A model of contextual and personal motivations in creativity: How do the classroom goal structures influence creativity via self-determination motivations?

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ABSTRACT

Previous studies suggested that classroom goal structures play prominent roles in students’ learning processing and outcomes; however, little is known about the association between the classroom goal structures and creativity. This study aimed to determine whether – and how – the classroom goal structures could affect creativity. Specifically, we constructed a theoretical model consisting of the classroom goal structures, self-determination motivations, and creativity; further, we tested how well this model fits the observed data, and then we analyzed the association among these three variables. Data on these three variables were collected from 913 Taiwanese junior high school students (463 girls), and all of the testing instruments were within the mathematical field. We performed structural equation modeling to analyze the data. The results showed that the theoretical model was supported by the observed data, and that the model had satisfactory overall model fit and fit of the internal structure of the model. Firstly, we found that mastery-approach goal structure shaped individuals’ autonomous motivation and positively influenced their creativity. Secondly, performance-avoidance goal structure shaped individuals’ controlled motivation and had no effect on their creativity. Finally, mastery-avoidance and performance-approach classroom goal structures exerted a positive effect on divergent production – a specific type of creativity – only when they shaped individuals’ autonomous motivation. Thus, we propose that classroom goal structures can shape an individual’s different types of self-determination motivation, thereby indirectly influence learners’ creativity. Additionally, mastery-approach is the classroom goal structure that exerted the greatest effect on creativity via autonomous motivation.

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1. Introduction

Achievement goal theory addresses both the personal and contextual aspects of goals. For the personal aspect this theory explores the relationship between the goal orientation of learners (achievement goal theory) and various learning behaviors and outcomes. For the situational aspect this theory explores how teachers lead students to form a perceived goal orientation (classroom goal structures) through information delivery or classroom activities (Murayama & Elliot, 2009; Peng & Cherng, 2005; Schwinger & Stiensmeier-Pelster, 2011). Numerous studies have indicated that the classroom goal structures can
affect learners' motivation, emotion, learning participation, achievement and performance (Ames & Archer, 1988; Kaplan & Midgley, 1999; Karabenick, 2004; Urdan & Midgley, 2003; Wolters, 2004; Xiang & Lee, 2002). Most of the research results have indicated that a mastery goal structure is related to adaptive behavioral patterns, while a performance goal structure is correlated with low-level adaptive or non-adaptive behavioral patterns (e.g., Kaplan, Chee, & Midgley, 2002; Wolters & Daugherty, 2007). As a result, classroom goal structures could explain the various learning behavioral patterns of individuals in the learning situation.

However, some previous studies proposed that achievement goal theory is correlated with creativity (e.g., Amabile, 1996; Beghetto, 2005; Collins & Amabile, 1999; Wu, 2002), and their results supported that an individual with mastery or learning goals could cultivate his or her creativity (e.g., Archer, 1997). Consequently, it can be inferred that achievement goal theory can be used to explore creativity. However, previous studies either merely claimed that there is a possible relationship between achievement goal theory and creativity, or studied creativity based on individual achievement goals alone, only few studies investigated creativity with adaptation “classroom goal structure” which belonged to the contextual aspect of achievement goal theory. In other words, previous researches failed to explain whether students’ perceived classroom goal structures influence creativity, meaning that which types of classroom goal structures can promote or inhibit an individual's creativity have seldom been investigated.

For the personal aspect, although previous studies have focused on the relationship between creativity and intrinsic and extrinsic motivations, existing research results support the benefit of the intrinsic motivation on creativity, but they did not fully explain several inconsistencies between extrinsic motivation and creativity (Amabile, 1985, 1996; Amabile, Hennessey, & Grossman, 1986; Choi, 2004; Deci & Ryan, 1985; Moneta & Siu, 2002). Some research has suggested that autonomy is the main determinant of creativity (Barron & Harrington, 1981; Feist, 1998); for example, Deci and Ryan (2008) and Shih (2008) indicated that individuals with autonomy might possess a relatively high creativity. The self-determination theory (SDT) classified motivation into several types according to levels of autonomy (amotivation, extrinsic motivation and intrinsic motivation), and the SDT claimed that some extrinsic motivations (i.e., identified regulation) possessed a high level of autonomy (Ryan & Deci, 2000a). From this, it can be inferred that self-determination motivations may be more appropriate than intrinsic and extrinsic motivations for exploring creativity. Therefore, this study adapted the concept of self-determination motivation in the SDT to analyze which types of motivation could contribute most to creativity.

However, the relationship among the classroom goal structures, self-determination motivations and creativity remains unclear. Previous research indicates that situations can shape an individual’s motivation, thereby indirectly affecting his or her behavior and outcomes (Choi, 2004; Church, Elliot, & Gable, 2001; Glynn, 1996; Lin & Cherng, 2007; Newman, 1998; Peng & Cherng, 2005). For example, Peng and Cherng (2005) demonstrated that classroom goal structures could influence academic help-seeking through goal orientation. Thus, we inferred that classroom goal structures may indirectly affect creativity via self-determination motivations. Therefore, based on motivation theory, this study focused on the learning creativity and incorporated personal and situational factors of individuals in order to explore how they perceive situations (classroom goal structures) that can shape their motivation (self-determination motivations) and thereby influence creativity.

### 1.1. Classroom goal structures

Classroom goal structures are conceptualized as competence-relevant environmental emphases that have been made salient through general classroom practice and specific messages that teachers communicate to their students. This construct belongs to the contextual aspect in achievement goal theory. Given that students’ perception about the classroom goal structures (i.e., the psychological environment) plays a prominent role in affecting their goal adoption, it is important to note that the investigation of classroom goal structures focuses on students’ perception, instead of any objective environment (Ames, 1992). In fact, the classroom goal structures develop in accordance with personal achievement goal (Peng & Cherng, 2005; Wolters & Daugherty, 2007). Ames (1992) initially proposed a two-factor classroom goal structure based on normative goal theory: a mastery goal structure means that learners perceive the learning goal created by teachers in classes and focuses on mastery, understanding and personal improvement, while a performance goal structure means that students perceive that the learning goal created by teachers in classes and emphasizes the relative ability and competition (Middleton & Midgley, 1997; Urdan, Midgley, & Anderman, 1998).

Follow-up research, based on the revised goal theory, expanded the performance construct to distinguish approach and avoidance motivations. This yielded two performance classroom goal structures: (1) performance approach, in which the classroom environment emphases on engaging in academic task to demonstrate competence, especially normative competence; and (2) performance avoidance, in which the classroom environment emphases on engaging in academic task to avoid demonstrating incompetence, especially normative incompetence. (Kaplan et al., 2002; Karabenick, 2004; Murayama & Elliot, 2009; Schwinger & Stiensmeier-Pelster, 2011; Wolters, 2004). Peng and Cherng (2005) further expanded the mastery construct to distinguish approach and avoidance motivations, developing two types of mastery classroom goal structure. One is mastery approach, in which the classroom environment focuses on engaging in academic work to develop one's skills and abilities, understand and master task, especially task- and intra-personally based competence. The other is mastery avoidance, in which the classroom environment focuses on engaging in academic work to avoid losing one's skills and abilities, forgetting what one has learned, misunderstanding material, or leaving a task incomplete or unmastered, especially task- and intra-personally based incompetence.
In short, Peng and Cherng (2005) extended the four fundamental goal orientations, which were proposed by Pintrich (2000) and Elliot and McGregor (2001), and constructed a four-factor classroom goal structure, which comprised mastery-approach, mastery-avoidance, performance-approach and performance-avoidance. Peng and Cheng further adopted a competition approach to examine whether two-factor, three-factor, or four-factor classroom goal structures, which were based on normative goal theory, revised goal theory, and $2 \times 2$ goal orientation theory respectively, fit the observed data better. The empirical results showed that the four-factor classroom goal structures fitted the observed data well, and that classroom goal structures were indeed divided into four factors. In other words, the four-factor classroom goal structure was more appropriate than the two-and-three factor classroom goal structures for explaining the data obtained from Taiwanese junior-high school students. That result led to several researchers adopting the four-factor classroom goal structure in further investigations (e.g., Lin & Cherng, 2006, 2007).

