. Over the past 60 years, several researchers developed a variety of interventions to cultivate students' learning motivation. For example, Robertson (2000) comprehensively reviewed 20 intervention studies conducted from 1955 to 1997, in which researchers mainly used attribution training as their intervention method, with most interventions employing experimental designs and focusing on a particular subject area such as mathematics or reading. In these studies, participants were primary and secondary students with learning difficulties or low self-concept. Garcia-Sanchez and Caso-Fuertes (2005) improved students' motivation toward writing through an instructional program designed around four motivational determinants: (a) task value; (b) standards of performance; (c) students' attitudes, expectations, self-esteem, and self-efficacy beliefs; and (d) attributions concerning success and failure. The participants were fifth- and sixth-grade students with learning disabilities and/or low achievement between the ages of 10 and 13. These interventions/programs focus on students with learning difficulties in particular subjects and appear to be suitable primarily for small numbers of students with learning difficulties.

In recent years, motivation interventions have been integrated across subject areas, treating learning motivation as content general. For example, Martin (2005, 2008) implemented a series of workshops targeting high school students' motivation embedded within a youth enrichment program. Birdsell, Ream, Seyller, and Zobott (2009) increased seventh-grade students' motivation by offering students four types of choices: group choice, curriculum choice, assignment choice, and assessment choice.

Some other programs embed the intervention within a specific content area, which is exemplified by Grolnick, Farkas, Sohmer, Michaels, and Valsiner's (2007) development of an after-school program to enhance seventh-grade students' autonomous motivation, learning goals, school engagement, and performance. This program, called the Investigators' Club, was developed as a manual-based set of curricular units, each with a particular content focused on science (e.g., air pressure, sinking and floating, mass and motion) that did not overlap with that of the science class curriculum and with a set of common activities. Saleh, Lazonder, and Jong (2007) adopted structuring collaboration by group roles and ground rules to enhance average-ability students' (between 9 and 10 years old) motivation, and the intervention was administrated within the context of plant biology lessons. The disadvantage of these content-specific interventions/programs may be a lack of transfer to other content areas and tasks.

These programs largely reflect debates over the past several years about the content specificity and generality of a number of constructs related to learning, such as intelligence (Carroll, 1993; Gardner, 1983; Herrnstein & Murray, 1994), creativity (Hong & Milgram, 2010; Plucker, 2005; Plucker & Zabelina, 2009), motivation (Pajares & Urdan, 2002), and intellectual development (Johnson, 2011; Rakison & Yermolayeva, 2011; Rhemtella & Tucker-Drob, 2011).

A relatively new position in generality-specificity debates is a hybrid position, with interventions that acknowledge both the general and contextualized aspects of specific constructs (e.g., see Beghetto & Plucker, 2006; Plucker & Beghetto, 2004; related to creativity). In light of these developments—and in response to the disadvantages of the two approaches to the training of motivation—a "Learn to Think" (LTT) curriculum was designed, activities of which are contextualized in almost all areas studied by primary school students, including mathematics, language and literature, science, society, art, and daily life experiences.

TESTING A LEARN TO THINK CURRICULUM

On the basis of Hu's thinking ability structure model (Hu et al., 2011), Piaget's cognitive development theory (as cited in Evans, 1973), and Vygotsky's social construction theory (Vygotsky, 1978), an LTT curriculum was designed consisting of a series of learning situations intended to develop students' thinking ability and learning motivation.

The thinking ability structure model includes:

- thinking content (mathematics, language and literature, science, society, art, other disciplines, and daily life experience),
- thinking methods (e.g., space cognition, comparison, classification, inductive and deductive reasoning, reorganization, brainstorming, transfer, questioning), and
- thinking quality (profundity, flexibility, critical thinking, agility, and originality).

This suggests that the cultivation of thinking ability requires the teaching of thinking methods and the training of thinking quality and that these must be set within the context of a body of knowledge.

Piaget (as cited in Evans, 1973) proposed that children proceed through four stages of cognitive development: sensorimotor, pre-operations, concrete operations, and formal operations. Each stage has major cognitive tasks that must be accomplished. Vygotsky asserted that children's development can be fostered both by adults and more competent peers when working in the zone of proximal development (Vygotsky, 1978) and that the only "good learning" (p. 89) is that which is in advance of development.

Piaget's conception of four stages of cognitive development that allows specification of the cognitive complexity of tasks and Vygotsky's zone of proximal development and the principle that good learning must be in advance of development are the theoretical bases for estimating the relative difficulty of activities of the LTT curriculum. That is, the difficulty of activities is adjusted not just to match current ability but to provide challenge to promote the development of students' thinking ability, creativity, academic performance, and learning motivation (Hu et al., 2011).

Every grade from first through sixth of primary school has a specific manual, each including 16 activities covering different thinking content and methods. The thinking content is used as the carrier, the thinking methods are the main thread, and thinking qualities are taught in each activity. Every activity is delivered in four steps:

1. setting up a learning situation via cognitive conflict to arouse children's maximum interests;
2. facilitating children to observe, think, discuss, and conduct experiment;
3. leading children to reflect the process of the activity, how they thought and what they learned; and
4. facilitating transfer of thinking skills and motivation to daily life and other subjects of study, named *broadening*—or *bridging* per Adey and Shayer's (1994) terminology.

A sample lesson is included in Appendix A.

To achieve the program's aims of cultivating children's thinking ability, creativity, and learning motivation, we need not only well-described curriculum content but also advanced teaching methods in the processing of activities, expressed in the following five principles: stimulating interest and motivation, cognitive conflict, social construction, self-regulation and metacognition, and application and transfer (Adey & Shayer, 1994; Hu et al., 2011).

Stimulating Interest and Motivation

The LTT curriculum aims not just to teach skills and knowledge but also to develop student interest and motivation. All aspects of activity selection, from choosing activity content, materials, and situations to producing cognitive conflict, teacher–student and student–student interactions, as well as reflection or transfer, are focused on stimulating children's learning interest and motivation, encouraging children to explore learning methods and strategies, and staying positive and active in the acquisition of learning. Specifically, activity content is designed to be at least mildly entertaining to children of the target grade.

For instance, the Grade 2 activity "Little Ant Crossing the River" aims to train students to solve a problem in as many ways as possible, identify the most effective approach, and be happy to help others; at the beginning of this activity, a situation is set up that there is a new infectious disease in the Ant Kingdom, and if there is not timely treatment, all ants will be dead. A little ant named John is sent by the king to invite a doctor, but on the journey John encounters a huge river that he cannot cross; listening here, students become nervous and actively think about how to help John cross the river.

Another example is the activity named "What Does One Plus One Equal?" in Grade 6, which sets up a question situation surrounding assumptions of addition and combining units to arouse students' interest and guide them to design creative products by recombining different items. Here, stimulating students' interest and motivation is integrated through the whole LTT activity of the four steps, in order to encourage students to explore by themselves actively.

