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Full Length Research Paper

Student self-reports of metacognitive activity in physical education classes. Age-group differences and the effect of goal orientations and perceived motivational climate

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The present study examined age-group differences in students' self-reports of metacognitive activity in physical education settings. Five hundred and ten students of public elementary, junior and senior high school provided self-reports concerning the metacognitive processes they use during physical education lessons, their goal orientations and motivational climate of their class. The results showed that younger students reported more frequent use of metacognitive processes scoring higher in scales assessing task-orientation and perception of a task-involving motivational climate. The differences in metacognitive activity between the three age-groups were examined using task-orientation, and task-involving motivational climate as covariates in a multivariate analysis of covariance. The results revealed that task-orientation and task-involving motivational climate had a significant impact on students' self-reported metacognitive activity in physical education classes. All results are discussed in relation to achievement goal theory.

Key words: Metacognition, goal perspectives theory, age-group differences.

INTRODUCTION

Individual differences in learning is a respectable topic of investigation in educational psychology, aiming to identify students' cognitive processes and learning conditions under which some students achieve a higher learning performance compared to others. Attempts to address these issues included a large body of research conducted, focusing on students' self-regulation of behavior and cognition in academic and sport settings (Bandura, 1993; Chen and Singer, 1992; Crews, 1993; Schunk and Zimmerman, 1994; Zimmerman and Schunk, 1989). Based on constructivist theories, self-regulation "refers to actions occurring during the actual performance of a cognitive task that allow an individual to control, govern, or direct his own activity through self-imposed rules or regulations that better adapt his performance to different circumstances or surroundings" (Ferrari et al., 1991).

In this way, learning is not considered as a passive stimulus-response process between the learner and the environment, but as a process of active construction where students react upon information, using prior knowledge, skills and strategies (Fox, 2001).

An important element of self-regulation is metacognition (Efklides, 2001), a term firstly introduced in late 70s (Brown, 1978; Flavell, 1979). Since then, related efforts to describe what the concept of metacognition actually entails, run the risk of getting involved into an argument regarding the nature and functioning of metacognition that are not yet clearly verified. Prescribing metacognition as an individual's ability to know and control his/her cognitions, Flavell (1979) was the first who portrayed the two metacognition functions, that is, monitoring and regulatory function. Focusing his interest on the monitoring function, he allegedly made a distinction between metacognitive knowledge and metacognitive experiences. Metacognitive experiences are products of self-initiated monitoring of cognition and are specific in their scope referring to features of particular tasks including

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feelings experienced in relation to tasks, whereas metacognitive knowledge is the product of generally monitoring memory knowledge, including beliefs about persons, tasks and strategies that could be not only self-initiated but motivated from others as well (Efklides, 2001).

Several researchers (Brown et al., 1983; Brown, 1987; Flavell, 1987; Jacobs and Paris, 1987; Otero and Campanario, 1992) view metacognition as a global construct comprised of two cognition features related to knowledge and regulation, Knowledge of cognition includes declarative knowledge about self and personal strategies, procedural knowledge on how to use these strategies and conditional knowledge referring to when and why to use these strategies, whereas regulation of cognition includes activities/skills such as planning, information management, self-monitoring, problem solving strategies and evaluation (Artz and Armour-Thomas, 1992; Baker, 1989).

Metacognitive skills are partially independent of intellectual ability and not necessarily conscious. However, they can be used for purpose once the individual becomes aware of their existence and effect on performance (Veenman and Spaans, 2005). Individuals who possess higher 'metacognitive skillfulness' (Veenman and Spaans, 2005), are expected to learn more effectively as they are in position to monitor their progress and determine when problems occur, adjusting their learning accordingly (Ford et al., 1998). Several studies examining the relationship between metacognition and academic achievement showed that students with higher levels of metacognition were more strategic in mind, resulting to better performance compared to students with lower metacognition levels (Garner and Alexander, 1989; Haller et al., 1988; Maqsud, 1997; Meloth, 1990; Pappa et al., 2003; Pintrich and De Groot, 1990; Pokay and Blumenfeld, 1990; Pressley and Ghatala, 1990; Swanson, 1990).