In summary, most of the results indicate that the mastery classroom goal structure is correlated with adaptive behavioral patterns, while the performance classroom goal structure is correlated with low-level adaptive or non-adaptive behavioral patterns. The effects of classroom goal structures – with “approach” and “avoidance” motivation added – remain to be tested and confirmed. Therefore, this study adapted the latest developed concept of the four-factor classroom goal structures (Peng & Cherng, 2005) to analyze whether different types of classroom goal structures have different effects on creativity.

1.2. Classroom goal structures and self-determination motivations

Unlike previous motivation theories, which focused on the overall amount of motivation that people have for particular learning task, SDT has put emphasis on the quantity or type of learners’ motivations. That is, SDT not only examines the intensity of individuals’ motivations, but distinguishes different types of motivations. Thus, SDT is sufficient to predict various behaviors or psychological constructs, such as well-being, effective performance, learning engagement, psychological health (Ryan & Deci, 2000a, b; Deci & Ryan, 2008). According to Deci and Ryan (1985), the learners’ motivations can be broadly categorized into intrinsic motivation, extrinsic motivation, and amotivation, based on a continuum ranging from high to low levels of self-determination. The highest level of self-determination is intrinsic motivation, in which students are highly autonomous in attending learning activities for the feelings of fun, pleasure, and satisfaction. The lowest level of self-determination is amotivation, which is similar to learned helplessness (Otis, Grouzet, & Pelletier, 2005), in which the students lack of any motivation to participate in any learning activities. The reasons of learners’ amotivation can be attributed to lacking of abilities or not care about learning outcomes. The motivation between above two is extrinsic motivation, in which students participate in learning activities not because they are interested in the events per se, but because they intend to gain separable outcomes, such as scores, prizes, or recognitions.

Nevertheless, Ryan and Deci (2002) suggested that extrinsic motivation is not invariably controlled. According to the levels of self-differentiation, from low to high, extrinsic motivation can be further divided into four subtypes—external regulation, interjected motivation, identified regulation, and integrated regulation. External regulation is the motivation with the least autonomy; individuals perform activities in order to satisfy their external needs, such as to gain rewards or to avoid punishments. Introjected regulation belongs to the controlled form of regulation while it also exhibits partially internal behavior. With this motivation, individual attend activities because they feel that they have the obligations, trying to avoid the feelings of sin, guilt, or anxiety. The third dimension of extrinsic motivation is identified regulation. It is one type of autonomous motivation; activities are performed out of the values and the identifications that individuals hold for the tasks. The latest one is integrated regulation, which is the most autonomous form of extrinsic motivation. It occurs when an individual’s identified regulation have been incorporated into his/her self, meaning that the self-identification has been assessed and brought into congruence with the individual’s values and needs.

Aside from above categories, several researchers who favor SDT further partitioned motivation into autonomous motivation and controlled motivation (e.g., Deci & Ryan, 2008; Nix, Ran, Manly, & Deci, 1999). Autonomous motivation consists of identified regulation, integrated regulation and intrinsic motivation, indicating that an individual works on an assignment out of his or her own free will or due to self-determination. By contrast, controlled motivation comprises both external regulation and introjected regulation, meaning that an individual works on an assignment due to the external pressure or limitations. According to Deci and Ryan (1985), autonomous motivation enables individuals to understand their authentic selves, whereas controlled motivation compels individuals to experience internal or external pressures. Thus, SDT researchers exploring learning motivation based on the perspective of internalization and regulation led SDT to move the emphasis from intrinsic and extrinsic motivations to the distinction between autonomous motivation and controlled motivation. Much research showed that, compared with controlled motivation, autonomous motivation could result in a more adaptive learning behavior and outcome, such as psychological health, effective performance and greater long-term persistence (Ciani, Sheldon, Hilpert, & Easter, 2011; Deci & Ryan, 2008; Shih, 2008; Vansteenkiste, Zhou, Len, & Soenens, 2005).

A growing body of studies has indicated that contextual factors such as schools would enhance or hinder students’ motivations (e.g., Peng & Cherng, 2005; Shih, 2008; Wolters, 2004). Research based on SDT proposed that autonomy-supportive contexts are the circumstances that empower individuals to go through processes of choice and to experience autonomy and that decrease pressure or urge from teachers to students to the minimum. Additionally, these studies suggested that autonomy-supportive contexts tend to enhance intrinsic motivation, facilitate the internalization of extrinsic motivation, and produce more adaptive pattern of learning (e.g., Ryan & Deci, 2000a, b; Shih, 2008; Vansteenkist, Simons, Lens, Sheldon,
and among mathematical contexts, removal, or contrast, self-determination education relationships. The positive possibility, controlled motivation, and mastery-avoidance, (i.e., success) (Elliot, 1999). Specifically, approached-based goals focus on success and motivate individuals move toward to positive possibilities or desirable events, whereas avoidance-based goals focus on failure and lead individuals to remove negative events or to stay away from negative possibilities (Elliot, Murayama, & Pekrun, 2011). On the other hand, Wolters and Daugherty (2007) reviewed literature and concluded that mastery classroom goal structure is significantly associated with adaptive cognition, affect, and achievement outcomes; nevertheless, performance classroom goal structure is related with lower-level adaptive or higher-level maladaptive learning patterns.

Taken together, mastery-approach goal structure, similar to autonomous-supportive contexts, maintains the beneficial characteristics of mastery goal and approach motivation which can elicit adaptive behavioral patterns. Thus, we hypothesized that the perception of mastery-approach climate would have positive association with autonomous motivation. By contrast, performance goal and avoidance motivation which embedded in performance-avoidance goal structure may elicit non-adaptive behavioral patterns. It was hypothesized that performance-avoidance climate would have positive association with controlled motivations. Additionally, mastery goal contained in mastery-avoidance goal structure may elicit positive learning patterns and thus have positive association with autonomous motivation, while avoidance motivation within this goal structure tends to connect with negative learning outcome and thereby has positive correlation with controlled motivation. Similarly, approach motivation derived from performance-approach goal structure may elicit positive or desirable behavioral outcome and thus it can positively predict autonomous motivation, while performance goal is closely related to negative learning outcome and therefore it can predict controlled motivation. In other words, since mastery-avoidance and performance-approach goal structures are consisted of motivations that can elicit both positive and negative learning outcomes, these two goal structures are able to predict autonomous and controlled motivations. In summary, the present research examined the relationship between students’ perceptions of their classroom goal structure and their adoption of self-determination motivation. Thus, we investigated the association among four types of classroom goal structure: mastery-approach, mastery-avoidance, performance-approach, and performance-avoidance – and two types of self-determination motivation adoption – autonomous motivation and controlled motivation.