Cognitive Conflict

Cognitive conflict is a term drawn from the Cognitive Acceleration through Science Education project designed by Adey and Shayer (1994). It is used to describe an event or observation that the students find puzzling and discordant with previous experience or understanding. Cognitive conflict is an effective means to improve students' motivation and can lead them to pay more attention to the learning material or the topic (Kang, Scharmann, & Noh, 2004; Kim & Bao, 2004) and can arouse more curiosity and interest (Frick, 1992; Kong, Scharmann, Kang, & Noh, 2010; Yarlas & Gelman, 1998). It is a feature both of Piaget's account of the impact of environmental stimulus and children's constructivist response on cognitive growth and of teaching thinking programs. Here, at the beginning of an LTT activity, a learning/problem situation is set up via cognitive conflict to inspire students' curiosity and intrinsic motivation and to encourage their positive thinking; which also is needed in the activity processing such as students' observation, thinking, discussion, practicing, and more.

Social Construction

Social constructivism emerges from Vygotsky's contention that social interaction is central to children's development. The teaching environment for social construction means that teacher–student interactions and student–student interactions

are emphasized in the delivery of the LTT curriculum. Teachers encourage students to explain their reasoning to each other and to learn from each other through cooperative learning. Discussion is a well-established method, but it must involve analysis of the processes of argument if it is to be effective in teaching thinking. In addition, cooperative learning could increase students' motivation (Haywood, Kuespert, Madecky, & Nor, 2008), and a peer-learning partner has a motivational effect even before the actual cooperation takes place (Eisenkopf, 2010). Here, in the processing of each whole LTT activity, there are more exchanges and actions between teachers and students (i.e., strengthening the teacher–student interactions); student–student interactions were mainly strengthened in the processing of discussion/cooperation in groups.

Self-regulation and Metacognition

Underlying all of these methods are the principles of metacognition and self-regulation. Metacognition is the awareness and control of your own thinking processes. Regarding motivation, self-regulated learners are thought to hold a collection of adaptive beliefs and attitudes that drive their willingness to engage in and persist at academic tasks (Wolters, 2003). Metacognition affects motivation, and there are significant correlations between metacognition and motivation (Sperling, Howard, Staley, & DuBois, 2004), specifically intrinsic motivation (Baleghizadeh & Rahimi, 2011; Oxford & Ehrman, 1995; Vandergrift, 2006). The goal with this aspect of the LTT program is to give pupils practice in monitoring their own thinking, with the teacher initially making their strategies explicit and the learners then internalizing them, making them part of their habitual mode of thinking. Near the end of each activity, the students should reflect and summarize the thinking methods, thinking strategies, problem-finding and -solving methods, and what they learned from the activities.

Application and Transfer

Generally, each activity in LTT is situated in a specific domain. To encourage transfer, the program also includes opportunities for broadening content in each activity—or bridging in Adey and Shayer's (1994) terminology. That is, the thinking methods and strategies studied in the activity need to be applied and transferred to daily life or other domains for training the thinking qualities and forming general habits of effective thinking. Success application and transfer can provide students positive reflection, enhance their self-efficiency, and, in turn, improve their motivation to apply what they have learned in other subjects. Meanwhile, motivation is regarded as one of the key variables in the transfer process (Gegenfurtner, Veermans, Festner, & Gruber, 2009; Machin & Fogarty, 1997), and motivation to learn is proven to be a strong predictor of motivation to transfer (Facteau, Dobbins, Russell, Ladd, & Kudisch, 1995; Kontoghiorghes, 2002; Tannenbaum, Mathie, Salas, & Cannon-Bowers, 1991). Here, at the last broadening step of each activity, students are required to apply what they have learned to solve problems of daily life or in other domains.

The LTT program was first developed in 2001. We have explored the effects of the program on primary school students' graphic thinking (Du & Hu, 2008), thinking ability, and academic achievement (Hu et al., 2011) and have shown significant positive effects compared to control groups in both cases. For example, experimental studies with 6- and 7-year-old students provide evidence of effects after one or more years after starting the curriculum in thinking ability (d = 0.78–1.45), Chinese (d = 0.68–1.07), and math (d = 0.58–.87). Qiang and Hu (2010) also found that the LTT program improved the teaching behavior of primary school teachers: The cognitive level of their classroom questioning improved, the use of active and efficient questioning strategies increased, and the application of positive feedback instead of neutral and negative feedback were enhanced.

Therefore, based on the theoretical foundations of the program, the design of the curriculum units, and the results of previous experimental evaluation, we hypothesized that the LTT curriculum can play an important role in cultivating learning motivation: It may decrease maladaptive surface motivation while increasing adaptive deep motivation and achieving motivation; we also hypothesize that the program's effects on perceived learning motivation are long-lasting.

METHOD

Participants

Participants for the study were 158 first- to third-grade students (86 boys, 72 girls) in three classes from a primary school in Shanxi Province, China. The mean age of Grade 1 students was 6.57 years old, Grade 2 students' mean age was 7.21 years old, and Grade 3 students' mean age was 8.45 years old. By random sampling, 30 students in Grade 1 were assigned to the experimental group, and the remaining students in the same class were assigned to the control group. By stratified random sampling according to their final examination results of the previous term, 30 students in each class of Grade 2 and Grade 3 were assigned to the experimental group, with the others in the control group. Of the sample, 86 participants (42 boys, 44 girls) participated in the LTT curriculum, and 72 participants (44 boys, 28 girls) were in the control group. Attrition was modest, with 140 students remaining (an attrition rate of 11.4%) in the study over the course of the 4-year intervention (75 experimental group, 65 control group).[1]

Materials

Learning Motivation Questionnaire

The Learning Motivation Questionnaire was based on Biggs's (1987a, 1987b, 1987c) Learning Process Questionnaire (LPQ). Liu, Xin, Huang, and Shen (2000) modified the learning motivation subquestionnaire of Study Process Questionnaire to create a 9-item scale, and we continued amending and added seven additional items for a total of 16 that are suitable for primary school students (see Appendix B), each rated on a 4-point scale from 1 (*strongly disagree*) to 4 (*strongly agree*) with three subscales: surface motivation (SM), deep motivation (DM), and achieving motivation (AM), with 3 items, 8 items, and 5 items separately. The Cronbach's alpha internal consistency estimates of the subscales (SM, DM, AM) were .41, .52, and .76, respectively; the split-half reliability estimates were 0.44, 0.64, and 0.81, respectively, providing acceptable evidence of reliability for research purposes. The correlation coefficients among the subtests were lower, whereas the correlation coefficients between the whole questionnaire and each subtest were higher (i.e., ranging from 0.86 to 0.88), suggesting acceptable validity. Confirmatory factor analysis showed that the fit index for three factors is good, ($\chi^2 = 292.84$, $df = 101$, Comparative Fit Index [CFI] = 0.86, Incremental Fit Index [IFI] = 0.86, Goodness of Fit Index [GFI] = 0.88, root mean square error of approximation < 0.08), providing evidence of acceptable construct validity.

