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Enhancing divergent thinking in visual arts education: Effects of explicit instruction of meta-cognition

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Background. The main purposes of visual arts education concern the enhancement of students' creative processes and the originality of their art products. Divergent thinking is crucial for finding original ideas in the initial phase of a creative process that aims to result in an original product.

Aims. This study aims to examine the effects of explicit instruction of meta-cognition on students' divergent thinking.

Sample and method. A quasi-experimental design was implemented with 147 secondary school students in visual arts education. In the experimental condition, students attended a series of regular lessons with assignments on art reception and production, and they attended one intervention lesson with explicit instruction of meta-cognition. In the control condition, students attended a series of regular lessons only. Pre-test and post-test instances tests measured fluency, flexibility, and originality as indicators of divergent thinking.

Results. Explicit instruction of meta-cognitive knowledge had a positive effect on fluency and flexibility, but not on originality.

Conclusions. This study implies that in the domain of visual arts, instructional support in building up meta-cognitive knowledge about divergent thinking may improve students' creative processes. This study also discusses possible reasons for the demonstrated lack of effect for originality.

The enhancement of students' creativity is one of the main purposes of visual arts education (Seidel, Tishman, Winner, Hetland, & Palmer, 2009). In a meta-analysis, Ma (2009) showed that to be creative, divergent thinking is crucial. We will argue that to enhance divergent thinking, it is necessary to have meta-cognitive knowledge about this form of thinking and that, unlike what is common practice in regular visual arts education lessons, this needs to be taught explicitly. In this study, we investigated the effects of explicit instruction of meta-cognition on students' divergent thinking.

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Theoretical framework

The basic activity in the initial phase of a creative process is divergent thinking: the ability to produce a diversity of responses to an open-ended problem (Guilford, 1959). Divergent thinking requires creative ideation, that is the generation of many (fluency), and different kinds (flexibility) of original ideas (originality) (Runco & Acar, 2010). Divergent thinking starts as early as the problem finding phase, when the task concerned is explored and defined (Finke, Ward, & Smith, 1992; Getzels & Csikszentmihalyi, 1976; Lee & Cho, 2007), and the process continues for as long as people keep exploring creative solutions. Creative ideation also requires persistence and flexibility (Nijstad, De Dreu, Rietzschel, & Baas, 2010). The role of persistence was first theorized by Mednick (1962), whose associative theory of divergent thinking claims that ideas which appear late in the associative chain are more remote and therefore more likely to be original. Gilhooly, Fioratu, Anthony, and Wynn (2007) showed that next to persistence, flexibility plays an important role in divergent thinking. Here, a strategy is concerned that is cognitively more demanding, asking first for the analysis of a stimulus (e.g., parts of a shoe) and subsequently for the selection of a single element for further development in another category (e.g., parts of a shoe that could be used for another purpose or in another context). Gilhooly *et al.* (2007) found that participants move from this type of associative memory retrieval to strategies in which they switch between different categories with great flexibility and finally combine ideas at the end of the generating process. This implies that creative ideation requires deliberate switches between retrieval cues, including the inhibition of dominant uses and cues already retrieved (Gilhooly *et al.*, p. 618).

When we assume that at least two different processes are involved in divergent thinking, namely associative thinking and flexibly switching between categories, we may also assume that some sort of executive monitoring must play a role (Ellamil, Dobson, Beeman, & Christoff, 2012). It can be argued that the ability to alternate between associative thinking and flexibly switching between categories requires knowledge about when, how, and why to shift between these processes (Gabora, 2010; Nijstad *et al.*, 2010; Sowden, Pringle, & Gabora, 2014). This means that cognition must be involved in divergent thinking processes.