Drawing from the goal perspectives theory (Ames, 1984; Ames and Archer, 1988; Dweck and Legget, 1988; Nicholls, 1984a, 1984b, 1989) several researchers (Dweck, 1986; Lochbaum and Roberts, 1993; Nolen, 1988; Roberts and Ommundsen, 1996) claimed that an essential component of effective self-regulation in learning and consequently of metacognitive activity is students' goal orientations, referring to task- and ego-orientation in achievement settings such as sports and school. Task-orientated individuals conceive ability as modifiable and believe that effort determines the attainment of skills' mastery. Valuing the process of learning itself, they try hard to learn and perfect new skills, intrinsically motivated to develop personal competence without the need of external rewards or threats. On the other hand, ego-orientated individuals seek to demonstrate their abilities either by outperforming others or by achieving success with little effort, aiming to be judged by others as attaining a higher level of abilities compared to people of the same class, age, or gender. Success and satisfaction or failure and negative emotions that ego-oriented individuals experience depend solely on other peoples' perceptions regarding their higher or lower performance level respectively.

As a result of the two different approaches towards learning, task-orientated individuals are more likely to employ deep processing strategies that require cognitive effort leading to complete task understanding, whereas ego-orientated individuals are more anticipated to try completing a task as quickly as possible with the use of shallower processing learning strategies (Al-Emadi, 2001; Bouffard et al., 1995; Ford, et al., 1998; Meece et al., 1988; Meece et al., 1990; Navarro et al., 2006; Pintrich and De Groot, 1990; Pintrich, 2000; Schraw et al., 1995; Wolters, 2004).

According to Elliot (1999), there is another distinction of achievement goals in two different types, that is approach and avoidance goals, which in turn influence motivation, cognition and achievement differently. Individuals, either task- or ego-orientated, could focus on attaining a positive, desirable possibility (approach goal) or on avoiding a negative undesirable possibility (avoidance goal). Combining the two dimensions (approach-avoidance) with achievement goals, Elliot (1999) presented a 2×2 conceptualization regarding performance and mastery anchored by approach goals or avoidance goals. Thus, a performance approach goal represents striving to do better than others while a performance avoidance goal represents striving not to do worse than others. In the same way, a mastery-approach goal represents striving to attain task mastery or improvement while a mastery-avoidance goal represents striving not to fall short of task mastery.

Several researchers seem to agree that the aforementioned individual goal orientation differences may result from family and social influences (Ames and Archer, 1987; Gottfried et al., 1994; Papaioannou, et al. 2008; Parsons et al., 1982), previous experiences (Stipek and Hoffman, 1980), or teachers' behavior (Carr and Weigand, 2002; Marshall and Weinstein, 1986; Viciana et al., 2007; Weinstein and Middlestadt, 1979). More specifically, the teachers' approach concerning instruction, recognition and evaluation and type of tasks chosen for teaching, are important factors that influence the way students perceive their class climate, thus, they could be described under the term 'motivational climate' as they affect students' motivation that is task- or performance-orientated. Keeping in mind Elliot's (1999) 2×2 conceptualization regarding performance and mastery anchored by approach or avoidance goals, motivational climate can be orientated as anchored by mastery approach or avoidance, and performance approach or avoidance. In general, research findings indicate that when teachers emphasize the nature, importance, and meaning of individual progress and effort to accomplish various academic tasks, students are more intrinsically motivated, expe-

rience less anxiety and focus on learning and on the belief that success derives from hard work. On the other hand, teachers who emphasize normative ability and public evaluation lead students towards attempts of ability demonstration and performance comparisons with others, resulting to anxiety feeling related to performance (Ames, 1992; Escarti and Gutierrez, 2001; Maehr and Anderman, 1993; Maehr and Midgley, 1991; Yoo, 2003; Weigand, 2001).

In Greek physical education settings, research findings (Papaioannou, 1997a; Digelidis and Papaioannou, 1999) indicate that younger students appear as more task-orientated and task-involved in physical education classes. However, as they grow and move from elementary to junior and senior high school classes, they lose their intrinsic motivation, become less task-orientated, perceive motivation climate as more performance-orientated and as a result they feel less competent and do not participate. As for gender differences, results of previous studies conducted in Greece (Digelidis and Papaioannou, 1999; Papaioannou and McDonald, 1993; Tsigilis et al., 2003) and in other countries (Goudas and Biddle, 1994; Li et al., 1996; Solmon, 1996; White, 1993; White, 1995; White and Duda, 1994) indicate that males are more ego-orientated than females, a finding that suggests males as stressing more importance on competition and acquisition of social status that characterizes Western civilization.

