The Benefits of the Learn to Think Program for Preschoolers' Creativity: An Explorative Study

Abstract

This paper presents the Learn to Think preschool (LTT-P) program for promoting creativity in preschoolers and reviews its potential benefits. LTT-P was designed within the framework of the successful Learn to Think (LTT) creativity program for older students and both were developed to fit the Chinese education system. To assess the potential benefits of LTT-P, a quasi-experimental pretest-posttest control group study was conducted in a preschool in an urban region in the northwest of China, involving 68 middle level and 87 senior level children. The Lines and Circles subtests of the Torrance Test of Creative Thinking were used to examine the development of children's creativity on the dimensions fluency, originality, and elaboration between pretest and posttest. The results suggest that the LTT-P program has the potential to promote young children's creative thinking, especially with regard to the aspects of originality and elaboration. The results for fluency are less clear. To the best of our knowledge, LTT-P is the first program, grounded in a structured learning theory and sound curriculum framework, to support children's creativity development in Chinese early childhood education.

Keywords: Learn to Think, creativity, early childhood

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Creativity is considered a key competence in current societies, and education systems across the world are seeking ways to foster creativity in children. According to widely used definitions, creativity refers to the ability to produce original and valuable ideas (Runco & Jaeger, 2012; for on-going debates of the criteria, see e.g., Smith & Smith, 2017), which is grounded in the interaction of person, process, and context (Glăveanu, 2013, 2018; Plucker, Beghetto, & Dow, 2004). Early childhood education in daycare centers and preschools is a particularly important context in this regard, for three reasons. First, young children, compared to older children and adults, show still a relatively high level of creativity and related characteristics such as flexibility and curiosity (Glăveanu, 2011), competences which, however, have been found to decrease over time in formal education (Kim, 2011). Second, the predominantly child-centered pedagogy in early, informal compared to later, formal education offers more possibilities to support creativity development (Doddington & Hilton, 2007). Third, early childhood education has been found to generate long-term impact on several skills and competences to the benefit of individuals and society, in particular on 'soft' competences such as social skills and behavioral self-regulation (Heckman & Kautz, 2012), and possibly also creativity (e.g., Runco, Millar, Acar, & Cramond, 2010).

The early childhood education system in China is currently struggling with the implementation of creativity education. The traditional emphasis on learning outcomes and the increasing use of standard tests have led to a dominance of direct instruction in (pre)academic skills in early education, often at the expense of activities that could promote creativity (Zhu & Zhang, 2008). In 2012, to change this situation, the Chinese Ministry of

Education released The Early Learning and Development Guidelines for 3- to 6-year-old Children, highlighting the need "to respect and protect children's curiosity and learning interests, helping them to build up learning habits such as taking initiative, being focused, daring to face difficulties, explore and try, and willingness to imagine and create" (p.2). Yet, preschools and especially preschool teachers are observed to have many difficulties with implementing these national guidelines, indicating that they need concrete support (Gao & Huo, 2017)

One way to support preschools is to provide them with well-designed programs for fostering creativity in young children. A number of recent studies from different countries describe and evaluate the results of such programs for fostering creativity in children in the preschool age (e.g., Abdullah Mirzaie, Hamidi, & Anaraki, 2009; Alfonso-Benlliure, Meléndez, & García-Ballesteros, 2013; Chronopoulou & Riga, 2012; Dziedziewicz, Oledzkab, & Karwowski, 2013; Garaigordobil & Berrueco, 2011; Gupta, 2008; Smogorzewska, 2012, 2014). The present study adds to this growing body of evidence, introduces a new program for stimulating creativity in preschoolers, the Learning to Think Program for Preschoolers (LTT-P), and reports the results of an a quasi-experimental evaluation of LTT-P. LTT-P was designed within the framework of the existing Learn to Think (LTT) program for older children. Both LTT and LTT-P were designed to fit in with the context of the Chinese education system, in particular with regard to the usual classroom setting, predominant pedagogy, and common curriculum contents.

Brief Introduction of LTT

LTT was originally designed by Hu et al. (2011) to stimulate students' creativity through

the cultivation of their thinking ability. The LTT program includes instruction and practice exercises for different thinking methods across several content domains, and is generally conducted throughout the entire school year. A four-year experimental study on the effectiveness of LTT, involving 166 children from grade 1 to 3, revealed that LTT promoted children's thinking ability and academic achievement. Subsequent studies showed that LTT also facilitated the development of scientific creativity in secondary school (Hu et al., 2013) and other creativity-related competences such as meta-cognitive learning strategies (Hu, Jia, Liu, & Shan, 2016) and learning motivation (Hu, Jia, Plucker, & Shan, 2016). Following the positive results, LTT was integrated in the curriculum of over 300 schools in China (Hu et al., 2013), covering grade 1 to 8.