LTT Curriculum Survey Questionnaire

This questionnaire was a survey intended to tap experimental students' attitudes about the LTT curriculum. There are 10 items in this survey (see Table 1), and each item has four response options: *strongly disagree, do not agree very much, almost agree*, and *strongly agree*.

Interviews

The interview protocol (see Appendix C) was intended to explore what the experimental group students thought about the LTT curriculum and the change in themselves caused by the program. The interview content included what they have learned after participating in the LTT curriculum, the self-perceived changes in themselves before and after the LTT activities, self-perceptions about how their parents or teachers judge them after the LTT, identification of LTT activities or units that were particularly impressionable, and transfer of the skills and knowledge to other subjects or daily life, among other related topics.

Procedure

For each of the three classes that formed the sample, experimental and control groups had the same teacher and teaching conditions, with the only difference being that the students of the experimental group (approximately half of the class) attended an LTT curriculum lesson once every 2 weeks that was taught by three members of the research team—one member was in charge of one grade—and that was different from and did not overlap with the topics that they learned in the regular classroom, whereas students in the control group did their homework or worked independently, monitored by their head teachers. Note that the extra teaching received by the experimental group amounts to only an extra 16 hours per year (about 45 minutes for each activity/intervention session) compared to a total of over 750 hours of teaching in a school year (about 2%).

TABLE 1
Results of the LTT Curriculum Survey

	Percentage Almost Agree *and* Strongly Agree			
Items	*Grade 1*	*Grade 2*	*n*	*M*±*SD*
I like the LTT very much.	92	97	50	3.56 ± 0.72
I feel learning is something more meaningful.	88	94	50	3.16 ± 0.68
I often spend more time on learning what I like than before.	69	90	50	2.93 ± 0.73
I like to restructure my knowledge more than before.	69	81	50	3.02 ± 0.76
What I have learned can often be applied.	88	93	50	3.40 ± 0.67
When doing something, I am more likely to compare it with something similar.	77	90	50	3.39 ± 0.64
I'm better at raising questions than before.	69	87	50	3.26 ± 0.79
I have become more active in answering and asking more questions in class and less afraid of failing.	69	68	50	2.70 ± 0.96
I dare to say my own ideas in front of strangers more bravely than before.	88	90	50	3.29 ± 0.68
I dare to put forward different ideas on issues in front of elders than before.	77	90	50	3.30 ± 0.80

Note. At the time of the survey administration, the Grade 1 and 2 cohort students were in Grades 5 and 6, respectively (i.e., about 11–13 years old).

TABLE 2
Results of Repeated Measure ANOVA: Effects of Intervention on Learning Motivation

	Surface Motivation		*Deep Motivation*		*Achieving Motivation*	
Source	F	*Partial* η^2	F	*Partial* η^2	F	*Partial* η^2
Time	2.58*	0.02	15.68**	0.12	0.18	0.00
Time × Intervention	1.27	0.01	2.95*	0.03	1.40	0.01
Intervention	0.42	0.00	16.78**	0.13	3.12	0.03

Note. $^*p < .05$. $^{**}p < .001$.

The school year starts in September and is divided into two semesters. Before the formal experiment, we collected second- and third-grade students' final examination results from the previous school year, which were then used to assign students into experimental or control groups using stratified random sampling. Specifically, Grade 2 and Grade 3 students were categorized into three groups (high-score group, $n = 15$; mid-score group, $n = 74$; and low-score group, $n = 19$) according to their final examination results (Chinese and math scores) of the previous term. Students were randomly selected from each group and distributed proportionally among the experimental and control groups to help control for prior academic achievement in core subjects.

Students also completed the LMQ. During the 5-year study, experimental group students participated in the LTT activities for 4 years. Most experimental and control group students were administered the LMQ on five occasions: at the end of year 1, the end of year 2, midway (January) through year 4, the end of year 4, and 1 year after the end of the intervention (third-grade students did not complete the LMQ 1 year later, because they had graduated from the primary school and attended seventh grade in a number of other schools).

As a complement to the LMQ, 1 year after the end of the intervention, 10 experimental group students in each grade were interviewed, and the LTT Curriculum Survey Questionnaire was administered to all experimental group students who started the treatment in first and second grade (i.e., they were in fifth and sixth grade when they were interviewed and completed the LTT Curriculum Survey Questionnaire).

RESULTS

Pretest Scores

No significant differences were found in LMQ scores between the experimental and control group students before the intervention, providing evidence that the randomization and assignment procedures produced experimental and control groups with similar levels of learning motivation at the start of the study.

Development of Learning Motivation Over 4 Years

During the 4 years of the study, all participants were posttested four times with the LMQ. Repeated measures 5 × 2 analysis of variance (ANOVA) was used to test the main effects and interaction of time (5) and intervention (2: experimental, control). The results are presented in Table 2 and Figures 1–3.

There was no significant difference in the interaction effect of time and intervention ($p > .05$, partial $\eta^2 = 0.01$), but from an overall point of view, and the SM score of the experimental group students was lower than that for control group students at almost every point except T2 (see Figure 1).

As predicted, there was a significant Time × Intervention interaction, $F_{(4, 456)} = 2.95$, $p = .045$, partial $\eta^2 = .03$, although the effect size was small. Simple effects analyses showed that except in T1 (pretest), the DM scores of experimental students were significantly higher than that of controls ($p_{T2} = .004$, $p_{T3} = .001$, $p_{T4} < .001$, $p_{T5} < .001$); the partial η^2 values were from medium to large (see Table 3 and Figure 2).

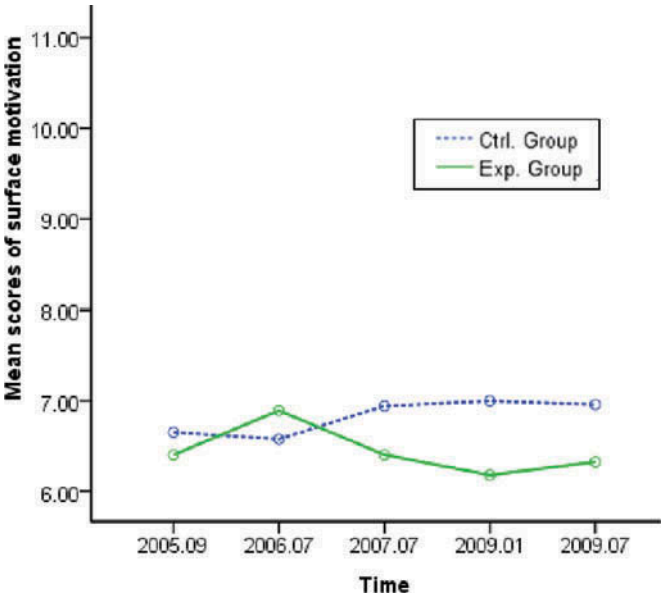

FIGURE 1 Developmental trends of surface motivation.