A large body of research conducted in physical education settings focus on goal orientations and their relationship with students' self-regulation (Duda et al 2005), showing in early studies that such relationship exists. Solmon and Boone (1993) showed that task-involvement of college students was positively related with the use of learning strategies and self-regulation in learning, whereas ego-involvement was negatively related. Similarly, Solmon and Lee (1997) found that task-orientation of elementary and middle school students, was associated with behaviors reflecting self-regulated learning and the use of strategies in physical education classes. A weaker but positive association was also found between the aforementioned adaptive behaviors with mastery-oriented motivational climate.

Having in mind that a precondition of task-orientation is people's perception that ability is modifiable (Dweck, 1985), Ommundsen (2003) examined the relationship between this perception and pupils' self-reported metacognitive control, finding that students who believed that ability is modifiable reported more frequent use of metacognitive self-regulatory strategies. More specifically, students holding an incremental perspective of ability were more likely to plan, monitor, and regulate their cognition while working with different learning tasks in physical education compared to those holding a stable theory of ability.

In another study, Ommundsen (2006) examined the role of achievement goals in students' self-regulation in physical education classes using the trichotomous achievement goal framework (Elliot, 1999; Elliot and Harackiewicz, 1996). The results of this study mainly stressed the importance of pupils' task engagement but also revealed that in some instances performance-approach goals could positively effect pupils' self-regulation during physical education lessons. In particular, it was found that although performance-avoid goals were related to maladaptive behaviors such as self-protective thoughts and tactics, in some cases performance-approach goals could be related with adaptive behaviors such as intrinsic motivation, task engagement and performance. Finally, as expected mastery oriented motivational climate was noted to play a significant but less important role on pupils' self-regulation, directly or indirectly mediated by their achievement goals.

In line with the above mentioned results were the findings of a recent study (Gano-Overway, 2008) where the possible effects of goal involvement on athletes' self-regulation were examined under negative feedback conditions. These are very important in sport domain, due to the fact that performance improvement requires extended effort in practice, emotion control, use of analyzing strategies and modification of prior knowledge, all key self-regulation components that frequently have to be applied while athletes are facing failure or adversity. The findings of this study also suggested that a task-involving condition is more likely to promote application of self-regulatory processes during practice. On the contrary, ego- or performance-involving condition was not found to have a positive correlation with the usage of self-regulation strategies that help athletes to overcome performance difficulties.

All the results of the aforementioned studies are in fact consistent with achievement goal theory, which suggests different cognitive processes based on different achievement goals. However, it seems that none of these studies examined possible age differences in students' metacognitive activity or the relationship of goal-orientations and motivational climate within classes, taking at the same time into account all the elements of metacognition. As an example, none of these studies took into consideration the elements of knowledge of cognition, that is, procedural and declarative knowledge (Brown et al., 1983; Brown, 1987; Flavell, 1987; Jacobs and Paris, 1987; Otero and Campanario, 1992). Procedural knowledge represents the breadth and depth of skills that a person acquired in a variety of domain-specific activities, while declarative knowledge refers to the conceptual knowledge that people develop and store within the action domain. Both types of knowledge are considered important in motor skill learning, as through their continuous interplay individuals gain experience about the use and influence of their actions, thus, helps people as their declarative knowledge is increased to attach conceptual meanings to their actions which in turn stimulates the use and understanding of their actions and strategies

(Wall et al., 1985).

In addition, with regard to age and gender differences the results of these studies seem to be inconsistent. In particular, several researchers supported that metacognition and consequently self-regulation develop with age and experience (Vukman, 2005; Garner and Alexander, 1989; Kuhn, 2000). Expert-novice studies revealed that experts use more often, either consciously or unconsciously, strategies in order to optimize their performance (Ferrari, 1996; Ferrari et al., 1991; Wall et al., 1990). In particular, experts gain through experience a more elaborate and articulate knowledge base which allows them to recognize information more effectively, to develop strategies and to attain and adjust their goals in case facing adversity. Indeed, early research findings derived from completely different motor domains such as tennis (Goulet et al., 1989; McPherson and Thomas, 1989; Singer et al., 1994), typing (Gentner, 1988), dancing (Foley, 1991; Smith and Pendelton, 1994), basketball (French and Thomas, 1987), or even long distance running (Wrisberg and Pein, 1990) indicate that experts process information and regulate their performance more efficiently than novices.