1.3. Self-determination motivations and mathematical creativity

Prior research on creativity can be labeled as either domain-general or domain-specific. Domain-general means that a creative individual can extract his/her creativity in any domains, whereas domain-specific means that an individual can only extract his/her creativity in a certain domain such as arts, language, music, composition, or math (Hong & Milgram, 2010; Silvia, Kaufman, & Pretz, 2009); mathematics is one principle subject in that prominent research field. Mathematical creativity refers to a research domain highlights the investigation concerning mathematics and creativity jointly. In terms of creativity, mathematical creativity also has no single or clear definition. Haylock (1987a,b, 1997) suggested that mathematical creativity can be delineated by either the notion of creative process or production. Firstly, creative process examines characteristics of cognitive process underlying successful problem solving. The ability to overcome fixations, which is also know as to break from mental sets, means that an individual can adopt methods that are more effective than stereotyped or standard methods to solve problems. Secondly, creative production is to evaluate, based on the products that individuals generated, how creative the individuals are. Researchers, who are outcome-focused, adopted the domain-general testing indices of divergent thinking and they claim that individuals’ creative production can be observed by the indices of fluency, flexibility, and originality assessed from the produced mathematical results. Fluency is the ability to think out various methods or ideas to solve a problem rapidly, flexibility is the adoption of alternative methods or devising various strategies to solve a problem,
and originality is attempting new and unusual methods to solve a problem. According to Wakefield’s (1992) framework of problem solving, overcame of fixations (OF) is a concept similar to insight problem; both of them have open problem and close solution situation. In contrast, divergent production (DP) is identical to divergent thinking, which has closed problem and open solution situations. Thus, although OF and DP are creativity problems, they belong to different problem type of questions. In light of these concepts, (Haylock, 1987a, 1997) developed two categories of mathematical creativity problems – OF and DP – to tap individuals’ mathematical creativity.

The empirical research conducted by Haylock (1987b) indicated that both OF and DP were positively correlated with mathematical achievement. In high-achievement groups, OF was positively correlated with an adventurous trait, and negatively correlated with anxiety about mathematics; while DP was positively correlated with self-concept of mathematics, and was negatively correlated with anxiety about mathematics. Furthermore, based on the concepts and problems proposed by Haylock (1987a,b), most subsequent studies have revised mathematical problems so as to evaluate an individual’s mathematical creative performance, as well as comparing the differences in mathematical creativity between average students and talented students (e.g., Hung, 2004). In short, although there has been less research on mathematical creativity than on general creativity, it has been shown to be closely related to mathematical learning. Therefore, it is necessary to analyze what types of motivation can enhance or inhibit mathematical creativity.

The previous research on motivation and creativity has mostly drawn attention to the effects of intrinsic and extrinsic motivations on creativity, with most of the results indicating that intrinsic motivation can promote creativity (e.g., Amabile, 1985; Sternberg & Lubart, 1996). Researchers have not yet reached a consensus on the effect of extrinsic motivation on creativity (e.g., Amabile, 1985; Choi, 2004; Deci & Ryan, 1985), but some have claimed that creativity can be inspired only on the absence of external limitations (Amabile, 1997; Sternberg, 1998). In addition, some research has suggested that autonomy is one of the major traits of a creative personality (Barron & Harrington, 1981; Feist, 1998; Deci and Ryan (2008) and Shih (2008) noted that individuals with autonomous motivation might possess a relatively high creativity. The empirical studies of Sheldon (1995) indicate that autonomy is the key trait of highly creative individuals, while Eisenberger, Rhoades, and Cameron (1999) and Deci and Ryan (1985) discovered that promoting individuals’ autonomy of self-perception could help to enhance their creativity.

In summary, autonomy seems to play a significant role in cultivating an individual’s creativity. According to SDT, some extrinsic motivations (e.g., identical regulation and integrated regulation) are associated with higher level of autonomy. Moreover, SDT classified motivation into autonomous motivation and controlled motivation in accordance with the level of autonomy. Therefore, this study suggested that the level of self-determination is the key determinant of individuals’ creativity, and that investigations have not yet clarified the relationship between motivation and creativity merely by distinguishing the differences between intrinsic and extrinsic motivations. This study adopted the concept of autonomous motivation and controlled motivation instead of intrinsic and extrinsic motivations to investigate the relationship between self-determination motivation and creativity. In short, taking mathematical creativity as one way to assess creativity, the present study assumes that when individuals own higher-level self-determined motivations (i.e., autonomous motivation), they would perform better creativity; whereas when individuals have lower-level self-determined motivations (i.e., controlled motivation), it would lead to negative of no effects on creativity performance.

1.4. Classroom goal structures, self-determination motivations and mathematical creativity

After reviewing the relationship between classroom goal structures and self-determination motivations as well as the relationship between self-determination motivations and creativity respectively, in the following, we further survey the relationship among classroom goal structures, self-determination motivations, and creativity.

Firstly, a great deal of studies suggested that contextual factors have significant effects on an individual’s motivation (e.g., Ryan & Deci, 2000a; Shih, 2008; Vansteenkist, Simons, Lens, Sheldon, & Deci, 2004; Wolters, 2004). Therefore, we inferred that classroom goal structures have effects on self-determination motivations. Secondly, individual’s motivations (e.g., intrinsic motivation or extrinsic motivation) exercise influence creative performance (e.g., Amabile, 1985; Hung et al., 2008; Moneta & Siu, 2002), so it was inferred that self-determination motivations have effects on creativity. Thirdly, a great deal of research has supported that contextual factors play important roles in creativity (e.g., Amabile, 1996; Hunter, Bedell, & Mumford, 2007; Shally, Zhou, & Oldham, 2004), and Peng, Cheng, & Chen (2013) indicated that both mastery and multiple classroom goal structures promoted an individual’s divergent thinking performance in math. As a result, students’ perception of classroom goal structures could predict their creativity. Additionally, drawing on previous theory and research (e.g., Amabile, 1996; Deci & Ryan, 1985; Shally et al., 2004), contextual characteristics should influence creativity through its effect on an individual’s “intrinsic motivation” to perform a task.

Based on the above literatures, classroom goal structures can predict both self-determination motivations and creativity, and self-determination motivations can predict creativity. Therefore, it is possible that classroom goal structures have an influence on creativity via self-determination motivations, meaning that self-determination motivations are mediators between classroom goal structures and creativity. In brief, we proposed that classroom goal structures may shape an individual’s distinctive type of self-determination motivations, thereby exerting an indirect effect on creativity. However, via what paths that classroom goal structures would have indirect effect on creativity? Whether contextual or personal motivations lead to different effects on different types of creativity problems? These questions would be further examined and answered in this study.
2. The proposed model

The major purposes of the present study were as follows: (a) to investigate creativity by adopting the contextual factors of the achievement goal theory (i.e., classroom goal structures), as well as autonomous motivation and controlled motivation of the self-determination theory, and (b) to examine how contextual factors impact different types of creative problem-solving in mathematical domain through the mediation of autonomous motivation and controlled motivation. In short, we constructed a theoretical model to explore the relationships among the classroom goal structures, self-determination motivations and creativity. The study investigated the following hypotheses:

**Hypothesis 1.** The theoretical model used in this study fits the observed data of Taiwanese junior-high-school students.

**Hypothesis 2.** The classroom goal structures can predict self-determination motivations.
   2-1: The mastery-approach goal structure can positively predict autonomous motivation.
   2-2: The mastery-avoidance goal structure and performance-approach goal structure can positively predict autonomous motivation and controlled motivation.
   2-3: The performance-avoidance goal structure can positively predict controlled motivation.

**Hypothesis 3.** The self-determination motivations can predict creativity.
   3-1: The autonomous motivation can positively predict creativity.
   3-2: The controlled motivation cannot predict creativity.

**Hypothesis 4.** The classroom goal structures impact creativity through self-determination motivations.

3. Method

3.1. Participants

According to the statistical data from the Ministry of Education, Taiwan, the proportional distribution of the population of junior-high-school students in the north, middle and south of the country is 6:4:5, respectively. This study selected 913 students, comprising 380 in the north, 238 in the middle and 295 in the south, of which 450 were boys, 463 were girls, 433 were in Grade 7 and 480 were in Grade 8. All of the participants were Taiwanese. The average age of the participants was 12.72. All principals granted initial consent for data to be collected in their schools. The schools districts were primarily middle class in terms of socioeconomic status. Participants were assured that all of their responses would remain confidential and would not influence their course grades.