Thinking Ability Structure Model (TASM) and the design of LTT activities

LTT was built upon the Thinking Ability Structure Model (TASM), proposed by Hu and colleagues (2011). In TASM, thinking ability is regarded as multifaceted, comprising three dimensions: (1) thinking content, i.e., the knowledge that is embedded in different learning materials, and the outcomes of reasoning with this knowledge; (2) thinking methods, i.e., the different kinds or strategies of thinking and reasoning (e.g., divergent, inductive, deductive, imaginary, et cetera); and (3) thinking quality, referring to the degree of fluency, flexibility, critical evaluation, originality and profundity of the thinking of a person. LTT provides a series of activities across different content domains (thinking content dimension), which stimulate the use of a variety of thinking methods (thinking methods dimension) to improve the quality of students' thinking. As described in Hu et al. (2011), the two main dimensions of TASM specify in theory 6 (thinking content domains) × 22 (thinking methods) cells, 132 in

all, that form the basic structure for designing the activities. However, only the cells deemed most important according to teachers were subsequently transformed into LTT activities per grade level.

Features of LTT conducive for creativity

In addition to the activities directly designed to foster creative thinking, a number of general pedagogical principles were included in LTT to ensure successful delivery. These principles can be regarded as conducive for creativity as well (Hu et al., 2013): LTT (1) stresses the use of teaching strategies that introduce cognitive conflict, increase students' motivation and evoke their meta-cognition; (2) emphasizes the importance of creating a social-emotionally safe classroom climate when implementing thinking activities; and (3) encourages students to transfer learned thinking methods to new content domains. These principles are included in a manual for the teachers and addressed in the teacher training program of LTT through lectures, workshops, and teaching simulations. In practice, teachers typically start an LTT activity by introducing the topic, meanwhile stimulating students' interest and motivation; after the introduction, the teachers present examples that contradict students' prior knowledge to evoke cognitive conflict; subsequently, students are given opportunities to work in groups and to discuss their thinking process with group members; at the end of an activity, teachers ask students to reflect and summarize the thinking methods they have learned in the activity to practice meta-cognitive skills. After each activity, additional enriching content is provided, usually in the form of an extra task, which requires the students to apply the learned thinking method to a different content domain.

LTT-P: The Design, and The Adaptions Made to LTT

In view of the effectiveness of LTT for promoting creativity and the wide acceptance of the program by schools, a preschool version of the LTT program was designed, entitled LTT-P. LTT-P adopted TASM as the theoretical foundation, but used a simpler structure based on the two dimensions thinking method and content domain (see Appendix I). Thinking methods that would require a high level of abstraction or cause a high cognitive load, such as philosophical thinking, were excluded to match the developmental level of preschoolers. The contents were mainly selected based on the national guidelines for stimulating 3- to 6-year-old children's development (Chinese Ministry of Education, 2012) and on common subjects in preschool education. Eventually, 20 activities were designed for children at the middle and the senior level in preschool, respectively, 40 in total (see Appendix II).

In addition to TASM as theoretical foundation, LTT-P used the same general pedagogical principles for conducting the activities, with a few adaptions. One adaptation was to put stronger emphasis on independent exploration on beforehand as a way to familiarize children with the learning materials and content domain of a particular activity. For each activity, teachers provided children with ample opportunities to explore the materials and encouraged them to think about the questions or problems posed before starting the group work. Additionally, several procedures were adjusted to reduce the demands on children with regard to abstract discussion and meta-cognition in the activities. First, story-based scenarios were used in almost all activities with concrete materials and drawings, picturing the scenery. Second, in addition to evoking cognitive conflicts, modeling by the teacher was used in most activities to help children understand the particular thinking method at stake. For example, in the activity of Finger Drawing, the teacher first demonstrated how she used finger prints to

paint an animal or an object before asking the children to do this. Third, teachers implementing LTT-P explicitly supported children in their cooperation, showing them how to listen to each other, how to express their own ideas, and how to react to others' ideas. Finally, after an activity was completed, children were encouraged to share what they had learned and how they appreciated the activities as an age-appropriate way to promote meta-cognition. In addition, instead of asking the children to do this as in LTT, the teacher summarized and repeated the targeted thinking method at the end of an activity.