In contrast, Solmon and Lee (1997) noted higher levels of self-regulation in younger students. Having in mind the results of Solmon and Lee (1996) earlier research where a higher use of learning strategies was also reported for younger students, the researchers argued that these differences were probably related to the degree of difficulty of the learning context. Usually, skilled performance in sports is characterized by automaticity and it is considered to be fast and effortless without the need of controlled processing (Singer et al., 1993). Consequently, Solmon and Lee (1997) suggested that older students, who are considered as higher skilled students, may not need to use strategies, especially in case the skill presents little difficulty, a conclusion that is further supported by the notion that self-regulation has its basis on costructivism. One of the claims used to define constructivist views of learning is that 'effective learning requires meaningful, open-ended, challenging problems for the learner to solve' (Fox, 2001), therefore, the aspects of the 'threshold of problematicity theory' could be true (Elshout, 1987; Prins et al., 2006). According to this theory there is a critical point on the learning task complexity which determines whether an individual will, or will not activate metacognitive processes. In other words, for easy tasks below the threshold of the learner cognitive processes are relatively automatic, whereas for tasks slightly above the learner's threshold, cognitive processes become more heuristic stimulating the learner to apply or to modify a learning strategy.

Furthermore, in contrast to research findings in other academic domains (Pokay and Blumenfeld, 1990; Zimmerman and Martinez-Pons, 1990) where girls were reported to use more frequently metacognitive strategies, Ommundsen (2003), stated that boys were more likely to use metacognitive/elaboration strategies in physical education settings.

Such results underline the need to further understand self-regulation in physical education and sport settings, especially regarding the metacognitive skills students develop and under which conditions. Summarizing, the purpose of this study was to examine possible age and gender differences in students' metacognition during physical education lessons and the effect of goal orientations and perceived motivational climate on students' metacognitive ability. In consistency with the results of previous studies in this domain, it was expected that younger students (Solmon and Lee, 1996, 1997) and boys (Ommundsen, 2003) would demonstrate higher levels of metacognition.

According to goal perspectives theory, high task-oriented students are more likely to use metacognitive strategies or metacognitive skills. On the other hand, high ego-oriented students are more likely to take a shallower approach toward learning. Thus, it can be hypothesized that task-orientation could emerge as a significant mediator of possible differences in metacognition. Assuming that positive but not so strong relations have also been noticed between self-regulation strategies and task-involving climate in previous studies (Solmon and Lee, 1997; Ommundsen, 2006), the perception of a task-involving motivation climate could also come out as a less significant mediator of the afore mentioned differences.

MATERIALS AND METHODS

Participants

Five hundred and ten students (217 boys, 277 girls, 16 did not provide gender information) of public elementary (n = 109; grades 5 and 6), junior high school (n = 229; grades 8 and 9) and senior high school (n = 172; grades 11 and 12) participated in this study, all coming from urban areas of northeastern Greece. Prior study, permission from the Greek Ministry of Education was obtained and the students agreed to take part voluntarily.

Measures

Metacognition in physical education settings

In this study metacognition was measured in terms of metacognitive knowledge and metacognitive regulation (Brown, 1987). A number of measurement techniques have been used to assess metacognition and broader self-regulatory constructs (Winnie and Perry, 2000). Generally, there is a major distinction between off-line and on-line methods. On-line methods assess metacognition during the task and off-line methods assess metacognition either prior or after the task (Veenman et al., 2006). Although on-line methods appear to be more predictable, questionnaires are easy to administer to large groups, simple to analyze and useful for theoretical research (Sperling et al., 2002). Typically questionnaires measure self-regulation as an ability to be accurate with responders answering the questions by generalizing their actions across

Table 1. Standardized regression weights of MPIPEQ's items.

Item	value	Item	value	Item	value
DK1	.593	PK4	.662	PSS1	.590
DK2	.649			PSS2	.750
DK3	.775	P1	.679	PSS3	.721
DK4	.792	P2	.775	PSS4	.772
DK5	.782	P3	.664	PSS5	.818
DK6	.729	P4	.729	PSS6	.713
CK1	.595	SM1	.542	E1	.573
CK2	.645	SM2	.670	E2	.664
CK3	.702	SM3	.719	E3	.694
CK4	.765	SM4	.654	E4	.720
CK6	.667			E5	.631
CK6	.781	IMS1	.591	E6	.742
		IMS2	.650	E7	.619
PK1	.581	IMS3	.688		
PK2	.689	IMS4	.806		
PK3	.645	IMS5	.660		