3.2. Theoretical model in this study

The theoretical model (see Fig. 1) used in this study contained eight latent variables: mastery-approach goal structure ($\xi_1$), mastery-avoidance goal structure ($\xi_2$), performance-approach goal structure ($\xi_3$), performance-avoidance goal structure ($\xi_4$), autonomous motivation ($\eta_1$), controlled motivation ($\eta_2$), OF ($\eta_3$) and DP ($\eta_4$); where the first and last four variables were latent independent and dependent variables, respectively. Autonomous motivation and controlled motivation were regarded as mediators. This study assumed the following relationships among the eight latent variables: the mastery-approach goal structure directly affects autonomous motivation, the mastery-avoidance goal structure and performance-approach goal structure directly affect autonomous motivation and controlled motivation, the performance-avoidance goal structure directly affects controlled motivation, and both autonomous motivation and controlled motivation directly affect OF and DP. Finally, this study assumed that the four latent independent variables were correlated with each other.

With regards to the measurement index, DP was measured based on an index of fluency, flexibility and originality, while the remaining latent variables were measured based on the parcelling technique proposed by Bandalos (2002) in order to simplify the model. This technique involved randomly dividing scale items into two observed indices. For instance, mastery-approach goal structure ($\xi_1$) is composed of mastery-approach goal structure1 ($X_1$) and mastery-approach goal structure2 ($X_2$) (see Fig. 2). There are 17 measurement indices in total.

3.3. Procedure

Measurements were administered by trained teachers and research assistants in a group manner. Prior to the formal tests, a principal researcher explained the procedure and the instruction of measurements to experimenters (teachers and research assistants). Data collection was divided into two sessions. In the first session, participants were asked to fill out the self-reported questionnaires comprised of classroom goal structure scale and self-determination motivation scale orderly. There was no strict time limit to complete the questionnaires. In the second session, Mathematical creativity test consisted of OF and DT was conducted with a counter-balance design. Before each subtest, the experimenters gave standard instruction and explained the questions; they began the test after they made sure that the participants understood the instruction. The creative test has strict time limit for each question and the experimenter used a timekeeper to guide the participants to next question. For every question of OF, the participants had three to five minutes to answer it, depending on the question.
Fig. 1. Theoretical model depicting the classroom goal structures, self-determination motivations, and mathematical creativity.

Notes: MAPCGS = mastery-approach goal structure; MAVCGS = mastery-avoidance goal structure; PAPCGS = performance-approach goal structure; PAVCGS = performance-avoidance goal structure; AM = autonomous motivation; CM = controlled motivation; OF = overcome of fixation; DP = divergent production (measurement indices and estimated parameter are omitted).

Fig. 2. The complete standardized path coefficient and significance test of the theoretical model.

Notes: (1) *p < 0.05; (2) ** as a reference index represents a limit estimated parameter; (3) part of the estimated parameters are omitted for simplicity; (4) dashed lines indicate nonsignificant relationships.
For every question of DT, the participants had 10 min. The instructions of the mathematical creativity test are presented as below:

Now, we are going to do a mathematical test, which consists of two parts (in a counter-balanced order). This test will not affect your grade score and your test score is confidential. Please try your best to answer the question.

Part 1 (e.g., OF)
1. This part of test consisted of four questions. Please follow my instruction to answer each question. I will lead you to finish all questions. So, please DO NOT move on to the next page or answer any questions UNTIL you hear my intrusion.
2. You will have different time limits to answer different questions. The time for every question is shown on the upper right position of the question. Please be alert to the time limit while answering the question.
3. Now, fill out your personal information and wait for my instruction. I will tell you when to start the test. Do not open your test booklet until you hear my instruction.

Part 2 (e.g., DT)
1. Draw a figure to form 2cm² for its measure of area within a nine-dot square. Please draw as many figures as you can in given 10 minutes.
2. Note. (1) One nine-dot square for one answer (2) Any figure that can from 2 cm² for its measure of area would count.

3.4. Measurement

All measurements were conducted in mathematical subject and Chinese language. The following were the detail description of three measurements.

3.4.1. Classroom goal structures

This study revised the four-factor classroom goal structures and its scale proposed by Peng and Cherng (2005) so that it contained the mastery-approach goal structure (six items, Cronbach α = 0.83; e.g., “Maths teachers care about whether we master or understand the learning materials, instead of our test scores.”), the mastery-avoidance goal structure (six items, Cronbach α = 0.92; e.g., “Maths teachers often ask us to avoid making mistakes in mathematical assignments”), the performance-approach goal structure (five items, Cronbach α = 0.88; e.g., “Maths teachers are most concerned about how to increase our mathematical scores”) and the performance-avoidance goal structure (six items, Cronbach α = 0.90; e.g., “Maths teachers tell us that the purpose of learning maths is to avoid being regarded as incapable”). The complete scale comprised 23 items. Participants completed the questions in the four scales by indicating their agreement on a 6-point Likert scale ranging from 1 (“strongly disagree”) to 6 (“strongly agree”). Furthermore, a confirmatory factor analysis (CFA) of 913 Taiwan junior–high-school students produced the following results: \( \chi^2 \) (657, N=913) = 1099.77, \( p < 0.05 \); RMSEA = 0.06, GFI = 0.97, AGFI = 0.96, NFI = 0.91, NNFI = 0.92, CF1 = 0.93 and IFI = 0.93; the factor loadings of the 23 measurement indices were between 0.44 and 0.88; the individual item reliability was between 0.19 and 0.78; the composite reliabilities of the mastery-approach goal structure, performance-approach goal structure, mastery-avoidance goal structure and performance-avoidance goal structure were 0.87, 0.83, 0.94 and 0.92, respectively, and the corresponding average variances extracted from the four factors were 0.53, 0.51, 0.72, and 0.66.

3.4.2. Self-determination motivations

This study adopted the self-determination motivations scale developed by Chen and Cherng (2010) in order to measure the self-determination motivations of the included Taiwanese junior–high-school students, in which the autonomous motivation scale included the intrinsic motivation scale (eight items, Cronbach α = 0.95, e.g., “I enjoy doing my mathematical homework a lot”) and the identified regulation scale (four items, Cronbach α = 0.93, e.g., “For me, doing mathematical homework is very important”), and the controlled motivation scale included the external regulation scale (five items, Cronbach α = 0.84, e.g., “I do mathematical homework because I want avoid being punished by my teacher”) and the introjected regulation scale (six items, Cronbach α = 0.86, e.g., “I would feel terrible about myself if I do not do my mathematical homework”). The complete scale comprised 23 items. Participants completed the questions in the four scales by indicating their agreement on a 6-point Likert scale ranging from 1 (“strongly disagree”) to 6 (“strongly agree”). A CFA of the 913 students produced the following results: \( \chi^2 \) (224, N=913) = 1264.28, \( p < 0.05 \); RMSEA = 0.075, GFI = 0.98, AGFI = 0.97, NFI = 0.97, NNFI = 0.97, CFI = 0.97 and IFI = 0.97; the factor loadings of the 23 measurement indices were between 0.41 and 0.92; the composite reliabilities of intrinsic motivation, external regulation, identified regulation and introjected regulation were 0.98, 0.90, 0.95 and 0.91, respectively, and the corresponding average variances extracted from the four factors were 0.87, 0.63, 0.84 and 0.64.

3.4.3. Mathematical creativity

In order to develop a mathematical creativity test suitable for Taiwanese junior–high-school students, this study referred to the definition and problems of mathematical creativity proposed by Haylock (1987a, b, 1997). The developed test consisted two types of problems on mathematical creativity. The first was the problem of OF, which is mainly used to assess whether individuals can adopt methods to work out problems that are better than conventional or standard problem-solving rules (four items, Guttman split-half coefficient = 0.59. See Table 1 for examples—Cut test). Every OF problem consists of one example and three questions. The example and the first two questions are designed to draw the participants into fixations.
The third question taps participants’ ability to overcome fixation, which is the key of solving OF problem. The scoring relies on participants’ responses of third problems. One credit is given if the participant’s answer is correct, while no credit is given if the participant’s answer is wrong; if the participant has already known the correct answer, they should mark the items as requested and their responses would be treated as missing values.