The Present Study

The main purpose of the present study was to assess the potential contribution of LTT-P to the development of creativity in preschool children. The study used a quasi-experimental design and was conducted in two classes at the middle, respectively the senior grade level in one urban preschool in the northwest of China. LLT-P was administered during one school year to a randomly selected group of children in one class at each grade level and compared to control children in the same and the other class. Being an age-adjusted version of the successful LTT, LTT-P was expected to stimulate the development of creativity in preschool children.

Method

Participants

The participants were recruited from a provincial key preschool located in an urban area of the northwest of China. This preschool is affiliated to and funded by the public university, which hosts the research lab that conducted the current study. Compared to the majority of

preschools in China, which are privately owned and usually do not receive public funding, the preschool involved in this study employs better qualified teachers and has access to ample educational facilities and resources. However, the preschool shares typical characteristics with most Chinese preschools, especially regarding structural conditions such as class size and children-to-staff ratio, educational goals, learning contents, and applied pedagogical and instructional strategies. Similar to the mainstream of preschools in China, the participating preschool admits children to three grade levels: 3- to 4-year-olds are admitted to the junior level, 4- to 5-year-olds to the middle level, and 5- to 6-year-olds to the senior level. The LTT-P program was designed for children at the middle and the senior level.

Four classes in total, two at each grade level, were included in this study. At each grade level, one class was chosen to conduct the LTT-P activities. Most LTT-P activities were designed for small group team-work. It was not feasible to include all children in the class, with a size of around 45, in the LTT-P activities, given the time and energy needed to manage the class. Therefore, children within the classes chosen for the implementation of LTT-P were randomly assigned to either the experimental (participation in LTT-P) or the within-class control condition. By randomly assigning children from the same class to either the experimental or control condition, class-related effects on the outcome measures could be controlled. To control for possible spill-over effects, which imply that children of the within-class control condition may increase in creative thinking due to daily interaction with children of the experimental condition, children of two other classes were assigned to the between-class control condition, one class per grade level. In these classes, none of the children received LTT-P.

Eventually, a total number of 182 children participated in the study. Passive parental consent was obtained for virtually all children in all classes. The data of 27 children had to be excluded for several reasons: (a) 25 children did not have complete data (either pretest or posttest data were missing); (b) one child in the experimental group at the senior level participated in only six out of 20 LTT-P activities, which was considered insufficient; (c) one child in the within-class control group at the middle level was much older (67 months) than the average and was reported by the teacher to be a child with special educational needs. The final sample included 155 children (92 boys). Table 1 includes information with regard to the age and gender of the children, and the final sample size by grade level and condition.

Measurements

The Lines and Circles subtests of the figural Torrance Test of Creative Thinking (Torrance, Ball, & Safter, 1992/2008) were used at, respectively, the pretest and the posttest to evaluate children's creativity. The forms used at pre- and posttest differed but are psychometrically equivalent and can be considered parallel forms (Torrance et al., 1992/2008). TTCT is one of the most widely used tests for assessing creativity. Test-retest reliability of TTCT is reported to exceed 0.80 (Torrance, 1972), and the test scores correlate highly with individuals' creative behaviors and personality traits as measured by an established scale (Garaigordobil & Berrueco, 2011).

The test at pretest presented children with pairs of lines, and the test at posttest presented children with circles. For both tests, children were requested to make as many drawings as possible while integrating the presented stimuli in their drawings (Torrance et al., 1992/2008). The tests took 10 to 20 minutes to finish. No strict time limit was set in this

study, given the age of the children, allowing them sufficient time to express their thinking in the drawings. Testing was stopped when children repeated previous drawings several times or when children indicated that they wanted to stop.

Trained research assistants administered the tests to groups of four to five children. The assistants were intensively instructed, performed trial tests on each other, and were closely supervised by the first author during the first test session. At pretest, due to practical limitations, no separate test room was available at the preschool and tests were administered in the classroom during one session. At posttest, the tests were administered in a separate room during several short sessions. Before starting the actual test, one training item was presented, while the research assistants demonstrated how to make a drawing (a pair of lines was extended to a pencil and a circle was extended to an apple) in order to ensure that children understood the test. When the children had completed the test, they were asked to name all their drawings. If the name could not unequivocally be related to the drawing, children were asked to explain the drawing in detail. These names and explanations were recorded by the research assistants for later scoring.