Note: DK: declarative knowledge, CK: conditional knowledge, PK: procedural knowledge, P: planning, SM: self monitoring, IMS: information management, PSS: problem solving strategies, E: evaluation

situations whereas on-line methods measure self-regulation as an event (Winne and Perry, 2000). The main problems identified with the use of questionnaires are that questionnaires measure people's perception about the use of metacognitive activity rather than metacognitive activity itself, they are probably influenced by tendencies such as social desirability and may not be suitable for children who have difficulties to recall their learning behaviour (de Jager et al., 2005). However, questionnaires have been used successfully in several studies measuring metacognition and self-regulatory processes (de Jager, et al., 2005; Miller et al., 1993; Ommundsen, 2003, 2006; Pintrich et al., 1993; Schraw and Dennison, 1994; Sperling et al., 2002; Weinstein et al., 1983; Weinstein et al., 1987).

For the purpose of the study eight scales of the Metacognitive Processes in Physical Education Questionnaire (MPIPEQ) (Theodosiou et al., 2005) were used. MPIPEQ was developed to measure students' metacognitive activity in physical education lessons. The scales that were used were designed to assess the eight factors mentioned by Brown (1987): 1. declarative knowledge (6 items: e.g., *In the Physical Education class,* I realize which exercises I can perform right), 2. procedural knowledge (5 items: e.g., …the steps I have to follow in order to put in practice a good learning method I have been taught are clear to me), 3. conditional knowledge (6 items: e.g., …when I want to grow better in a game I put into practice a learning strategy), 4. information management (6 items: e.g., …I think if the exercise I am learning reminds me of another one I already know), 5. planning (4 items: e.g., …it is clear for me what I want to learn), 6. self-monitoring (4 items: e.g., …the moment I perform an exercise, I check if I actually learn it right), 7. problem solving strategies (7 items: e.g., …when I make a mistake I stop and try again being more careful) and 8. evaluation (7 items: e.g., …since I have learned an exercise I think if there was an easier way to succeed). There were not negatively formulated questions and responses were given on 5-point Likert Scale (*5* = Strongly Agree, *1* = Strongly Disagree).

Goal orientations

The Task and Ego Orientations in Sport Questionnaire (TEOSQ) (Duda, 1989) was used to measure goal orientations. TEOSQ measures two factors: task-orientation (7 items) and ego-orientation (6 items) and has been used successfully in previous studies (Bortoli and Robazza, 2005; Papaioannou and Digelidis, 1997; Papaioannou and McDonald, 1993; Papaioannou and Theodorakis 1996; Papaioannou, 1997b; Papaioannou et al., 2004). Recently, it was successfully used in a longitudinal study (Marsh et al., 2006) with Greek students.

Perceived motivational climate

A short version of the Learning and Performance Orientations in Physical Education Classes Questionnaire (LAPOPECQ) (Papaioannou, 1994; Papaioannou, 1998; Papaioannou, et al., 2004) was used. The original version of LAPOPECQ has been adapted and used in other European countries (Biddle et al., 1995; Dorobantou and Biddle, 1997). This short version has 13 items measuring perceptions of task-involving climate (7 items) and ego-involving climate (6 items) in physical education and was also used successfully in the longitudinal study of Marsh and his colleagues (2006).

Procedure

One of the authors visited schools and administered the questionnaires in the classroom. Apart from verbal instructions given to the students on how to complete the questionnaires, a brief introductory section was included at the start of MIPEQ providing a definition of a learning strategy-method that is "the way a person thinks when he/she wants to learn something". The researcher remained into the classroom during the whole procedure in order to answer any questions posed by students facing difficulties to comprehend the questions.

RESULTS

Factor structure of MPIPEQ

Confirmatory factor analysis was conducted to examine the structure of the MPIPEQ. In agreement with the theoretical expectations an eight-factor model was tested. Each item was freed to the factor that was assumed to assess and was fixed to zero to the remaining eight factors. Intercorrelations among factors were specified but no correlated residuals. The goodness-of-fit indices (x^2 = 1322, *df* = 791, x^2/df = 1.67, *TLI* = .94, *CFI* = .94, *RMSEA* = .04) imply that the structure of the model was acceptable. The standardized regression weights shown in Table 1 suggest that all items had high loadings and all of them were highly significant ($p < .001$) ranging from .542 to .818.