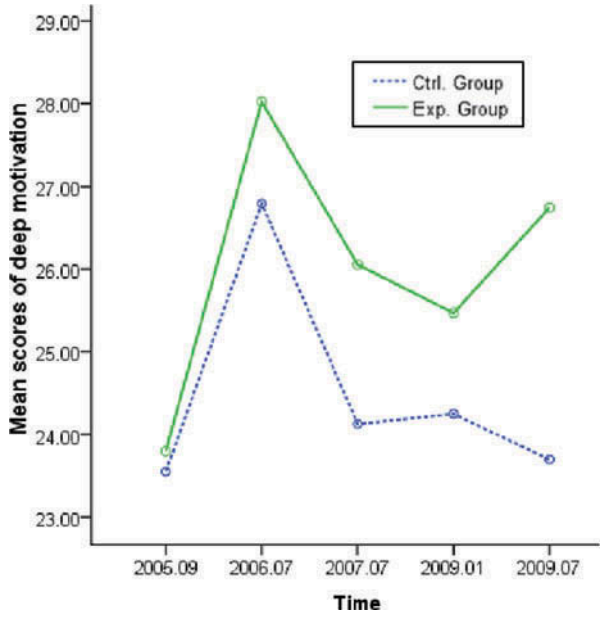

FIGURE 2 Developmental trends of deep motivation.

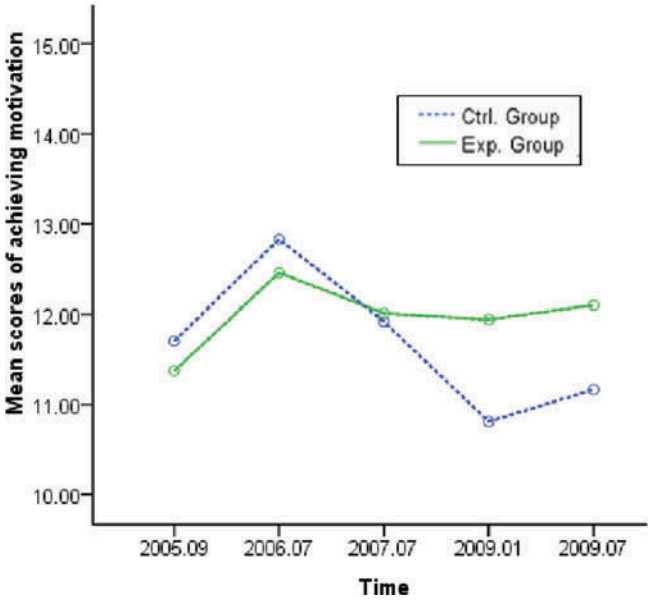

FIGURE 3 Developmental trends of achieving motivation.

The ANOVA provided evidence that there was no significant difference in the interaction effect of time and intervention ($p > .05$, partial $\eta^2 = 0.01$), but from T2, the trend for AM appears to be declining through primary school, with the experimental group experiencing less decline over time than the control group (see Figure 3).

Delayed Effects

One year after the end of the intervention, all students except those in the Grade 3 cohort completed the LMQ. The results are presented in Table 4, indicating that 1 year after terminating the intervention, the LTT still appears to have influenced the development of experimental students' perceptions of their deep motivation, $F_{(1, 81)} = 8.78$, $p = .004$, partial $\eta^2 = 0.10$.

LTT Curriculum Survey and Interviews

In order to tap the experimental student reactions to the LTT curriculum, as well as their feelings after the conclusion of the intervention, all first- and second-grade cohort students were asked to complete the LTT Curriculum Survey. In addition, the research team interviewed a random sample of 10 experimental group students in each cohort to obtain a richer set of data about participant experiences. Table 1 presents the percentage of experimental group students who agreed or strongly agreed with each item.

From the survey and interviews, students provided evidence that their behaviors, motivation, and attitudes toward learning changed significantly and positively due to the program; they felt that they had become more active, more independent, and more self-reflective in class and perhaps even much braver—an important finding within the Chinese context, where independence and forthrightness are often neither present nor encouraged. For example, one student shared, "I like the lesson, because in class all of us are happy and the teacher is happy, too. . . . I didn't like answer questions in class before because I am afraid of making mistakes. Now I would like to answer and ask questions after attending the LTT. My parents treat me like an adult, and I can argue against what they said." Another student noted that "the lesson is very interesting, it helped me think things which I never considered before and made me learn better. Before the course, I disliked writing, but now my composition is more and more imaginative. My parents were very strict with me before, but after the LTT my father looks at me with new eyes."

Students also generally felt that they could better analyze and solve problems from different perspectives, and think

TABLE 3
Effects of Intervention on Deep Motivation at Each Data Collection Point

	T1 (September 2005)	*T2 (June 2006)*	*T3 (June 2007)*	*T4 (January 2009)*	*T5 (June 2009)*
F	0.47	8.61*	11.40*	17.97**	13.53**
Partial η^2	0.00	0.06	0.08	0.13	0.10

Note. $^*p < .01$. $^{**}p < .001$.

TABLE 4
Results of Multivariate ANOVA: Delayed Effects

	SM		*DM*		*AM*	
Source	$F_{(1, 81)}$	*Partial* η^2	$F_{(1, 81)}$	*Partial* η^2	$F_{(1, 81)}$	*Partial* η^2
Intervention	0.63	0.01	8.78*	0.10	0.18	0.00

Note. $^*p < .001$.

about problems in more complex ways. For example, one student observed, "I remembered that in a maths class about calculating angles, I got the results as fast as I could by rotating the graphic. I can analyze and solve everyday problems from different perspectives."

Interestingly, students appear to believe that learning was more interesting and meaningful and that they could transfer their new knowledge and skills to other domains or to daily life. For example, one student said, "This course is of great help to my studies. It makes me know how to solve the problems, observe things carefully and be more interested in learning. What is more important is that I can think in depth. In addition, when my parents encounter problems in daily life, they would like to seek help from me." Another student shared, "Once I found my room was messy, and then I used the classification method which we had just learned to put my books and notebooks together, pencils and ruler together, old books together by grades."