Children's drawings were scored on the common aspects fluency, originality, and elaboration (Torrance et al., 1992/2008). Fluency was scored following the scoring manual (Torrance et al., 1992/2008). Repeated drawings and drawings that clearly did not use the given stimulus were excluded from the scoring. For each child, a fluency score was calculated as the total number of the remaining drawings. Originality was scored based on the frequency of the ideas expressed by a child in his or her drawings (as also indicated by the names or the more detailed explanation given) relative to all ideas expressed by all children

in the whole sample: the more infrequent relative to the whole sample, the more original. Drawings that appeared in the tests of less than 10% of the children were scored one on originality, all other drawings zero. We used a relative measure of originality rather than the established norm of the test, because this norm is based on a US sample and might possibly not fit the Chinese background of the children. For drawings in which two or more of the given stimuli were combined, bonus scores for originality were given, in accordance with the scoring manual. Eventually, an overall originality score per child was computed as the sum of the originality scores of all valid drawings plus the bonus scores. Finally, elaboration was scored based on the overall impression of the richness of details in a child's drawings rated on a 5-point scale (1 = *not elaborated at all*; 5 = *very elaborated*). Scoring was done by the first author.

Limitations of the design

It should be noted on beforehand that the current design suffered from several limitations: (1) There was only one preschool involved, which moreover benefitted from its relation with the public university. The findings of this study, therefore, cannot be easily generalized to the entire system of preschool education in China. (2) The experimental group and the within-class control group were in the same class throughout the whole school year, except for the LTT-P activities. This could lead to a spill-over effect, possibly obscuring the experimental effect. (3) Only one researcher scored children's creativity products. Although several procedural measures were taken to assure the objectivity and reliability of the scoring, coder bias cannot be ruled out.

Procedure

The study was conducted in the semesters before and after the winter break, spanning a total period of around nine months. The winter break lasted one month. The program provided activities for around six months. Depending on the preschool schedule, one or two activities (of 30-45 minutes) per week were conducted at each grade level. The first author conducted the program under the supervision of the preschool vice-principal of teaching and the second author. All children took the pre- and posttests, but only children of the experimental group took part in the LTT program activities. Pretest and posttest were conducted two weeks before, respectively two weeks after the LTT-P program,.

Results

Means and standard deviations of fluency, originality, and elaboration by condition are presented in Table 1, separately for the pre- and posttest. Two repeated measures MANOVAs were applied to the data of the middle and the senior level, respectively, to assess differences between the experimental condition and the two control conditions in the increases of the creativity measures fluency, originality, and elaboration between pre- and posttest. For both grade levels, the Box's tests were significant ($p_{middle} = .017$ and $p_{senior} = .011$), indicating that the assumption of equality of covariances across groups was violated. Furthermore, Levene's tests were not significant for the creativity measures at pretest, but significant for all measures at posttest. Altogether, these results suggest that implementation of LTT-P enlarged the differences between children in the measures between the conditions. Wilks' Lambda's were used to interpret the results, because the Box's tests were not significant at $p < .001$ and

the sample sizes were fairly equal across groups (Mertler & Vannatta, 2013). The results of MANOVAs and the post-hoc ANOVAs are presented in Table 2.

(Insert Table 1 and Table 2 here)

The results of the MANOVA for the middle level, Wilk's $\Lambda = .78$, $F(6, 126) = 2.86$, $p < .05$, $\eta_p^2 = .12$, showed a significant multivariate Condition × Time interaction effect on fluency, originality, and elaboration. Subsequently, post-hoc univariate ANOVAs revealed condition effects on the gains of fluency, $F(2, 65) = 3.83$, $p < .05$, $\eta_p^2 = .11$, originality, $F(2, 65) = 3.32$, $p < .05$, $\eta_p^2 = .13$, and elaboration, $F(2, 65) = 5.15$, $p < .01$, $\eta_p^2 = .14$. Finally, pairwise comparisons were conducted with a Bonferroni corrected significance level of $p < .05/3 = .018$. The comparison results showed that (1) children in the experimental group had a significantly larger increase in fluency, $F(1, 35) = 6.16$, $p = .018$, but not in originality and elaboration, than children in the within-class control group; (2) children in the experimental group had significant larger increases in originality, $F(1, 50) = 6.02$, $p = .018$ and elaboration, $F(1, 50) = 9.09$, $p = .004$, but not in fluency, than children in the between-class control group; and (3) children in control groups did not differ in any measure.