Internal consistency

The alpha reliabilities (Cronbach, 1951) of the scales of the three questionnaires are shown in Table 3. The

Table 2. Correlations between scales assessing metacognitive processes, achievement goals and perceived motivational climate.

	1	2	3	4	5	6	7	8	9	10	11	12
1. Declarative knowledge	1											
2. Conditional knowledge	.41**	1										
3. Procedural knowledge	.53**	.53**	1									
4. Planning	.56**	.48**	.64**	1								
5. Self-monitoring	.46**	.64**	.59**	.54**	1							
6. Problem solving strategies	.39**	.49**	.49**	.43**	.59**	1						
7. Information management	.35**	.49**	.40**	.38**	.50**	.38**	1					
8. Evaluation	.33**	.55**	.41**	.42**	.57**	.44**	.61**	1				
9. Task-orientation	.43**	.48**	.50**	.45**	.58**	.50**	.44**	.40**	1			
10. Ego-orientation	.045	.039	.13**	.087	.070	.028	.13**	.11*	.16**	1		
11. Task-involving climate	.32**	.37**	.40**	.30**	.49**	.40**	.29**	.29**	.49**	-.009	1	
12. Ego-involving climate	-.004	-.014	-.003	-.039	-.067	-.99*	.052	.13**	-.075	.35**	-.22*	1

Table 3. Internal consistency and gender differences for scales assessing metacognition, goal orientations and perceived motivation climate.

		Male		Female			
	Alpha reliability	**M**	**SD**	**M**	**SD**	**F values**	**η^2**
Declarative knowledge	.87	4.22	0.77	4.34	0.72	5.56*	.011
Conditional knowledge	.84	3.58	0.93	3.49	0.90	.010	.000
Procedural knowledge	.74	3.86	0.78	3.72	0.78	1.23	.003
Planning	.80	3.93	0.91	3.89	0.83	.052	.000
Self-monitoring	.74	3.77	0.84	3.77	0.83	2.20	.004
Problem solving strategies	.87	3.68	1.00	3.98	0.91	18.15**	.036
Information management	.81	3.38	0.92	3.25	0.93	.63	.001
Evaluation	.85	2.99	0.97	2.84	0.87	.87	.002
Task-orientation	0.77	3.99	0.66	3.88	0.79	.81	.002
Ego-orientation	0.86	2.99	.98	2.82	.86	1.27	.003
Task-involving climate	0.82	4.03	0.72	3.97	0.73	.016	.000
Ego-involving climate	0.75	2.67	0.87	2.44	0.76	15.26**	.034

*$p < .05$, ** $p < .001$

results indicate acceptable scale reliabilities.

Following the factor analysis and reliability analysis results, eight scale scores were computed for MIPEQ (declarative knowledge, procedural knowledge, conditional knowledge, information management, planning, self-monitoring, problem solving strategies, and evaluation) two scale scores for the TEOSQ (task- and ego-orientation) and two scales scores for the LAPOPECQ (perceived task-involving and perceive ego-involving climate).

Correlations

Pearson correlations between the composed scale scores of the questionnaires are presented in Table 2. As it can be seen, task-orientation and mastery climate perception had positive and significant correlations with all the variables measuring metacognitive processes. Ego-orientation displayed significant although low correlations with procedural knowledge, information management and evaluation.

Age and gender differences

The composed scale scores of the questionnaires were also used as dependent variables in a series of multivariate analyses of variance (MANOVAs). Age (elementary, junior and senior high school students) and gender were used as independent variables. Univariate *F* tests and Scheffe post-hoc test followed, in order to examine between-group differences.

Differences in metacognitive activity during physical education classes

Results of the 3X2 MANOVA revealed statistical signifycant age (Wilks' $\lambda = .789$, $F_{16,962} = 7{,}543$, $p < .001$, $\eta^2 = .111$) and gender (Wilks' $\lambda = .905$, $F_{8,481} = 6.315$, $p <$

.001, η^2 = .095) differences with no significant interacttions. As it can be seen in Table 3, small but statistically significant differences emerged between genders in declarative knowledge and in problem solving strategies with the girls scoring higher compared to boys. Strong differences were also found between the three age-groups in conditional knowledge, in procedural knowledge, in self-monitoring, and in evaluation. Moderate differences were noted in declarative knowledge, in planning and in problem solving strategies and small although statistically significant differences were spotted in information management. In general, younger students scored higher in most of the scales of MPIPEQ (Table 4).