Some authors refer to what they call 'strategic knowledge', that is knowing when to apply divergent thinking as a strategy and knowing under which conditions and in which contexts this is required to ensure good performance (Baer, 1993; Hu *et al.*, 2010). Another cognitive factor is what is generally termed 'conceptual knowledge': knowing what the concepts of creativity, divergent thinking, and originality entail. Such knowledge plays a particularly important role in the elimination of misconceptions that may inhibit the creative process (Sternberg & Lubart, 1999), such as the idea that people are creative by nature. Such misconceptions have affective consequences: they reduce creative self-efficacy, the belief to improve, and thus the effort to improve (Ranellucci *et al.*, 2013; Silvia & Phillips, 2004). Affective factors also involve the effects of mood states on the process of generating ideas. Nijstad *et al.* (2010, p. 61), for instance, reported that positive activating mood states stimulate creativity through flexibility and that negative activating mood states stimulate creativity through persistence. Worrying about the self – a negative mood state – or negative self-judgement reduces intrinsic motivation and creative self-efficacy (Baas, De Dreu, & Nijstad, 2008; Bandura & Locke, 2003). As a consequence, the generative process will be a disruptive one. Interestingly, this negative effect does not occur when one feels able to achieve future improvements (Silvia & Phillips, 2004; Tierney & Farmer, 2011), that is when one attributes failure to the specific situation rather than to a stable factor such as ability. It is this feeling of being 'able to improve' that forms

the driving force not only in learning processes in general, but especially in creative processes (Dweck, 1986; Herman & Reiter-Palmon, 2011).

The key to orchestrate the above factors is regulation: it monitors and controls (Groenendijk, Jansen, Rijlaarsdam, & Van den Bergh, 2013; Nelson & Narens, 1990). In the model developed by Nelson and Narens (1990), monitoring concerns a flow of information from the object level to the meta-level, changing or confirming the task representations built so far. Conversely, in control processes, information moves from the meta-level to the object level and may change the executive process. Monitoring the effects of these executive changes may, in turn, lead to changes in the meta-level, where knowledge about processes is consolidated. We assume that this model also holds when learners are involved in divergent thinking.

Using think aloud protocols, Ku and Ho (2010) examined students' critical thinking processes and concluded that the difference between low performers and high performers concerned the use of meta-cognitive strategies: these were applied by high performers in particular. The investigators also demonstrated the importance of meta-cognitive knowledge with respect to the effective regulation of – critical – thinking skills. We may therefore argue that to obtain meta-cognitive knowledge, it is important to *explicitly* teach related meta-cognitive knowledge, so that the habit of regulation can be built that is needed to enhance students' divergent thinking (Dignath & Büttner, 2008). To support students, it is also effective and efficient to teach domain-specific meta-cognitive knowledge in an explicit manner (Gama, 2004; Houtveen & van de Grift, 2007). However, the meta-analysis carried out by Scott, Leritz, and Mumford (2004) reveals that intervention studies on the improvement of creativity generally do not include explicit instruction on meta-cognition, for example meta-cognitive knowledge about creativity, discussion, and reflection about students' own creative processes and their divergent thinking skills.

Including explicit instruction on meta-cognition is an uncommon practice in visual arts education too. Arts education generally involves students looking at art works (reception), creating art products (production), or reflecting on artworks (reflection) (Hetland, Winner, Veenema, & Sheridan, 2007). During arts education lessons, students interact with each other and the teacher about their own art production, a process which feeds the repertoire of ideas, designs, and techniques. The art reception and art production assignments set during the creative process, which can take several weeks, aim to generate and consolidate knowledge that supports the further mastery of creative processes. However, and by definition, the construction of knowledge through such individual reflection tasks is bound by the individual creative experience that is built during the process of making that particular product. Precisely, this may limit the speed and quality of learning: it takes many art reception and production tasks before students have built a rich knowledge base that supports the further enhancement of creativity and divergent thinking. In addition, common misconceptions about originality and creative processes may lead to negative self-evaluations that disrupt the generative processes. Misconceptions about creativity are not easily corrected, and we expect that explicit instruction is required to correct these. Furthermore, we assume that divergent thinking processes in art practices can be boosted when impulses related to creativity knowledge building and meta-cognitive knowledge building are interspersed. This is what we tested in this study: does the explicit instruction of meta-cognition aimed at gaining insight into creative processes improve creative thinking, that is does it lead to enhanced divergent thinking skills?