The results of the MANOVA for the senior level, Wilk's $\Lambda = .74$, $F(6, 164) = 4.54$, $p < .001$, $\eta_p^2 = .14$, showed also a significant Condition × Time interaction effect. The post-hoc ANOVAs revealed condition effects on the gains of fluency, $F(2, 84) = 3.11$, $p < .05$, $\eta_p^2 = .069$, originality, $F(2, 84) = 6.16$, $p < .01$, $\eta_p^2 = .13$, and elaboration, $F(2, 84) = 6.55$, $p < .01$, $\eta_p^2 = .14$. Pairwise comparisons showed that (1) there was no significant difference between children in the experimental group and the within-class control group; however, (2) children in the experimental group had significant larger increases in originality, $F(1, 63) =$

10.81, $p = .002$, and elaboration, $F(1, 63) = 14.13$, $p < .001$, but not in fluency, than children in the between-class control group, and (3) children in the within-class control group had a significant larger increase in originality, $F(1, 61) = 6.32$, $p = .015$, than children in the between-class control group.

In summary, children at the middle level who participated in LTT showed larger increases in fluency than children in the within-class control group, and in originality and elaboration than children in the between-class control group. Children at the senior level showed larger increases in originality and elaboration than children in the between-class control group, but not than children in the within-class group. Regarding the two control groups, no differences were found in increases in creativity at the middle level. At the senior level, children in the within-class condition showed a larger increase in originality than children in the between-class condition.

Discussion

The results of the current study suggest that the development of children's creativity, at least regarding the originality and elaboration of their responses to the widely used Torrance Test of Creative Thinking, can be supported by implementing a program of activities, such as LTT-P, in preschool classrooms that stimulate different ways of thinking across different content domains. LTT-P is a new creativity program for preschoolers at the middle (4- to 5-year-olds) and the senior level (5- to 6-year-olds) in China and was based on the previously developed LTT framework for older children. The current findings add to the evidence on the usefulness of the LTT framework for promoting creativity (Hu et al., 2013) and creativity-related capacities (Hu, Jia, Plucker, et al., 2016; Hu, Jia, Liu, et al., 2016).

As a general trend, the data showed that children who participated in LTT-P gained more in creativity on most outcome measures than children in the between-class control condition. However, with regard to the within-class control condition the results were less clear (at the middle level: no difference regarding originality and elaboration gains; at the senior level: no differences in creativity gains at all). The results for one dimension of creativity, fluency, were also much less clear. We will elaborate on the main findings and offer explanations for the unexpected results below.

The Benefits of LTT-P on Originality and Elaboration

Regarding originality and elaboration, significant differences in growth were found between the experimental and the between-class control groups. These two groups of children were not strictly equivalent as we were not able to work with random assignment, but they can be considered as comparable. The children were from the same social backgrounds and shared a similar educational context (for example, regarding class size, curriculum, educational climate, teacher qualifications). However, we found no significant differences in growth between the experimental and within-class control children. Note that due to within-classroom randomization both groups could be considered as fully equivalent with only the experimental treatment differing between the groups, while other potentially relevant classroom factors were fully shared and thus controlled for. Therefore, the lack of significant differences in gains in originality and elaboration between experimental and within-class control group may point to spill-over effects that counter-acted the experimental effect. Although children in the within-class control condition did not participate in the LTT-P program activities, they were in the same classrooms as children who did. The increased

motivation and enthusiasm of the experimental children may have influenced the classroom climate and thereby stimulated the creativity of the within-class control children also. Likewise, the training of the experimental children in reflecting and elaborating on ideas and activities may have had a wider influence on classroom processes, impacting also within-class control children. Second, in actual practice, we observed that within-class control children were very curious about what the experimental children were experiencing during program time and they were found to be very motivated to do the post-tests. These effects, of course, were not present in the between-class control group.

The positive influence of LTT-P on originality found in the current study may actually point to a moderating effect of the context of Chinese preschool education, as previous studies in other countries have revealed that creativity programs are not always successful in promoting originality (e.g., Alfonso-Benlliure et al., 2013; Smogorzewska, 2014). Originality, unlike fluency, seems more difficult to stimulate in education contexts in other countries. Chinese education has been thought to hinder students' creativity more than education programs in other countries (Niu & Sternberg, 2001, 2003; Niu, Zhang & Yang, 2007), but may for this reason leave more room for creativity-promoting programs to yield effect. Several researchers have pointed to Confucianism as a factor in this regard (e.g., Niu & Sternberg, 2001). As a system of values and norms, Confucianism favors the creation and maintenance of a hierarchical social system and emphasizes socialization of proper behavior according to prevailing social norms (Wu & Albanese, 2010). It especially discourages arguments and discussions (Wu, 2004). These ideological features have profoundly influenced the value system of education as well, already in preschool, giving rise to a

pedagogical climate in classrooms that prevents students from generating and, in particular, expressing novel ideas. Originality, thus, is hindered or under-stimulated in this context, insofar as originality requires students to cross boundaries, think out of the box, and express novel ideas. Therefore, an intervention program that explicitly (and intensively) encourages children to generate, express and share novel ideas may show relatively large effects. Evidence pertaining to older children indeed indicates that, when given explicit instructions, Chinese students perform better in creativity tasks than their counterparts in other countries (Wong & Niu, 2013).