The second was the problem of DP, nine dot areas test (see Fig. 3), which students were instructed to draw as many shapes measuring 2 cm² as possible within 10 min. (scorer reliabilities of fluency, flexibility and originality = 0.94, 0.99 and 0.99, respectively). There are three scoring methods for DP: (a) fluency: one credit is given for a correct 2 cm² response, while repeated responses would be consider as one response; (b) flexibility: one credit is given for a distinct category (24 categories in total); (c) originality: credits are given based on the how much a participant’s response account for total responses from all participants. If the proportion is above 5%, no credit would be given; if the proportion is between 2% and 4.99%, one credit would be given; if the proportion is below 1.99%, two credits would be given. The scores of the participant’s mathematical creativity consisted of four indices: OF, and the fluency, flexibility and originality of DT.

This study selected 247 Taiwanese junior-high-school students to analyze criterion-related validity, and found that the coefficient for the correlation between OF and insightful problems (Hsu, Lin, & Chen, 2011) was 0.49 (p < 0.05); the coefficients for the correlations of fluency, flexibility and originality of DP with the New Creativity Test (Wu, 1998) were 0.34, 0.26 and 0.16 (p < 0.05), respectively. Although the reliability of OF, 0.59, is relatively lower, it is consistent with prior research revealed that most of the reliabilities of creativity measurements are not high. For example, in Lin, Hsu, Chen, and Wang’s (2012) study, the Cronbach’s alpha coefficients of their insight problem task were between 0.51 and 0.68. Thus, the 0.59 reliability of OF in the present was acceptable.

3.5. Data analysis

This study conducted statistical analysis using LISREL8.51 and tested the four hypotheses using structural equation modeling (SEM). Moreover, based on many previous proposals (Diamantopoulos & Siguaw, 2000; Hair, Anderson, Tatham, & Black, 1998; Kline, 1998; Marsh, Balla, & Hau, 1996; Rubio, Berg-Weger, & Tebb, 2001), the present study adopted absolute, relative and parsimonious fit indices to evaluate the theoretical model. It also adopted the individual item reliability, composite reliability of latent variables and average variance extracted to evaluate the fit of the internal structure of the theoretical model. In accordance with the suggestions of previous researchers, this study used values of RMSEA < 0.08, GFI > 0.90 and AGFI > 0.90 as the absolute fit standard; NFI > 0.90, NNFI > 0.90, CFI > 0.90, RNI > 0.90 and IFI > 0.90 as the relative fit standard; and PNFI > 0.50 and PGFI > 0.50 as the parsimonious fit standard. Furthermore, this study regarded an estimated factor loading above the significance level, individual item reliability >0.50, composite reliability of latent variance >0.60 and average variance extracted >0.50 as the measurement standards of fit of the internal structure of model.

4. Results

4.1. Descriptive statistics and gender differences test

Table 2 lists the mean, standard deviation and cross-correlation coefficient values of the original scores of the 17 measurement indices of this theoretical model. This study adopted Hotelling $T^2$ values to test the variances in the measurement indices of the classroom goal structures, self-determination motivations and creativity, in terms of gender. The results indicated that boys and girls exhibited significant differences only for the performance-avoidance goal structure (Hotelling $T^2 = 26.24, p < 0.05, \eta^2 = 0.03$) and autonomous motivation (Hotelling $T^2 = 10.96, p < 0.05, \eta^2 = 0.03$). The mean was higher for boys than for girls while, in contrast with $\eta^2 = 0.03$, gender differences had a low explanatory ability toward the variables outlined above. Therefore, gender was not considered a control variable since it exerted only minor effects on the measurement indices of this model.
Table 1
Cut test—one example of overcome fixation (OF) problems. Each OF problem consists of one example and three questions. Every OF problem contains six pages. Please follow the instructions to answer the questions.

<table>
<thead>
<tr>
<th>Page</th>
<th>Materials</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Page1</td>
<td>Explain the problem and provide an example</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Diagram: Use minimal amount of lines to separate the rectangle into 2 square measures equally.]</td>
<td></td>
</tr>
<tr>
<td>Problem1:</td>
<td>Please use minimal amount of lines to separate the rectangle into 3 square measures equally.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Please respond on the rectangle!</td>
<td></td>
</tr>
<tr>
<td>Solution1:</td>
<td>Please use minimal amount of lines to separate the rectangle into 3 square measures equally.</td>
<td></td>
</tr>
<tr>
<td>Page2</td>
<td>Present problem 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Diagram: ]</td>
<td></td>
</tr>
<tr>
<td>Page3</td>
<td>Provide solution for problem 1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Diagram: ]</td>
<td></td>
</tr>
<tr>
<td>Problem2:</td>
<td>Please use minimal amount of lines to separate the rectangle into 5 square measures equally.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Please respond on the rectangle!</td>
<td></td>
</tr>
<tr>
<td>Solution2:</td>
<td>Please use minimal amount of lines to separate the rectangle into 5 square measures equally.</td>
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</tr>
<tr>
<td>Page4</td>
<td>Present problem 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Diagram: ]</td>
<td></td>
</tr>
<tr>
<td>Page5</td>
<td>Provide solution for problem 2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>[Diagram: ]</td>
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</tr>
<tr>
<td>Problem3:</td>
<td>Please use minimal amount of lines to separate the rectangle into 9 square measures equally.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Please respond on the rectangle!</td>
<td></td>
</tr>
<tr>
<td>Instruction:</td>
<td>Draw a figure to form 2 cm² for its measure of area within a nine-dot square. Please draw as many figures as you can in given 10 min.</td>
<td></td>
</tr>
<tr>
<td>Note.</td>
<td>(1) One nine-dot square for one answer (2) Any figure that can from 2 cm² for its measure of area would count.</td>
<td></td>
</tr>
</tbody>
</table>
Table 2
Mean, standard deviation and cross-correlation coefficient values of the 17 measurement indices of the theoretical model used in the study (N = 913).

<table>
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<tr>
<th>Variable</th>
<th>Mean</th>
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<th>4</th>
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<th>14</th>
<th>15</th>
<th>16</th>
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<td>1.02</td>
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<td>MAVCGS2</td>
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<td>MAVCGS3</td>
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<td>0.34</td>
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<td>PAPCGS1</td>
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<td>0.40</td>
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<td>0.37</td>
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<td>-0.05</td>
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<td>0.28</td>
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<td>0.18</td>
<td>0.03</td>
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<td>0.06</td>
<td>0.05</td>
<td>0.02</td>
<td>0.03</td>
<td>-0.00</td>
<td>-0.10</td>
<td>0.08</td>
<td>0.09</td>
<td>-0.01</td>
<td>0.06</td>
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<tr>
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<td>0.04</td>
<td>0.05</td>
<td>-0.04</td>
<td>-0.02</td>
<td>-0.10</td>
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<td>-0.06</td>
<td>-0.09</td>
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<td>-0.05</td>
<td>0.34</td>
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<tr>
<td>DP: fluency</td>
<td>12.34</td>
<td>8.27</td>
<td>-0.03</td>
<td>-0.06</td>
<td>0.12</td>
<td>0.12</td>
<td>0.00</td>
<td>0.02</td>
<td>-0.04</td>
<td>-0.03</td>
<td>0.08</td>
<td>0.11</td>
<td>0.07</td>
<td>0.05</td>
<td>0.19</td>
<td>0.24</td>
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<tr>
<td>DP: flexibility</td>
<td>5.17</td>
<td>2.79</td>
<td>-0.04</td>
<td>-0.05</td>
<td>0.09</td>
<td>0.11</td>
<td>0.00</td>
<td>-0.01</td>
<td>-0.07</td>
<td>-0.08</td>
<td>0.08</td>
<td>0.11</td>
<td>0.06</td>
<td>0.04</td>
<td>0.19</td>
<td>0.31</td>
<td>0.74</td>
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<tr>
<td>DP: originality</td>
<td>8.96</td>
<td>10.93</td>
<td>-0.04</td>
<td>-0.07</td>
<td>0.11</td>
<td>0.10</td>
<td>0.01</td>
<td>0.02</td>
<td>-0.04</td>
<td>-0.04</td>
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<td>0.17</td>
<td>0.26</td>
<td>0.89</td>
<td>0.78</td>
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</tbody>
</table>

Note. MAPCGS = mastery-approach goal structure; MAVCGS = mastery-avoidance goal structure; PAPCGS = performance-approach goal structure; PAVCGS = performance-avoidance goal structure; AM = autonomous motivation; CM = controlled motivation; OF = overcoming of fixation; DP = divergent production.