Method

We implemented a quasi-experimental study with a pre-test, post-test control group design with switching replications (Shadish, Cook, & Campbell, 2002). Five classes with a total number of 147 students participated in our investigation. Three classes were randomly assigned to group A, and two classes were assigned to group B. In all classes, students worked on the same project assignment concerning art reception, production, and reflection. In the first panel, group A followed one intervention lesson with explicit instruction of meta-cognition, while group B followed a regular art reception lesson instead. Conditions were switched in the second panel.

Participants

Participants were 147 grade-11 students aged 16–17 years (80 female/67 male) from one single school for secondary education located in the Netherlands. All students attended compulsory classes in cultural and arts education. We opted for grade-11 students at pre-university level because we expected these students to be sensitive to (and to appreciate) the rather complex content involved in the explicit instruction of meta-cognition. All students, their parents, and the art teachers involved in the project provided their consent to participate.

Design

The 19-week project was part of the regular arts curriculum consisting of one 50-min lesson per week. During the project, an equal number of lessons was dedicated to art reception, art production, and reflection assignments.

All participants worked with the same materials and completed identical art reception, art production, and reflection assignments. These assignments resulted in a series of artworks in which students had to verbalize and visualize their concept of the disruptive and evanescent nature of reflective, non-reflective, or natural materials. This had to be carried out in an original way, and students were credited for their work. All classes participated in the intervention during one specific lesson held within this project, either in Panel 1 (Group A, week 5) or in Panel 2 (Group B, week 9).

Intervention

The intervention consisted of one compact session of 50 min. We based the explicit instruction of meta-cognition about divergent thinking on effect studies investigating creativity training (Scott *et al.*, 2004), meta-cognition (Dignath & Büttner, 2008; Dole & Sinatra, 1998; Houtveen & van de Grift, 2007), and strategy instruction (Elshout-Mohr, Van Hout-Wolters, & Broekkamp, 1999; Murphy & Alexander, 2006; Nelson & Narens, 1990). A summary of the intervention is included in Table 1 and Table S1.

Instructional scripts of the intervention lesson

The model proposed by Nelson and Narens (1990) states that students who are able to control and monitor their thinking process can generate new procedural and conditional knowledge to improve their divergent thinking skills. The instruction lesson on meta-cognitive knowledge consisted of explicit instruction concerning precisely what

Table 1. Intervention lesson

Lesson phase	Learning goals	Instructional and learning activities	Content of the lesson
1	Activating students' prior knowledge of creativity (5 min)	Whole-class discussion about examples of innovative art and design. Students were asked about their concepts of creativity and about their experiences with creativity	The innovation and usefulness (for the purpose of saving energy) of the award-winning power-aware cord by Static! were discussed
2	Constructing cognitive and meta-cognitive knowledge (12 min)	Direct instruction with classroom interaction concerning declarative, procedural, conditional, and contextual knowledge about creative processes and about using divergent thinking strategies in the generative phase of creative processes	With images, thinking strategies like divergent and convergent thinking, and problem finding and problem solving were explained and discussed
3	Constructing conceptual knowledge of creativity and thinking strategies (8 min)	Through whole-class discussion, students exchanged ideas to construct new concepts on creativity and divergent thinking. Students were asked to compare and combine their old and new concepts on creativity and thinking strategies	Through discussion experiences, strategies, conceptions, and misconceptions about creative processes, ideas were shared
4	Constructing higher order knowledge about divergent thinking strategies (10 min)	Direct instruction of abstract concepts and new examples from visual art and design (decontextualisation and recontextualisation). Next, students were asked to explain these concepts of creativity and originality	With the new notions about creativity and divergent thinking as a strategy, higher order knowledge was constructed. Also higher order knowledge was constructed by talking about the uses of a tablet computer as an example of divergent thinking and about the production of the tablet computer and the innovativeness of it
5	Practising and evaluating divergent thinking (15 min)	Students practised divergent thinking with a few simple exercises and an alternative uses task. Students were asked to go beyond clichés and to produce original solutions. They received feedback from their teacher and peers about the way they generated ideas and about the originality of their ideas. Finally, a new example was shown and students were asked to evaluate this example with the knowledge and concepts they had developed	Students practised divergent thinking with, for example, an alternative uses task (think of as many different types of original uses for a brick). The generated ideas and the process of generating ideas were discussed in dyads and later through whole-class discussions focusing on exchange of experiences. By talking about the possibilities and difficulties of applying new knowledge gained from this lesson and talking about their own past approach of strategy knowledge, task knowledge, and person knowledge students were reflecting on their approach in this particular alternative uses task

creativity, creative processes, and divergent thinking entail, and why, how, and when divergent thinking can be applied in creative processes. The instructional scripts for the instruction lesson on meta-cognition were formulated as follows:

1. Increase students' meta-cognitive knowledge through (1) the explicit instruction of monitoring and of regulating creative processes and divergent thinking; and (2) discussing and reflecting on students' practice in divergent thinking. (Lesson phases 1–5, Table 1 and Table S1).
2. Increase students' understanding of creativity, divergent thinking, and originality by (1) stimulating conscious reflection on students' own creative thinking processes; and (2) reflecting on examples from creative products in visual art and design. To this end, we used visual examples of award-winning innovative design products and artworks. (Lesson phases 1–4, Table 1 and Table S1).
3. Increase students' understanding of divergent thinking as a strategy, especially with respect to the differences between divergent thinking and convergent thinking. This was carried out through (1) instruction; (2) discussion; and (3) reflection concerning the different strategies applied in divergent thinking versus convergent thinking and the strategies used in problem-finding versus problem-solving processes. (Lesson phases 2–4, Table 1 and Table S1).
4. Increase understanding in terms of ways to generate many and different types of unusual or original ideas, ways to inhibit common uses, and knowing how and when to switch, by (1) exemplifying how to generate unusual ideas through whole-class exercises; and (2) discussing the process of generating ideas and the originality of ideas. (Lesson phases 3–5, Table 1 and Table S1).
5. Increase students' self-knowledge about divergent thinking skills by learning through (1) the experience of generating ideas; and (2) reflecting about the ideas generated. This should help students to estimate the chances of negative effects of self-evaluation occurring while they generate ideas, and it should also strengthen their improvement beliefs, which in turn could stimulate their efforts to improve (Silvia & Phillips, 2004). This was carried out through instruction and reflection, including *comprehensible*, *coherent*, *plausible*, and *rhotorically compelling information* about creativity and divergent thinking (Dole & Sinatra, 1998). (Lesson phases 4 and 5, Table 1 and Table S1).

After the intervention lesson, students started working on their art reception and production assignments; they started their creative and reflective processes and received guidance from art teachers as usual.

Control group

In the control condition and different from the intervention lesson, students worked for 50 min on a set of assignments focusing on art reception, production, and reflection concerning the meaning of artworks related to the concept of the photography theme used for this purpose.

Teacher training

The participating art teachers performed a divergent thinking test before the lessons started, so they could experience the test themselves. Test experiences were discussed

afterwards to understand the procedure of the test and the skills involved in divergent thinking. The first author demonstrated the intervention lesson to the two other art teachers involved. Afterwards, the intervention was discussed with these teachers. On the basis of their advice, certain adjustments were made: more visual examples of original creative products were included to stimulate the construction of conceptual knowledge about creative products. The teachers involved used the adapted protocol for the lesson and the adapted instruction materials (instructional scripts, presentation material, and tasks).

Fidelity measures

During the intervention by three different teachers, another art teacher, using a pre-structured observation form, observed whether the intervention had been performed according to the protocol described above. In Panel 1, it turned out that in one group (of three), only a small part of the instruction lesson had actually been performed. We therefore excluded this class of 28 students from the analyses. Of the remaining group of 119 students, another 15 students missed one or two of the tests due to absence in class.

Measures

A pre-test was administered in week 1, followed by the instruction in Panel 1 and a post-test 2 weeks later (week 7). In Panel 2, the instruction was carried out in week 9 and followed by a second post-test in week 15. We administered computerized verbal instances tests (Guildford, 1967). Students had to list within five minutes '*as many different kinds of original materials as they could think of*'. The materials varied per test: they were shiny (pre-test 1), non-shiny (post-test 1), or natural materials (post-test 2). These materials were part of the domain-specific task that students had received for their visual arts education classes, so the divergent thinking test was related to the context of a real-world creativity task (Chand & Runco, 1993).