As for elaboration, the results were largely consistent with our expectations. Children developed spontaneously in elaboration skills and the creativity program LTT-P added to that significantly, at least when comparing the experimental groups with the between-classroom control groups where no spill-over effect could have disturbed the findings. The positive influence of LTT-P on children's elaborated thinking may be due to two pedagogical processes introduced by LTT-P. First, as a key principle, children were explicitly encouraged to describe their thinking process and to explain their ideas to both peers and teachers in almost all activities. Second, collaborative team-work was an important element of many LTT-P activities, stimulating children to explain and compare their ideas with those of others, and to reflect explicitly on commonalities and differences. As a consequence of these two processes, children were trained to be elaborate in both thinking and expressing their ideas.

The Lack of Benefits of LTT-P on Fluency

There were no stronger gains in fluency for the experimental than the between-class control group, but at the middle grade level there was a significantly stronger gain for the

experimental than the within-class control group, contradicting the idea of a spill-over effect of LTT-P within classrooms. This finding can be coincidental, but perhaps, this also indicate that the spill-over effect, at least for the younger children, was not as strongly affecting fluency as it may have been affecting originality and elaboration. A possible explanation could be that fluency increased rather strongly between the pre- and posttest measurements regardless of condition, and more so at the middle level than at the senior level. This strong spontaneous increase in fluency in all conditions may have attenuated the effect of LTT-P. Note in addition that in the experimental condition the standard deviation at posttest was substantially larger than in the other conditions. This could suggest that the fluency training part of the LTT-P program worked well for part of the children only but less well for the rest, which could explain that an overall noticeable spill-over effect on the whole classroom was absent, while the mean scores still differed between experimental and within-class control conditions. Upon closer scrutiny of the data, we indeed found that about half of the children in the experimental group showed substantial gains in fluency, while the other half showed much smaller gains.

The lack of an effect of LTT-P on fluency seem to contradict findings reported in the literature, which suggest that fluency can be easily promoted, as almost all preschool creativity programs were reported to have effects on fluency (Abdullah Mirzaie et al., 2009; Chronopoulou & Riga, 2012; Dziedziewicz et al., 2013; Garaigordobil & Berrueco, 2011), but not always on the other dimensions of creativity (Alfonso-Benlliure et al., 2013; Smogorzewska, 2014). Although the substantial gain in fluency that children especially at the middle level showed in this study, regardless of condition, is in line with the idea that fluency

can be relatively easily promoted (and even can increase spontaneously), we did not find a clear condition effect. Possibly, the fluency training component of LTT-P could not add much to the already substantial spontaneous growth in fluency, explaining the difference in findings with other studies.

Conclusion

The present study reviewed the benefits of the Learn to Think preschool program on creativity in children using a quasi-experimental design. LTT-P was designed specifically to enhance the support of creativity and thinking skills in Chinese preschool education. The results suggest that LTT-P has the potential to promote young children's creative thinking, especially with regard to the creativity dimensions originality and elaboration, as was expected based on the results of the LTT program for older children. In the context of the Confucianist pedagogical climate of Chinese preschools, the positive influence of LTT-P on children's originality was regarded as promising, as children in such a climate may not develop the skill to generate and express original ideas spontaneously. However, it should be noted that the results are not fully conclusive as the study design suffered from several limitations.

In addition to the design limitations mentioned in the Method section, the current study showed two other shortcomings that should be improved in future research. First, with regard to measuring creativity, the TTCT, even though widely used, may not be the best choice. As indicated in the present study and also in the literature, creative thinking as currently defined and operationalized reflects a specific cultural construct which may not do full justice to creativity constructs in other cultural systems. Additionally, in LTT-P much emphasis was put

on promoting the processes of children's creativity, whereas the TTCT only measures the products. For future research, it is recommended to use a research strategy that can better capture the thinking processes that lead to creative products and can reveal how contextual factors may influence these processes (for further suggestions see John, 2017 and Van Dijk, Kroesbergen, Blom, & Leseman, 2018). Such a research strategy could entail qualitative analysis of children's explanations of how they came up with particular solutions.