* p < 0.05.
Table 3
Direct, indirect and total effects of the theoretical model.

<table>
<thead>
<tr>
<th>Latent independent variable</th>
<th>Latent dependent variables</th>
<th>Direct effect</th>
<th>Indirect effect</th>
<th>Total effect</th>
</tr>
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<tbody>
<tr>
<td>MAPCGS (ξ₁)</td>
<td>AM (η₁)</td>
<td>0.45*</td>
<td>-</td>
<td>0.45*</td>
</tr>
<tr>
<td></td>
<td>CM (η₂)</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>OF (η₃)</td>
<td>-</td>
<td>0.07*</td>
<td>0.07*</td>
</tr>
<tr>
<td></td>
<td>DP (η₄)</td>
<td>-</td>
<td>0.05*</td>
<td>0.05*</td>
</tr>
<tr>
<td>MAVCGS (ξ₂)</td>
<td>AM (η₁)</td>
<td>0.10*</td>
<td>-</td>
<td>0.10*</td>
</tr>
<tr>
<td></td>
<td>CM (η₂)</td>
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<td>-</td>
<td>0.19</td>
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<tr>
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<td>OF (η₃)</td>
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<td>0.00</td>
<td>0.00</td>
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<tr>
<td></td>
<td>DP (η₄)</td>
<td>-</td>
<td>0.02*</td>
<td>0.02*</td>
</tr>
<tr>
<td>PAPCGS (ξ₃)</td>
<td>AM (η₁)</td>
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<td>-</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>CM (η₂)</td>
<td>0.18</td>
<td>-</td>
<td>0.18</td>
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<tr>
<td></td>
<td>OF (η₃)</td>
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<td>0.01</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>DP (η₄)</td>
<td>-</td>
<td>0.02*</td>
<td>0.02*</td>
</tr>
<tr>
<td>PAVCGS (ξ₄)</td>
<td>AM (η₁)</td>
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<td>CM (η₂)</td>
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<td></td>
<td>OF (η₃)</td>
<td>-</td>
<td>-0.01</td>
<td>-0.01</td>
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<tr>
<td></td>
<td>DP (η₄)</td>
<td>-</td>
<td>0.01</td>
<td>0.01</td>
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<tr>
<td>AM (η₁)</td>
<td>OF (η₃)</td>
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<tr>
<td></td>
<td>DP (η₄)</td>
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<td>0.10</td>
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<tr>
<td>CM (η₂)</td>
<td>OF (η₃)</td>
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<td></td>
<td>DP (η₄)</td>
<td>0.05</td>
<td>-</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Note. MAPCGS = mastery-approach goal structure; MAVCGS = mastery-avoidance goal structure; PAPCGS = performance-approach goal structure; PAVCGS = performance-avoidance goal structure; AM = autonomous motivation; CM = controlled motivation; OF = overcome of fixation; DP = divergent production.

* p < 0.05.

4.2. Overall model fit

The statistical data indicated that all of the indices except for the chi – squared value – which was beyond the significance level ($\chi^2 (101, N = 913) = 198.55, p < 0.05$) - demonstrated a perfect fit between the theoretical model and the observed data (GFI = 0.98 and AGFI = 0.96; Both were higher than the fit standard of 0.90). For the relative fit indices, NFI = 0.98, NNFI = 0.99, CFI = 0.99, RFI = 0.97 and IFI = 0.99, all of which were above the fit standard of 0.90. Finally, both of the parsimonious fit indices (PNFI = 0.73 and PGFI = 0.64) exceeded the fit standard of 0.50. All of these results indicate that this theoretical model provided an excellent overall fit of the observed data, indicating that the model was suitable for characterizing these Taiwanese junior-high-school students.

4.3. Fit of the internal structure of the model

Regarding the fit of the internal structure of the model, the statistical data indicated that all of the estimated parameter values of the 17 factor loadings achieved the significance level, with the standardized estimated values being between 0.47 and 0.97 [except for OF1 (X₁₃)]. The reliabilities of the remaining 16 individual item reliabilities were between 0.50 and 0.95, and hence conformed to the measurement standard of 0.50. The composite reliabilities of the eight latent variables of mastery-approach goal structure, mastery-avoidance goal structure, performance-approach goal structure, performance-avoidance goal structure, autonomous motivation, controlled motivation, OF and DP were 0.85, 0.96, 0.85, 0.95, 0.99, 0.97, 0.46 and 0.97, respectively. All of these except OF were higher than the measurement standard of 0.60. In addition, the average variances extracted from these variables were 0.76, 0.83, 0.66, 0.81, 0.89, 0.85, 0.36 and 0.84, respectively. Again, all of these except OF were higher than the measurement standard of 0.50. Therefore, this theoretical model exhibited a good fit to the internal structure of the model.

4.4. Classroom goal structures and self-determination motivations

Fig. 2 and Table 3 indicated that the mastery-approach goal structure positively affected autonomous motivation ($\gamma_{11} = 0.45, t = 11.27, p < 0.05$) and that the performance-avoidance goal structure positively affected controlled motivation ($\gamma_{24} = 0.13, t = 2.99, p < 0.05$). Additionally, both the mastery-avoidance goal structure and performance-avoidance goal structure positively affected autonomous motivation ($\gamma_{12} = 0.10, t = 2.53, p < 0.05$; and $\gamma_{13} = 0.12, t = 4.58, p < 0.05$; respectively) and controlled motivation ($\gamma_{22} = 0.19, t = 2.54, p < 0.05$; $\gamma_{23} = 0.18, t = 3.52, p < 0.05$).

4.5. Self-determination motivations and mathematical creativity

Fig. 2 and Table 3 indicate that autonomous motivation positively affected both OF ($\beta_{31} = 0.15, t = 3.12, p < 0.05$) and DP ($\beta_{41} = 0.10, t = 2.95, p < 0.05$), while controlled motivation had no significant effect on OF ($\beta_{32} = -0.06, t = -1.25, p > 0.05$) and DP ($\beta_{42} = 0.05, t = 1.35, p > 0.05$).
4.6. Classroom goal structures, self-determination motivations and mathematical creativity

Fig. 2 and Table 3 indicate that the mastery-approach goal structure positively mediated $OF$ ($EF = 0.07$, $t = 3.02$, $p < 0.05$) and $DP$ ($EF = 0.05$, $t = 2.86$, $p < 0.05$) through autonomous motivation. The mastery-avoidance goal structure and performance-approach goal structure positively mediated $DP$ ($EF = 0.02$, $t = 2.29$, $p < 0.05$) ($EF = 0.02$, $t = 2.32$, $p < 0.05$) through autonomous motivation, while they had no effect on $OF$. The performance-avoidance had no indirect effect on $OF$ ($EF = -0.01$, $t = -1.16$, $p > 0.05$) and $DP$ ($EF = 0.01$, $t = 1.23$, $p > 0.05$).