Given all of these benefits offered by the students, their self-reported increase in self-confidence and belief in the value of cooperation and communication with others is not surprising. Indeed, several students mentioned that they had learned how to draw on the strengths of others to offset their own weaknesses, therefore accomplishing things they could not have completed by themselves. For example, one student observed that "I like discussing very much, because it provides me the chance to cooperate with other members in our group and listen to their ideas. When I was in a group with students of higher academic achievement, their ideas inspired me to think more." Another student said, "In the group discussion, different persons have different ideas, and then combining different ideas will be a new idea. We are always inspired by others' ideas, and then more and more good ideas will be generated."

Even allowing for a tendency in students to answer positively to questions about their experiences of an innovative curriculum experience (i.e., what Plucker & Gorman [1999, p. 148] referred to as the "rose-colored glasses phenomenon") and the lack of comparison group data for the interviews and LTT Curriculum Survey, these qualitative responses about the subjective experiences of participating students and teachers represent additional evidence of the quantitative trends discussed earlier.

DISCUSSION

The results of this study provide evidence in support of Martin's (2005, 2008) findings suggesting that a multidimensional educational intervention can have long-term and replicable effects on young adolescents' learning motivation. Possible explanations for the positive and significant effects were as follows:

First, the intervention deliberately addresses students' interests and motivation through the use of multiple strategies, from choosing activity contents, materials, and activity situations to producing cognitive conflict, teacher–children social construction, and thinking method reflection or transfer. Although the importance of and ability to increase student interest and motivation through classroom-based intervention is well established (e.g., Renzulli & Reis, 1985, 1994), the finding that multiple avenues can be used to achieve this set of student outcomes is unique within the Chinese context (see Pang & Plucker, 2013).

Second, students are set in a learning or problem situation via cognitive conflict, which focuses student learning on problems that are interesting and approachable. The conflict is at least partially resolved as students' minds go beyond their previous thinking capability, and it is an effective way to make students think actively. Some previous studies suggest that students show more curiosity and interest when the given phenomenon or information is not consistent with their expectations (Frick, 1992; Yarlas & Gelman, 1998) and that students therefore pay more attention to the learning material or the topic at hand (Kang et al., 2004; Kim & Bao, 2004).

Third, the intervention attempts to create an open, democratic, and supportive atmosphere, and it encourages students to spend more time on discussing problems with partners, thinking independently, speaking out about their own ideas, and evaluating others' views; this stands in contrast to many Chinese classrooms, where student participation is often characterized (not unfairly) as students blurting out answers without thinking in order to get the teachers' attention. In the LTT context, student concerns about failing to share the "right answer" appear to be reduced. In Stevick's (1980) words, classroom climate greatly affects student learning motivation and learning attitude. Recent research suggests that cooperative learning can increase student motivation

(Haywood et al., 2008) and that a partner has a motivational effect even before the actual cooperation takes place (Eisenkopf, 2010). Moreover, when students are encouraged and allowed to take ownership of their learning in an environment in which they feel cared for, supported, and socially connected to teachers and peers, and when they are given meaningful and appropriately challenging work, they will likely experience enhanced motivation (Urdan & Schoenfelder, 2006).

Fourth, the intervention focuses heavily on improving student metacognition. Students are encouraged to reflect and summarize how the successful methods or strategies they used helped them solve the problems. Research suggested that there were significant correlations between metacognition and motivation (Baleghizadeh & Rahimi, 2011; Oxford & Ehrman, 1995; Sperling et al., 2004; Vandergrift, 2006). More specifically, exercising self-control probably caused an increase in approach motivation (Schmeichel, Harmon-Jones, & Harmon-Jones, 2010), and students reporting a greater use of metacognitive strategies also reported more motivational intensity (Vandergrift, 2005).

Fifth, the LTT program guides students to apply and transfer thinking methods, strategies, and interests to daily life or other domains. Successful application and transfer can provide students positive reflection, enhance their self-efficacy, and, in turn, improve their motivation to apply what they have learned in other subjects. Research suggests that learning motivation and transfer affect and promote each other (Facteau et al., 1995; Kontoghiorghes, 2002; Machin & Fogarty, 1997; Tannenbaum et al., 1991).

Finally, previous research suggests that this particular intervention has a consistent, long-term effect on primary students' general thinking ability (Hu et al., 2011). Given other studies that provide evidence that the teaching of thinking and motivation may have reciprocal benefits (Busato et al., 1998; Fan & Zhang, 2009), the focus on thinking strategies in the intervention may explain some of the motivation change.

We suspect that an advantage of the program is that it helps students feel competent, view learning as a process rather than an end, and meet their social–relational needs. Students are also frequently encouraged to share their thinking processes with other students. This approach to instruction mobilizes students' enthusiasm to think, makes students solve the problem that they encounter actively, and trains them to transfer motivation and the thinking methods they have learned consciously and effectively.

Hardly any significant differences were found on surface motivation and achieving motivation between experimental and control groups. The borderline reliability estimates for the SM scale may be a cause for the lack of significant change. Another possible reason may be that both surface motivation and achieving motivation are related to extrinsic motivation, yet the LTT program more directly seeks to cultivate students' intrinsic motivation, which originates from within the individual and results in enjoyment of the process of increasing one's competency (Deci & Ryan, 2000). By focusing on the general teaching of thinking skills, with application to a range of curricular topics and settings, an intervention grounded in psychological theory and represented by a multifaceted theoretical model can have a consistent, long-term, and growing effect on primary students' deep motivation.

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NOTE

1. Attrition had a differential gender effect on the control group, with fewer girls remaining in the study than boys, for which we have no explanation.

REFERENCES

Adey, P., & Shayer, M. (1994). *Really raising standards: Cognitive intervention and academic achievement*. London, England: Routledge.

Amabile, T. M. (1985). Motivation and creativity: Effect of motivational orientation on creative writers. *Journal of Personality and Social Psychology*, *48*, 393–399. doi:10.1037/0022-3514.48.2.393

Atkinson, S. (1998). Cognitive style in the context of design and technology project work. *Educational Psychology*, *18*, 183–194. doi:10.1080/0144341980180204

Baleghizadeh, S., & Rahimi, A. H. (2011). The relationship among listening performance, metacognitive strategy use and motivation from a self-determination theory perspective. *Theory and Practice in Language Studies*, *1*(1), 1–67. doi:10.4304/tpls.1.1.61-67

Beghetto, R. A., & Plucker, J. A. (2006). The relationship among schooling, learning, and creativity: "All roads lead to creativity" or "You can't get there from here"? In J. C. Kaufman & J. Baer (Eds.), *Creativity and reason in cognitive development* (pp. 316–332). New York, NY: Cambridge University Press.

Biggs, J. B. (1987a). *The Learning Process Questionnaire (LPQ): Manual*. Hawthorn, Victoria, Australia: Australian Council for Educational Research.

Biggs, J. B. (1987b). *Student approaches to learning and studying*. Camberwell, Victoria, Australia: Australian Council for Educational Research.