A second shortcoming of the current study is the use of a cross-sectional design to examine the added value of LTT-P for children at the middle and the senior level separately. LTT-P, however, is deliberately designed as one comprehensive program for both levels with a hierarchical goal-structure specifying different age-appropriate but over time coherent goals for younger and older children. In the current study, however, we could not examine whether the hierarchical structure was indeed appropriate and coherently spanned both grade levels. Future research should take this into account and preferably use a longitudinal design with a larger time span.

Notwithstanding these limitations, we argue that this study is valuable as it provides the first indications that a structured program to promote creativity in preschool children can be effective, at least in the context of the Chinese early education system. To the best of our knowledge, LTT-P is the first program, grounded on a structured learning theory (i.e., TASM) and a sound curriculum framework (i.e., LTT), to support the creativity development of preschoolers in China. Implementing LTT-P is likely beneficial for promoting originality in children's thinking and this makes the program of particular interest for preschools that attempt to reform their education programs. In addition, implementing LTT-P may also

contribute to the prevention of early gaps (educational inequality in China, e.g., Luo & Li, 2017) in the development of soft skills like creativity between children attending common preschools with a traditional pedagogy and children attending elite private preschools or public funded preschools, where open, child-following and soft skills supporting pedagogies have already been introduced (e.g., Wang & Chen, 2014). The accessibility, transferability and low costs of LTT-P, compared to creativity programs imported from other countries, can contribute to more equity in preschool education in China.

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Table 1

Sample descriptives and means and standard deviation in creativity measures, N_{total} = 155 (92 boys)

Groups	EXP				Ctrl-S				Ctrl-NS			
Middle level												
N cases	21[a]				16				31			
N boys (%)	11 (52.38%)				8 (50.00%)				18 (58.06%)			
Mean age in months (*SD*)	54.10 (2.92)*				54.25 (2.84)				57.35 (3.77)			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Fluency	4.52	4.16	14.67	8.26	4.41	4.65	9.71	4.22	5.39	3.58	11.94	4.65
Originality	3.67	4.54	8.76	6.84	3.18	3.68	5.65	4.89	4.1	3.94	5.03	3.29
Elaboration	1.33	.73	3.00	.89	1.35	.79	2.59	.80	1.74	.86	2.71	.78
Senior level												
N cases	24				22[b]				41			
N boys (%)	15 (62.50%)				14 (63.63%)				26 (63.41%)			
Mean age in months (*SD*)	68.00 (3.40)				66.84 (3.45)*				69.27 (3.74)			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Fluency	10.38	7.76	19.75	8.36	8.41	5.54	17.77	10.70	13.8	6.02	18.71	3.84
Originality	8.92	9.56	17.58	10.48	6.55	5.82	13.18	13.10	11.8	8.47	11.15	5.80
Elaboration	2.21	.78	3.67	.70	2.09	0.97	3.05	.38	2.66	.79	3.32	.61

Note. EXP = experimental group. Ctrl-S = within-class control group. Ctrl-NS = between-class control group.
[a] One child's age information was missing. [b] Three children's age information were missing. *The given mean age and *SD* were calculated based on the age information of the rest children

Table 2

Results of the repeated measures MANOVAs, and the subsequent ANOVAs

Statistics		Middle level	Senior level
MANOVA	Time	Wilk's $\Lambda = .21$, $F(3, 63) = 78.42$, $\eta_p^2 = .79$	Wilk's $\Lambda = .31$, $F(3, 82) = 59.58$***, $\eta_p^2 = .69$
	Group	Wilk's $\Lambda = .90$, $F(6, 126) = 1.15$[a], $\eta_p^2 = .05$	Wilk's $\Lambda = .76$, $F(6, 164) = 4.02$***, $\eta_p^2 = .13$
	Time×Group	Wilk's $\Lambda = .78$, $F(6, 126) = 2.86$*, $\eta_p^2 = .12$	Wilk's $\Lambda = .74$, $F(6, 164) = 4.54$***, $\eta_p^2 = .14$
ANOVA (Time × Group)	Fluency	$F(2, 65) = 3.83$*, $\eta_p^2 = .11$	$F(2, 84) = 3.11$*, $\eta_p^2 = .069$
	Originality	$F(2, 65) = 3.32$*, $\eta_p^2 = .13$	$F(2, 84) = 6.16$**, $\eta_p^2 = .13$
	Elaboration	$F(2, 65) = 5.15$**, $\eta_p^2 = .14$	$F(2, 84) = 6.55$**, $\eta_p^2 = .14$