5. Discussion

The present study examined a theoretical model of the relationship between motivation and creativity in mathematical domain. Specifically, the model was constructed based on the contextual factors (i.e., classroom goal structures) in the achievement goal theory (Ames, 1992; Ames & Archer, 1988) as well as the personal motivation factors (i.e., self-determination motivations) in the self-determined theory (Deci & Ryan, 1985, 2008). Further, this model examined the creativity–motivation process—how contextual motivations influence creativity through personal motivations. Our proposed theoretical model was supported by empirical data and performed good model-fitting. For future research, this model provides fairly complete research framework to address issues related to motivation and creativity.

5.1. Fit test for the theoretical model and observed data

The obtained data supported the theoretical model. In the test of overall model fit, all of the indices other than $\chi^2$ indicated that the theoretical model possessed a perfect overall fit in terms of absolute, relative and parsimonious fit indices; the exception of $\chi^2$ being significant was due to the inclusion of large samples. In addition, regarding the fit of the internal structure of the model, the individual item reliability for $OF$ was lower than the standard value of 0.45, but all the other measurement results indicated that this theoretical model possessed a perfect fit of the internal structure. In short, the theoretical model fitted the observed data, indicating that it explained the characteristics of the participated Taiwanese junior–high-school students. This result is consistent with Hypothesis 1.

5.2. Direct effect of classroom goal structures on self-determination motivations

With regard to the contextual achievement goal theory, our findings suggested that the manner, in which students perceive situational cues, as engendered by their teacher, have important implications for students' self-determination motivations. Specially, the present results showed that mastery-approach goal structures positively impacted autonomous motivation. In other words, when an individual perceives that teachers focus on the comprehension, task-mastery and regard making mistakes as part of learning; this provides a secure learning situation where individuals will participate in the learning activities with ease, thereby stimulating the formation of their autonomous motivation. This result is consistent with previous classroom-based research. That is, the perception of autonomy-supportive environment could positively predict important motivation-related constructs such as intrinsic motivation (e.g., Ryan & Deci, 2000a,b; Shih, 2008). When students are aware that classroom goal structures focus on mastery goal, they are more likely to feel self-determined and to enhance their intrinsic motivation (Brunel, 1999; Standage, Duda, & Ntoumanis, 2003). In short, given that mastery-approach goal structure is the combination of two positive benefits—mastery goal and approach motivation, it is better able to foster individuals to form adaptive autonomous motivation.

Moreover, performance-avoidance goal structure could positively predict controlled motivation. When students perceive that the teacher focuses on avoiding them to be regarded as stupid or incapable by others, the students tend to avoid participating in the learning activities so as not to be considered incapable. This perception about avoiding to be seen as stupid or incapable is an external reason for participating in activities. Thus, learning is driven by external factor controlled by other people, instead of by enjoyment or passion on learning activities, and this perception forms individuals’ controlled motivation therefore. In other words, the double negative effects of avoidance motivation and performance goal could easily cause learning pressure and anxiety, thereby hindering students from actively participating in learning activities. This results in their learning motivation being controlled rather than self-determined, and is similar to the controlled situation of SDT, thereby increasing the probability of forming controlled motivation.

Finally, both the mastery-avoidance goal structure and performance-approach goal structure could positively predict autonomous motivation and controlled motivation. This result is in line with the views of achievement motivation theory and achievement goal theory (Elliot, 1999; Wolters & Daugherty, 2007). The mastery goal of the mastery-avoidance goal structure and the approach motivation of the performance-approach goal structure both can generate or elicit positive outcomes and possibilities; thereby exerting positive predictive effects on autonomous motivation. However, the avoidance motivation of the mastery-avoidance goal structure and the performance goal of the performance-approach goal structure both tend to lead to negative outcomes or possibilities, thereby exerting positive predictive effects on controlled motivation. In other words, the respective positive and negative effects of the mastery-avoidance goal structure and performance-approach goal
structure could exert positive predictive effects on adaptive autonomous motivation and maladaptive controlled motivation. This result supports Hypothesis 2.

5.3. Direct effect of self-determination motivations on creativity

The research results indicated that autonomous motivation exerted the positive effect on OF and DP, while controlled motivation had no effect on OF and DP. These results were consistent with previous research indicating that an individual’s autonomy and self-determination are essential determinants of creativity (Barron & Harrington, 1981; Deci & Ryan, 1985, 2008; Eisenberger et al., 1999; Feist, 1998; Sheldon, 1995). In other words, when an individual identifies with and shows interest in participating in a learning activity with autonomy, he or she is more likely to reveal his or her potential in a more flexible manner and produce a better creative performance. However, if an individual participates in a learning activity merely to meet his or her external needs or only due to such controlled feelings as “should be” or “must be”, this low level of self-determination with controlled motivation may limit his or her cognitive ability, preventing the enhancement of creative performance.

Collectively, our findings demonstrated that it is self-determination the key factor to decide individuals’ creative performance. Prior research simply separated motivation into intrinsic and extrinsic motivations. We argue that this dichotomy is too sketchy. To determine whether individuals have good creative performance, it does not rely on any internal or external reasons of individuals to participate in activities; it depends on whether the individuals can have certain degree of self-determination. The present study divided motivation into autonomous motivation and controlled motivation on the basis of the degree of individuals’ self-determination. Our results suggested that an individual’s autonomous motivations could positively predict both types of OF and DT in math. On the contrary, individual’s controlled motivation had effect on neither OF nor DT. In brief, autonomous motivations were conducive to creativity, but controlled motivations were not. This result supported by Hypothesis 3.

5.4. Indirect effects of classroom goal structures and self-determination motivations on creativity

We found that the classroom goal structures exerted an indirect effect on creativity via self-determination motivations, which is similar to the finding of previous research, meaning that both contextual and personal factors contribute to creativity (Amabile, 1997; Choi, 2004; Glynn, 1996; Liang, Hsu, & Chang, 2013; Oldham & Cummings, 1996; Shally et al., 2004). Moreover, contextual factors shape an individual’s motivations or goals, thereby indirectly affecting their behavior or creativity (Choi, 2004; Church et al., 2001; Glynn, 1996; Lin & Cherng, 2007; Newman, 1998; Peng & Cherng, 2005; Shally et al., 2004). Together these results indicate that both contextual and personal factors are vitally important to the exploration of creativity.

Firstly, the results suggested that the mastery-approach goal structure exerted an indirect effect on OF and DP through autonomous motivation. This is consistent with the view of Wu (2002) and Amabile (1996) and Archer (1997) that mastery-approach goal can contribute to creativity. Nevertheless, our study went one step further by arguing that mastery-approach goal structure would shape individuals’ autonomous motivations first and then result in positive impact on creativity. In other words, the autonomous motivation of learners is more likely to be stimulated when they perceive that the classroom situation focuses on mastery, comprehension or the encouragement of learning new things, thereby exerting positive effects on both mathematical creative problems of OF and DP. Secondly, since both “avoidance motivation” and “performance goal” were negative effects, they can only instigate an individual’s controlled motivation. When an individual was induced to form controlled motivation, the controlled motivation has no benefits on OF and DP. This learning climate prompts students to feel anxious and pressured. Given that students pay more attention to avoid being regarded to be stupid or incapable by others, they are not able to concentrate on learning tasks. Therefore, performance-avoidance goal structure tends to elicit individuals to form controlled motivation and it rarely has positive effect on creativity. Thirdly, both mastery-avoidance and performance-approach goal structures would exert indirect effect on DP via autonomous motivation. Interestingly, both the mastery-avoidance goal structure and performance-approach goal structure have one positive factor (i.e., mastery goal of mastery-avoidance goal structure, or approach motivation of performance-approach goal structure) and one negative character (i.e., avoidance motivation of mastery-avoidance goal structure, or performance goal of performance-approach goal structure) of motivation; they would have indirect positive effect on DP problems through self-determination motivations.