Biggs, J. B. (1987c). *The Study Process Questionnaire (SPQ): Manual*. Hawthorn, Victoria, Australia: Australian Council for Educational Research.

Birdsell, B. S., Ream, S. M., Seyller, A. M., & Zobott, P. L. (2009). *Motivating students by increasing student choice* (Unpublished master's thesis). Saint Xavier University, Chicago, IL.

Brown, K., & Fletcher, A. (2002). Disaffection or disruptive engagement? A collaborative inquiry into pupils' behaviour and their perceptions of their learning in modern language lessons. *Pedagogy, Culture & Society*, *10*, 169–192. doi:10.1080/14681360200200138

Busato, V. V., Prins, F. J., Elshout, J. J., & Hamaker, C. (1998). The relation between learning styles, the Big Five personality traits and achievement motivation in higher education. *Personality and Individual Differences*, *26*, 129–140. doi:10.1016/S0191-8869(98)00112-3

Carroll, J. B. (1993). *Human cognitive abilities: A survey of factor-analytical studies*. New York, NY: Cambridge University Press.

Chi, L., & Xin, Z. (2006). The measure of learning motivation and the relationship between it and self-efficacy of college students. *Psychological Development and Education*, *2*, 64–70.

Dandy, J., & Nettelbeck, T. (2000). The model student? An investigation of Chinese Australian students' academic achievement, studying, and causal attributions for academic success and failure. *Australian Psychologist*, *35*, 208–215. doi:10.1080/00050060008257480

Deci, E. L., & Ryan, R. M. (2000). Self-determination theory and the facilitation of intrinsic motivation, social development, and well being. *American Psychologist*, *55*, 68–78. doi:10.1037/0003-066X.55.1.68

Du, Y., & Hu, W. (2008). Influence of the "Learn to Think" curriculum on 7–8 years old children's graphic thinking ability. *Education Exploration*, *12*, 44–45.

Eisenkopf, G. (2010). Peer effects, motivation, and learning. *Economics of Education Review*, *29*, 364–374. doi:10.1016/j.econedurev.2009.08.005

Evans, R. (1973). *Jean Piaget: The man and his ideas.* New York: E. P. Dutton.

Facteau, J., Dobbins, G., Russell, J., Ladd, R., & Kudisch, J. (1995). The influence of general perceptions of the training environment on pretraining motivation and perceived training transfer. *Journal of Management*, *21*, 1–25. doi:10.1177/014920639502100101

Fan, W., & Zhang, L. (2009). Are achievement motivation and thinking styles related? A visit among Chinese university students. *Learning and Individual Differences*, *19*, 299–303. doi:10.1016/j.lindif.2008.10.005

Fisher, L., & Evans, M. (2000). The school exchange visit: Effects on attitudes and proficiency in language learning. *Language Learning Journal*, *22*, 11–16. doi:10.1080/09571730085200191

Frick, R. W. (1992). Interestingness. *British Journal of Psychology*, *83*, 113–128. doi:10.1111/bjop.1992.83.issue-1

Garcia-Sanchez, J.-N., & Caso-Fuertes, A.-M. (2005). Comparison of the effects on writing attitudes and writing self-efficacy of three different training programs in students with learning disabilities. *International Journal of Educational Research*, *43*, 272–289. doi:10.1016/j.ijer.2006.06.006

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York, NY: Basic Books.

Gegenfurtner, A., Veermans, K., Festner, D., & Gruber, H. (2009). Motivation to transfer training: An integrative literature review. *Human Resource Development Review*, *8*, 403–423. doi:10.1177/1534484309335970

Grolnick, W. S., Farkas, M. S., Sohmer, R., Michaels, S., & Valsiner, J. (2007). Facilitating motivation in young adolescents: Effects of an after-school program. *Journal of Applied Developmental Psychology*, *28*, 332–344. doi:10.1016/j.appdev.2007.04.004

Haywood, J., Kuespert, S., Madecky, D., & Nor, A. (2008). *Increasing elementary and high school student motivation through the use of intrinsic and extrinsic rewards* (Master's thesis). Available from ERIC database. (ED503268)

Herrnstein, R. J., & Murray, C. (1994). *The bell curve*. New York, NY: The Free Press.

Hong, E., & Milgram, R. (2010). Creative thinking ability: Domain generality and specificity. *Creativity Research Journal*, *22*, 272–287. doi:10.1080/10400419.2010.503535

Hu, W., Adey, P., Jia, X., Liu, J., Zhang, L., Li, J., & Dong, X. (2011). Effects of a "Learn to Think" intervention programme on primary school students. *British Journal of Educational Psychology*, *81*, 531–557. doi:10.1348/2044-8279.002007

Johnson, M. H. (2011). Interactive specialization: A domain-general framework for human functional brain development? *Developmental Cognitive Neuroscience*, *1*, 7–21. doi:10.1016/j.dcn.2010.07.003

Kang, S., Scharmann, L. C., & Noh, T. (2004). Reexamining the role of cognitive conflict in science concept learning. *Research in Science Education*, *34*, 71–96. doi:10.1023/B:RISE.0000021001.77568.b3

Kim, Y., & Bao, L. (2004, August). *Development of an instrument for evaluating anxiety caused by cognitive conflict*. Paper presented at the Physics Education Research Conference, Sacramento, CA.

Komarraju, M., & Karau, S. J. (2005). The relationship between the Big Five personality traits and academic motivation. *Personality and Individual Differences*, *39*, 557–567. doi:10.1016/j.paid.2005.02.013

Komarraju, M., Karau, S. J., & Schmeck, R. R. (2009). Role of the Big Five personality traits in predicting college students' academic motivation and achievement. *Learning and Individual Differences*, *19*, 47–52. doi:10.1016/j.lindif.2008.07.001

Kong, H., Scharmann, L. C., Kang, S., & Noh, T. (2010). Cognitive conflict and situation interest as factors influencing conceptual change. *International Journal of Environmental & Science Education*, *5*, 383–405.

Kontoghiorghes, C. (2002). Predicting motivation to learn and motivation to transfer learning back to the job in a service organization: A new systemic model for training effectiveness. *Performance Improvement Quarterly*, *15*, 114–129. doi:10.1111/j.1937-8327.2002.tb00259.x

Lei, L., Zhang, Q., Hou, Z., & Zhou, J. (1998). The relationship between attribution and learning motivation of secondary school students with learning disability. *Psychological Development and Education*, *4*, 37–40.

Lin, W. (2007). The investigation and suggestion of primary school students' learning motivation. *Education Science BBS*, *8*, 32–33.

Linnenbrink, E. A., & Pintrich, P. R. (2002). Motivation as an enabler for academic success. *The School Psychology Review*, *31*, 313–327.