The approach we used to analyse divergent thinking skills is based upon the specific concept of divergent thinking, indicating thinking in many different directions (flexibility), generating many different ideas (fluency) that may – but not necessarily will – lead to many original, unusual, or infrequent ideas (Runco, 2008). Fluency was indicated by the number of all responses per student. Flexibility was indicated by the number of different categories of the responses for each student. From the data, we formed a total of 10 categories (e.g., organic materials such as organic metals or plants, human/animal materials such as skin or fur, artificial materials such as plastic, transport materials such as bikes, and utensils such as scissors). For each response, a category label was determined. To determine the reliability of flexibility, two raters each independently coded 800 responses. Inter-rater reliability was satisfactory ($\kappa = .83$, with a 95% interval between .67 and .98 for pre-test and post-test 1 and $\kappa = .89$ with a 95% interval between .81 and .98 for post-test 2).

To indicate the originality of responses, a choice can be made between subjective scoring – ratings by an expert jury – or objective scoring of originality as statistical infrequency (Runco, 2010; Runco & Acar, 2010). We opted for objective scoring, that is determining the originality of answers on the basis of the statistical infrequency of unusual or original answers in the sample (Plucker, Qian, & Wang, 2011). Responses that did not occur in the rest of the sample received a score of 2 (infrequent or original), responses that were given by two to four per cent of the students received a score of 1 (unusual), and all

other responses received a score of 0. Taking into account that originality can also be determined by dividing originality by fluency and to correct for confounding effects, we also included originality percentage scores (Plucker, Qian, & Schmalensee, 2014).

The three indicators were correlated at all three measurement moments (fluency and flexibility $r = .61-.67$; fluency and originality $r = .69-.79$; and originality and flexibility $r = .42-.56$).

Data analysis

In both conditions, the two groups did not differ in the pre-test: fluency, $t(96.02) = -.53$; $p = .60$, in terms of flexibility, $t(102) = .51$; $p = .61$, or in terms of originality, $t(102) = 1.83$; $p = .71$. The three verbal instances tests were similar but not equivalent or parallel tests. Therefore, a direct comparison of the observed scores between subsequent test occasions is not meaningful. To observe an intervention effect in Panel 1, we ran a multivariate analysis of covariance with condition as independent factor, scores for fluency, originality, and flexibility at time 1 as covariates and time-2 scores for fluency, and originality and flexibility as dependent variables. We repeated this analysis with time 3-scores for fluency, originality, and flexibility as dependent variables and hypothesized to find no effects as both groups had participated in the intervention at measurement time 3.

Results

The results for Panel 1 are presented in Table 2. The multivariate analysis of covariance showed a significant effect of the intervention, Wilks' $\lambda(3, 97) = .91$; $p = .02$; $\eta^2 = .09$, with significant condition effects for fluency, $F(1, 103) = 5.54$; $p = .02$; $\eta^2 = .05$; Cohen's $d = .40$, and flexibility, $F(1, 103) = 6.69$; $p = .01$; $\eta^2 = .06$; Cohen's $d = .45$, but not for originality, $F(1, 103) = 1.26$, $p = .26$; $\eta^2 = .01$; Cohen's $d = .30$, nor for originality percentage, $F(1, 103) = 0.70$, $p = .41$; $\eta^2 = .07$; Cohen's $d = .34$. This means that students in the intervention condition generated more (fluency) responses and also used a higher number of different categories (flexibility) than students in the control condition.

Table 2. Results of fluency, flexibility, originality, and originality percentage at time 2

	<i>M</i>	<i>SD</i>	<i>n</i>
Fluency			
Intervention	26.29	11.76	51
Control	21.75	10.76	53
Flexibility			
Intervention	4.92	1.11	51
Control	4.38	1.30	53
Originality			
Intervention	15.90	11.76	51
Control	12.26	12.77	53
Originality percentage			
Intervention	0.58	0.30	51
Control	0.48	0.29	53

Table 3. Results of fluency, flexibility, originality, and originality percentage at time 3

	M	SD	n
Fluency			
Intervention	27.51	12.15	53
Control	28.55	11.21	51
Flexibility			
Intervention	5.83	1.54	53
Control	5.92	1.48	51
Originality			
Intervention	10.70	14.43	53
Control	13.39	12.62	51
Originality percentage			
Intervention	0.41	0.04	53
Control	0.35	0.04	51

The results for Panel 2 are summarized in Table 3. As expected, no differences were observed at time 3, as at that time, all students had benefited from the intervention, either in Panel 1 or in Panel 2, Wilks' $\lambda(3, 97) = .98; p = .54$.