Our results suggested that individuals may tend to form autonomous motivation when the positive effect of mastery goal is greater than the negative effect of avoidance motivation or when the positive effect of approach motivation is greater than the negative effect of performance goal. Nevertheless, since there is a competition between positive and negative characters, the indirect effect may only happen on DP problems but not OF problems. These results support Hypothesis 4 of this study.

It is worth noting that classroom goal structures and self-determination motivations would have different influences on different types of creativity problems. Comparing the indirect effects of four classroom goal structures on creativity, a classroom situation that simultaneously emphasizes approach motivation (+) and mastery goal (+) will exert double positive effects on solving creative problems of OF and DP. Meanwhile, when approach motivation (+) is combined with performance

\[ \text{Note: The symbol “+” denotes a motivation type which leads to relative positive effect on learning patterns.} \]
goal (−2) to form performance–approach goal structure, and avoidance motivation (−) is combined with mastery goal (+) to form mastery-avoidance goal structure, the resulting positive–negative combination would affect DP alone. In other words, either approach motivation or mastery goal can help learners to improve their divergent-thinking ability in mathematics. Meanwhile, both approach motivation and mastery goal are indispensable for improving a learner’s OF performance in transformation ability or insight ability in the creative process. As for the classroom goal structures which consist of avoidance motivation and performance goal, the resulting negative–negative combination can only stimulate an individual’s controlled motivation and has no effects on OF and DP.

To sum up, our results suggest that classroom goal structures have impact on creativity through self-determination motivations; further, given that the effect of classroom goal structures on creativity is indirect, it demonstrate that OP and DP belong to different problem types. As mentioned earlier, OF is similar to insight problem, which has open question and close solution, while DP resembles in divergent thinking problem, which has close question and open solution (Wakefield, 1992). Our findings indicated that only if teachers can simultaneously emphasize approach motivation and mastery goal, these motivations can have indirect and positive effect on OF. Moreover, if teachers only emphasize one of these two motivations, either approach motivation or mastery goal would only have indirect effect on DP through autonomous motivation. Furthermore, when teachers emphasize avoidance motivation and performance, the resulting controlled motivation would have no effect on neither OF nor DP. In short, prior research addressed the issues between divergent-thinking problems and insight problems from cognitive process perspective, whereas, from contextual perspective, the present study took advantage of the motivation factors to support that OF problem is different from DP problem. However, follow-up studies are needed for answering why classroom goal structures have distinctive effects on different types of problem-solving.

6. Conclusions and future direction

This study has provided substantial evidence suggesting that classroom goal structures exert an indirect effect on creativity via an individual’s self-determination motivations can be extended to the investigation of creativity, in addition to explaining individuals’ various learning behavior patterns emphasized in literature. We demonstrated that classroom goal structures have an impact on creativity, and it is mediated by individuals’ self-determination motivations. In summary, the contribution of present study is threefold: First, prior studies focus on the relationships among classroom goal structures, various learning motivations, behaviors, and outcomes, while few research investigates how classroom goal structures affect creativity. Our results indicated that classroom goal structure can not only explain individuals’ learning behaviors, but elucidate which classroom goal structures facilitate or inhibit individuals’ creativity. Specifically, classroom goal structures that emphasize approach motivation and mastery goal have positive impact on creativity. They facilitate learners to form autonomous motivation and thus perform higher creativity. However, classroom goal structures that emphasize avoidance motivation and performance goal tend to lead learners to form controlled motivation and thus make no effect on creativity.

Second, the present study represents the first attempt to utilize autonomous and controlled motivations in the SDT to investigate creativity. We proposed that “self-determination” is the key factor for influencing creativity. Previous studies indicated that intrinsic motivation facilitates creativity while extrinsic motivation does not have consistent results. Our results suggest that if extrinsic motivation involves high-level self-determination (e.g., identified regulation or integrated regulation), it can actually have positive impact on creativity; nevertheless, without self-determination, controlled motivation has no impact on creativity. Indeed, our results tease apart the mixed evidence about how extrinsic motivation affected creativity. Third, from contextual motivation perspective, our results showed that four types of classroom goal structures have different indirect effects on OF and DP respectively, meaning that this study demonstrated OF and DP belonging to different problem types.

Our results shed light on pedagogical implications. Firstly, in order to foster creativity, if instructors can build appropriate learning climate in the classroom, it would facilitate individuals to form adaptive learning motivations, further produce positive indirect effect on creativity. This is an alternative and even more economic method compare to conducting instructional experiment (e.g., to design creativity-fostering curriculum). Moreover, if instructors give students more opportunities to make their decisions on learning task or problem solving, the nature of self-determination would motivate students to deeply be involved in problem-solving and perform more creatively. Furthermore, in order to enhance students’ divergent thinking abilities, instructors can achieve this by means of emphasizing approach motivation or mastery goal. However, if the goal is to foster students’ problem-solving abilities such as overcome of fixations or break from mental sets, the instructors need to emphasize both approach motivation and mastery goal.

Beyond research contribution and implication, there are several limitations in this study and thus we propose directions for future research. Firstly, although we attempted to build a theoretical model, adopting SEM to test the data fitting between the model and the observed data, the model only addresses possible correlations among classroom goal structures, self-determination motivations and creativity. In the future, in order to examine the causal relationships among these variables, we will conduct instructional experiments to investigate how motivation affects creativity while classroom goal structures varied. Secondly, though our results did find that, via self-determined motivation, classroom goal structures indirectly predict

Note. The symbol “−” denotes a motivation type which leads to relative negative effect on leaning patterns.
creativity, the effect size is not large. We consider the possible reasons are: (1) Creativity is a characteristic of personality, which means it is a stable and consistent ability (Oldham and Cummings, 1996). Even though several studies have indicated that contextual factors may influence individuals' creativity (e.g., Friedman & Förster, 2001; Shally et al., 2004), the effect might be minor. Thus, the small effect size of this study can be attributable to a fact that ability is relatively stable and not easily to be changed. (2) Classroom goal structures may not be a prominent factor in creativity-fostering. Given that classroom goal structure influences creativity via individuals' motivation, this effect is indirect. We suggest that future research should include other important variables (e.g., future goal) to investigate how they affect creativity.

Thirdly, our results showed that both the reliability and variance of OF are low. There may be two potential reasons for explaining above phenomena. The possible reasons are: (1) In terms of creativity measurements, most of the previous studies showed that their reliability and validity were not high. For example, the reliability of insight problems used in Lin, Hsu, Chen, and Wang's (2012) study were 0.51–0.68. The Cronbach αs of Creativity Assessment Packet (CAP) revised by Lin and Wang (1994) were 0.45–0.87. The re-test reliabilities of a New Creativity Test developed by Wu (1998) were 0.34–0.60. Given that these tests are commonly used and their reliability/validity range from 0.34 to 0.87, in present study, the Guttman Split-half coefficient of OF, 0.59, should be acceptable. (2) Apart from previous studies, the present study used “latent variable” to test the relationships among classroom goal structures, self-determination motivations and creativity. We found that the composite reliability of latent variance and average variance extracted did not reach a significance level. The results suggested that two measurement indices of OF may not be affected by only one latent variable, so it made that error of OF relatively high. For this reason, we suggested that future research can further distinguish more dimensions of OF as to increase the OF's reliability and validity.

Lastly, the present study is a cross-sectional study, which collects data on classroom goal structures, individuals' motivation, and behavioral results at one specific point of time. However, prior research suggests that classroom goal structures may vary over time (Bong, 2005) or there may be multiple classroom goal structures (Peng & Cherng, 2005; Schwinger & Stiensmeier-Pelster, 2011). Therefore, we suggest that future research to conduct a longitudinal study or to adopt multiple classroom goal structures to give us better understanding about how these factors vary as a function of creativity.

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