Note.
[a]Not significant. *$p < .05$. **$p < .01$. ***$p < .001$

Appendix I

Training goals of each thinking method for different grade levels

Thinking Methods	**Middle level**	**High level**
Observation	− Observe the typical features of objects under teachers' instructions. − Observe and perceive objects or events in order (e.g., according the alignment, time, or other rules) under teachers' instructions. − Observe and compare different visualized materials to find the differences.	− Find the features of objects through observation. − Observe objects in order and start to understand the strategy of observing in order under teachers' instructions. − Conduct systematic observation based on visualized materials and find the similarities and differences.
Association	− Associate different operative or visualized materials based on the similarities. − Associate described scenarios to related objects or themes.	− Skilled at associating visualized materials or objects/things based on similarities or other relations under familiar scenarios. − Compare and associate the features/properties of different operative/visualized materials under teachers' instructions.
Imagination	− Understand task requirements. − Build up imagination based on established scenarios or visualized materials under teachers' instructions. − Imagine with intention.	− Skilled at building up imagination based on established scenarios or visualized materials. − Start to imagine something with novelty and try to think about the possibility of realizing the imagination under teachers' instructions.
Aligning	− Find and compare differences among the same type of operative or visual objects. − Use the established standards to align objects.	
Classification	− Understand the basic idea of 'classification'. − Distinguish different uses of common objects based on daily experiences.	− Well understand the concept of 'classification'; − Classify different objects based on such as color, size, function or other features.
Reasoning	− Do simple reasoning with established stories or other established scenarios (with one cue) under teachers' instructions.	− Do reasoning with established stories or other complex established scenarios (with two or three cues) under teachers' instructions.

Reconstruction	− Understand the basic idea of 'reconstruction'. − Reconstruct new things with provided materials to and describe what has been made.	− Discover how objects or things that are reconstructed by other things from provided materials; − Use provided materials to reconstruct new things which contains some extent of novelty under teachers' instructions; and explain to what situations can the new things be applied and how the idea comes up.
Divergent thinking	− Explore an object or a scenario from different aspects. − Develop simple strategies that help promoting divergent thinking under teachers' instructions (e.g., think about different environments)	− Think divergently with an established question. − Apply simple divergent thinking strategies (e.g., think about different environment, decompose the objects) to explore a question and generate possible solutions under teachers' instructions. − Express different ideas through drawing, movement, or language.
Artistic creation	− Express ideas with artistic outcomes under teachers' instructions. − Children are given spaces and allowed to do replicative creation. − It is more important about the process of expressing and creating, rather than the quality of the final products.	− Create artistic products with richer content that have some extent of novelty. − Not only the process of expressing ideas, but also the reflection about the process and the products are emphasized. Novelty are expected in both aspects.
Problem finding	− Ask simple questions (e.g., 'what is it', 'how does it work', etc.) with daily phenomena or established scenarios under teachers' instructions.	− Ask complex, exploratory questions (e.g., 'Why is it work like this', 'Why is it different that…', etc.) with natural phenomena or established scenarios under teachers' instructions. Children are expected to combine several basic thinking methods, such as observation, comparing, break mind-set, to form informative questions.
Scientific Exploration	− Become interested in scientific exploration	− Find questions and describe them; − Think about possible solutions for questions under teachers' instructions

Appendix II

Different activities distributed across thinking methods and content domains

Thinking Methods	**Music &Movement**	**Language**	**Graphic/Drawing**	**Nature**	**Math & Geometry**
Observation	−Hair Shoulder Knees · Toe −Hide-and-seek of the shadow			−My little precious*	−Animal puzzles −The world of puzzle*
Association	−The picture of music*		−The network of an apple −The family of circles		−My own supermarket*
Imagination	−If I were an animal		−Finger drawing −The upside-down world*		
Aligning					−Line up the bottles
Classification				−The traveling of the seeds*	−Find a home for toys
Reasoning	−Challenge 1 2 3	−Junior detectors −Save the squirrel*			−Graphic reasoning*
Reconstruction			−The secrets of figures −I am an inventor!*		−The tangram with thousands of forms
Divergent thinking		−How to play with a grapefruit −Magic world of chopsticks −Special plastic bags* −Unexpected uses of newspapers*	−New uses of the hat −The show of squares*	−How do the chicken go through the river?*	

Artistic creation		−The little black fish −What happened in the fruit garden?* −The king of story-teller*	−The most lovely scarf −Ceremony for fruits* −Collage with beans*		
Problem finding		−Able to ask questions?		−Ten thousand questions about the marine*	
Scientific exploration				−The paper boat never drowns −The compass*	

Note.
*These activities are for children at the senior level, and the rest are for children at the middle level.