Discussion and conclusion

Divergent thinking is important for the generation of many different kinds of original ideas, and increasing students' meta-cognition about divergent thinking is presumed to result in an enhancement of their divergent thinking. This study shows effects of explicit instruction of meta-cognition on students' divergent thinking skills. We found an effect of explicit instruction of meta-cognition on students' fluency and flexibility for Panel 1 (Group A), but no effects were found for originality or originality percentage. The interpretation of the findings for Panel 2 is more complex. After the second intervention, we found no differences between Groups A and B at measurement occasion 3. This may indicate a treatment effect in Panel 2 for Group B, because the differences we found at measurement occasion 2 between the two groups, are now – as a result of the intervention in Panel 2 – diminished. Though, strictly speaking, this equalization effect might also be due to other effects in the experimental condition as well as the control condition. In other words, when tests are not equivalent, the research design with switching panels does in fact play an ethical role – all participants were involved in the experimental intervention – but cannot be considered to be a full replication of the experiment.

Nevertheless, the effects in Panel 1 demonstrate the effectiveness of the explicit instruction of meta-cognition. Our results confirm previous research on the effectiveness of explicit instruction of meta-cognition for self-regulation and add to this the effectiveness of explicit instruction of meta-cognition for the domain of visual arts and for developing skills such as fluency and flexibility in divergent thinking (Dignath & Büttner, 2008; Gama, 2004; Houtveen & van de Grift, 2007; Ku & Ho, 2010).

One intriguing issue that remains is why we found an effect for fluency and flexibility for Panel 1 but not for originality. First of all, the effects found for fluency and flexibility demonstrate that students did develop more effective regulating skills as a result of explicit instruction of meta-cognition (Dignath & Büttner, 2008). The effects found for

fluency and flexibility can be explained by the use of two different strategies that students obtained from the intervention, focusing to a greater extent on either persistence of generating words within one category (fluency) and/or switching to a flexibility strategy, with a greater focus on switching between different categories (flexibility). This means that different strategies have to be used with respect to either fluency or flexibility (Gilhooly *et al.*, 2007; Nijstad *et al.*, 2010). To enhance originality as well, different and even more complex cognitive processes such as selective encoding and selective combination will have to be part of the intervention. These may need greater attention in the instruction phase, and it may also be that students need more time to internalize the use of different strategies. Although our study demonstrated that the intervention had positive effects on fluency and flexibility in as little time as one single lesson, one may have to invest more learning time for improving originality.

It might also be the case that an even stronger focus on domain-specific explanations and exercises about originality in visual arts prove to be effective regarding the enhancement of originality. In this study, we based our instructions on interventions for language education and mathematics. A special adaptation to the domain-specific learning processes involved in visual arts education, namely using images and visual ideation as part of the exercises instead of words and verbal ideation, could have been more effective in this respect. In other words, the use of images instead of words in the divergent thinking exercises could be an important tool to relate divergent thinking to the domain of visual art.

Further research is needed to determine whether the effects we found are long-term effects. However, on the basis of research on the explicit instruction of meta-cognition in other domains, we believe that the explicit instruction of meta-cognition in arts education will also likely enhance students' divergent thinking skills in similar age groups (from grade 9 onwards) and at similar school levels.

The effects found in this study in terms of fluency and flexibility are relevant for the development of students' general divergent thinking skills and also for the development of methodologies for teaching divergent thinking skills within the domain of visual arts education. If enhancement of students' creativity is one of the most important purposes of arts education, then students should have access to meta-cognitive knowledge about divergent thinking and creative processes. They should be able to perceive that they themselves can use these strategies in actual creative and divergent processes, to become able to control these processes and learn from them via monitoring.

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Supporting Information

The following supporting information may be found in the online edition of the article:

Table S1. Intervention lesson.