Liu, J., Xin, T., Huang, G., & Shen, J. (2000). The relationship among learning motivation, learning strategy and achievement performance of middle school students. *Theory and Practice of Education*, *20*, 54–58.

Machin, M. A., & Fogarty, G. J. (1997). The effects of self-efficacy, motivation to transfer, and situational constraints on transfer intentions and transfer of training. *Performance Improvement Quarterly*, *10*, 98–115. doi:10.1111/j.1937-8327.1997.tb00051.x

Martin, A. J. (2001). The student motivation scale: A tool for measuring and enhancing motivation. *Australian Journal of Guidance and Counselling*, *11*, 1–20.

Martin, A. J. (2005). Exploring the effects of a youth enrichment program on academic motivation and engagement. *Social Psychology of Education*, *8*, 179–206. doi:10.1007/s11218-004-6487-0

Martin, A. J. (2008). Enhancing student motivation and engagement: The effects of a multidimensional intervention. *Contemporary Educational Psychology*, *33*, 239–269. doi:10.1016/j.cedpsych.2006.11.003

Maubach, A. M., & Morgan, C. (2001). The relationship between gender and learning styles amongst A level modern languages students. *Language Learning Journal*, *23*, 41–47. doi:10.1080/09571730185200081

Meece, J. L., Glienke, B. B., & Burg, S. (2006). Gender and motivation. *Journal of School Psychology*, *44*, 351–373. doi:10.1016/j.jsp.2006.04.004

Oxford, R. L., & Ehrman, M. E. (1995). Adults' language learning strategies in an intensive foreign language program in the United States. *System*, *23*, 359–386. doi:10.1016/0346-251X(95)00023-D

Pajares, F., & Urdan, T. (Eds.). (2002). *Academic motivation of adolescents*. Charlotte, NC: Information Age.

Pang, W., & Plucker, J. A. (2013). Recent transformations in China's economic and education policies for promoting innovation and creativity. *Journal of Creative Behavior*, *46*, 247–273. doi:10.1002/jocb.17

Plucker, J. A. (2005). The (relatively) generalist view of creativity. In J. C. Kaufman & J. Baer (Eds.), *Creativity across domains: Faces of the muse* (pp. 307–312). Mahwah, NJ: Lawrence Erlbaum.

Plucker, J. A., & Beghetto, R. (2004). Why creativity is domain general, why it looks domain specific, and why the distinction does not matter. In R. J. Sternberg, E. L. Grigorenko, & J. L. Singer (Eds.), *Creativity: From potential to realization* (pp. 153–167). Washington, DC: American Psychological Association.

Plucker, J. A., & Gorman, M. E. (1999). Invention is in the mind of the adolescent: Effects of a summer course one year later. *Creativity Research Journal*, *12*, 141–150. doi:10.1207/s15326934crj1202_6

Plucker, J. A., Runco, M., & Lim, W. (2006). Predicting ideational behavior from divergent thinking and discretionary time on task. *Creativity Research Journal*, *18*, 55–63. doi:10.1207/s15326934crj1801_7

Plucker, J. A., & Zabelina, D. (2009). Creativity and interdisciplinarity: One creativity or many creativities? *ZDM: The International Journal on Mathematics Education*, *41*, 5–11. doi:10.1007/s11858-008-0155-3

Qiang, H., & Hu, W. (2010). Influence of the "Learn to Think" curriculum on primary school teachers' teaching behavior. *Education Exploration*, *5*, 66–69.

Rakison, D. H., & Yermolayeva, Y. (2011). How to identify a domain-general learning mechanism when you see one. *Journal of Cognition and Development*, *12*, 134–153. doi:10.1080/15248372.2010.535228

Renzulli, J. S., & Reis, S. M. (1985). *The schoolwide enrichment model: A comprehensive plan for educational excellence*. Mansfield Center, CT: Creative Learning Press.

Renzulli, J. S., & Reis, S. M. (1994). Research related to the schoolwide enrichment triad model. *Gifted Child Quarterly*, *38*, 7–20. doi:10.1177/001698629403800102

Rhemtella, M., & Tucker-Drob, E. M. (2011). Correlated longitudinal changes across linguistic, achievement, and psychomotor domains in early childhood: Evidence for a global dimension of development. *Developmental Science*, *14*, 1245–1254. doi:10.1111/j.1467-7687.2011.01071.x

Robertson, J. S. (2000). Is attribution training a worthwhile classroom intervention for K–12 student with learning difficulties? *Educational Psychology Review*, *12*, 111–134. doi:10.1023/A:1009089118008

Saleh, M., Lazonder, A. W., & Jong, T. (2007). Structuring collaboration in mixed-ability groups to promote verbal interaction, learning, and motivation of average-ability students. *Contemporary Educational Psychology, 32*(3), 314–331.

Schmeichel, B. J., Harmon-Jones, C., & Harmon-Jones, E. (2010). Exercising self-control increases approach motivation. *Journal of Personality and Social Psychology*, *99*, 162–173. doi:10.1037/a0019797

Sperling, R. A., Howard, B. C., Staley, R., & DuBois, N. (2004). Metacognition and self-regulated learning constructs. *Educational Research and Evaluation*, *10*, 117–139. doi:10.1076/edre.10.2.117.27905

Steinmayr, R., & Spinath, B. (2009). The importance of motivation as a predictor of school achievement. *Learning and Individual Differences*, *19*, 80–90. doi:10.1016/j.lindif.2008.05.004

Stevick, E. (1980). *Teaching and learning languages*. Cambridge, England: Cambridge University Press.

Tannenbaum, S., Mathie, J., Salas, E., & Cannon-Bowers, J. (1991). Meeting trainees' expectations: The influence of training fulfillment on the development of commitment, self-efficacy, and motivation. *Journal of Applied Psychology*, *76*, 759–769. doi:10.1037/0021-9010.76.6.759

Tempelaar, D. T., Gijselaers, W. H., Loeff, S. S., & Nijhuis, J. F. H. (2007). A structural equation model analyzing the relationship of student achievement motivations and personality factors in a range of academic subject-matter areas. *Contemporary Educational Psychology*, *32*, 105–131. doi:10.1016/j.cedpsych.2006.10.004

Urdan, T., & Schoenfelder, E. (2006). Classroom effects on student motivation: Goal structures, social relationships, and competence beliefs. *Journal of School Psychology*, *44*, 331–349. doi:10.1016/j.jsp.2006.04.003

Vandergrift, L. (2005). Relationships among motivation orientations, metacognitive awareness and proficiency in L2 listening. *Applied Linguistics*, *26*(1), 70–89. doi:10.1093/applin/amh039

Vandergrift, L. (2006). Second language listening: Listening ability or language proficiency? *The Modern Language Journal*, *90*, 6–18. doi:10.1111/modl.2006.90.issue-1

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological process*. Cambridge, MA: Harvard University Press.

Wang, Y. (2003). A study on development characteristics of school children learning motivation in Northwest. *Psychological Development and Education*, *1*, 20–24.

Wolters, C. A. (2003). Regulation of motivation: Evaluating an underemphasized aspect of self-regulated learning. *Educational Psychologist*, *38*, 189–205. doi:10.1207/S15326985EP3804_1

Wu, Y. (2013). The investigation of secondary school students' learning motivation. *New Curriculum*, *1*, 107–108.

Yarlas, A. S., & Gelman, R. (1998, April). *Learning as a predictor of situational interest*. Paper presented at the Annual Meeting of the American Educational Research Association, San Diego, CA.

APPENDIX A

Sample Learning to Think (LTT) Lesson

Content of activity: Little Ant Crossing the River (one of activities in Grade 2)

Objectives of activity: (1) Methodological objectives: train the problem-solving ability of students—come up with as many creative solutions as possible stage by stage when they encounter problems, identify the most effective approach. (2) Ability objectives: cultivate students' abilities to observe, analyze, and solve problems. (3) Emotion objectives: culture students' compassion, willingness to help others and collaborate with peers, diligent thinking, and problem-solving abilities.

Highlights of activity: Cultivate children's dialectical thinking, divergent thinking, and problem solving in lower grades of primary school.

Difficulty of activity: How to choose the optimal one from so many solutions.

Preparation of activity: A few seconds of cartoon, some pictures of animals, multimedia courseware.

Procedures of activity:

Step 1: Set up a learning/problem situation via cognitive conflict to arouse children's maximum interests.

The situation that is set up: There is a new infectious disease in the Ant Kingdom, and if there is not timely treatment,

all ants will be dead. A little ant named John is sent by the king to invite a doctor, but on the journey John encounters difficulties.

Then a few seconds of cartoon on the screen: on the way to invite a doctor little ant John encounters a huge river that he cannot cross; listening and watching here, students become nervous and actively think about how to help John cross the river.

"Kiddy, are you willing to help John?" (Ss: Yes.) "How to help him? Think quickly." (Guide the students to speak freely.)

Design intent: Establish a problem situation to arouse children's interest in thinking, to stir up their enthusiasm for participating in the activity, and at the same time make students clearly aware of what the problem is in this activity.

Step 2: Activity process, involving facilitating children to observe, think, discuss, and conduct experiment.

Part 1: Help John find ways to cross the river.

The children freely answer, and the teacher guides students to be divergent. The teacher listens to children and writes on the blackboard.

"Wonderful. Now, let's cross off repeated methods. What's left? We want to divide all of these methods left into different groups; how will you classify it? Think." The teacher listens to children, while adjusting the content of the blackboard.

Design intent: Guide students to come up with as many solutions as possible.

Part 2: Choose the most effective and optimal way and the reasons why.

"Wonderful! There are so many solutions you have thought of and good classification. Well, now let's help John to select which methods are more effective."

"Well, let's have a competition in groups. Before the selection, there is something required: first, choose one recorder from your group quickly whose duty is to write down which you choose and the reasons; second, collaborate with each other; third, keep secret before sharing your group's result; fourth, lower your voice when in discussion." (Group discussion begins, and the teacher guides the groups.)

"Have you finished? Let's share your achievements. Each group sends a representative to speak first, and then others add, including which methods your group choose, according to what criterion, and what reasons. Who is the first?"

Design intent: This part is method optimization. In the form of cooperation within group and competition between groups, students are expected to choose the most effective ways according to some standards and criterion.

Step 3: Evaluation and reflection. Leading children to reflect on the process of the activity, how they thought, and what they learned.

Well, let's have a break for 2 minutes. Close your eyes. Have a rest while thinking, from the beginning of the class to the present, you help little ant John come up with many ways and choose the optimal way to cross the river. What is your profound experience? What have you learned? What would you like to share with others?

Design intent: Ask students to recall and reflect on what they have learned; summarize the emphasis and main points in order to cultivate students' metacognitive ability.

Step 4: Consolidation transfer (activity broadening). Facilitate transfer of thinking skills and motivation to daily life and other subjects of study.

Design different animals to cross the river. (Two situations need be set up by teachers: firstly, how do different animals cross the same river? Secondly, how do you cross different widths of the river?)

Design intent: Expect that students can successfully apply what they have learned in class to daily life or other domains.

APPENDIX B

Learning Motivation Questionnaire for Primary School Students

Name:_____ Gender: _____ Age: _____ Class: _____

		Strongly Disagree	*Sometimes Disagree*	*Always Agree*	*Strongly Agree*
1	I like studying very much.	1	2	3	4
2	I think that teachers shouldn't expect students to work on topics that are outside the set course.	1	2	3	4
3	I study hard in order to obtain new knowledge.	1	2	3	4
4	I think the learning itself is very interesting.	1	2	3	4
5	I think we study in order to learn how to think and master knowledge.	1	2	3	4
6	I study hard in order to be commended and encouraged.	1	2	3	4
7	I will work for top marks in a subject whether or not I like the subject.	1	2	3	4
8	I have a strong desire to do best in all of my studies.	1	2	3	4
9	I have a strong desire to learn new knowledge.	1	2	3	4
10	I am learning in order to win honor for teachers and parents.	1	2	3	4
11	I study in order to live a more comfortable life in the future.	1	2	3	4
12	I study hard in order to be a merit student.	1	2	3	4
13	I study in order that people will live a better life.	1	2	3	4
14	I think learning will enable us to become more intelligent and contribute to science.	1	2	3	4
15	I study hard in order to get a good grade.	1	2	3	4
16	I think if I study hard, I will have lots of delicious and fun stuff and make more friends.	1	2	3	4

Note. Items 2, 10, and 16 comprise Surface Motivation; Items 1, 3, 4, 5, 9, 11, 13, and 14 comprise Deep Motivation; Items 6, 7, 8, 12, and 15 comprise Achieving Motivation.

APPENDIX C

Interview Protocol

Q1: What you have learned after participating in the LTT curriculum?

Q2: Please evaluate the changes in yourself before and after the LTT activities.

Q3: How do your parents or teachers judge you after the LTT?

Q4: How do your teachers judge you after the LTT?

Q5: How do your classmates judge you after the LTT?

Q6: What is the change in your classmates who had the LTT curriculum with you?

Q7: What effects did the LTT curriculum have on your study and life? Is it still influencing your life now?

Please list some thinking methods that you learned in LTT, in what discipline curriculum you still use these methods, and how you use them. Also, how do you use these methods in your daily life? Please give an example.

Q8: What is/are the most impressive lesson(s)? Why did it give you a deep impression?

Q9: What are the differences between LTT curriculum and the usual curriculum, such as Chinese, math, and so on?

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