Differences in goal orientations

The results of the 3X2 MANOVA revealed statistically significant age differences (Wilks' λ = .901, $F_{4,916}$ = 12.274, p < .001, η^2 = .051) and no gender differences (table 4 and 3 respectively). Senior high school students attained lower scores compared to junior high school students in task- and ego-orientation scale and elementary students achieved higher scores than junior high school students.

Differences in perceived motivational climate

The 3X2 MANOVA indicated statistically significant differences between the three age-groups (Wilks' λ = .907, $F_{4,878}$ = 10.955, p < .001, η^2 = .048) and between genders (Wilks' λ =.964, $F_{2,439}$ = 8.244, p < .001, η^2 = .036), with small but statistically significant interaction (Tables 4 and 3 respectively). Elementary students scored higher in the task-involving scale than junior high school students and similarly junior high school students scored higher than senior high school students. Elementary and senior high school boys achieved higher scores than senior high school boys in the ego-involving scale. No score differences were found between the three age groups in the ego-involving scale and between genders in the task-involving scale.

The role of goal orientations and perceived motivational climate

The significant differences of MPIPEQ scores related to metacognitive strategies between the three age-groups were analyzed using a multivariate analysis of covariance (8X3 MANCOVA). The scores of task-orientation, ego-orientation and task-involving motivational climate scales, where strong differences were identified, were used as covariates. Results showed that the scores of task-orientation and task-involving climate scales explained a statistically significant proportion of variance of the reported metacognitive strategies use (Wilks' λ = .733, $F_{8,419}$ = 19.104, p < .001, η^2 = .267 and Wilks' λ = .910, $F_{8,419}$ = 5.153, p < 001, η^2 = .090 respectively) while the score of ego-orientation scale did not (Wilks' λ = .969, $F_{8,419}$ = 1.654, p = *.108*). After the removal of covariates' main effect there were still significantly statistical differences remaining between the three age groups, however, they were not as strong as before (Wilks' λ = .833, $F_{16,838}$ = 4.996, p < 001, η^2 = .087) (Table 4).

DISCUSSION

The present study aimed at investigating possible age-group and gender differences in students' self-reported metacognition in physical education classes and the effect of students' goal orientations and of the motivational climate in class on them.

First, gender did not emerge as a determinant factor of metacognition. Girls scored slightly higher in declarative knowledge and problem solving strategies scales compared to boys. These differences although statistically significant are not considered strong enough as indicated by η^2 values. These findings are fairly in accordance with the notion that in general, girls self-regulate better than boys in early childhood (McCabe et al., 2004) and with the results of studies in other cognitive domains (Pokay and Blumenfeld, 1990; Zimmerman and Martinez-Pons, 1990), where girls reported more frequent use of metacognitive strategies. On the other hand, this study's findings are in difference with the findings of Ommundsen (2003) who reported boys using more frequently metacognitive strategies in physical education. Apparently, such results are not judged as sufficient enough for reliable conclusions and suggest that possible gender differences in self-regulation have to be interpreted carefully, as it seems that they are not just an outcome attributed to gender influence but of other underlying and more effective variables.

As it was hypothesized, age was found to be a strong determinant of self-reported metacognition in physical education classes. Although previous studies in physical education settings examining age differences did not use the same research design by taking into account all the elements of metacognition (Solmon and Lee, 1996, 1997), it is worthwhile to mention that the results of the present study were similar. Particularly, pupils reported less frequent use of metacognitive strategies as they moved from the elementary to junior and senior high school.

Nevertheless, results of the multivariate analysis of covariance showed that both task-orientation and task-involving motivational climate significantly contributed to the explanation of these differences, confirming the general notion that there is a relation between personal environmental factors and the way students approach learning. This was also proved from correlation analysis results where all and metacognition variables demonstrated significant positive relations with task-orientation

Table 4. Age-group differences for scales assessing metacognition, task-orientation and perceived motivation climate. Age-group differences for scales assessing metacognition after the removal of covariates' main effect.

	Before the removal of covariates' main effect								After the removal of covariates' main effect				
	Elementary		J High school		S High school				Elementary	J High school	S High school		
	M	*SD*	*M*	*SD*	*M*	*SD*	*F* values	η^2	*M*	*M*	*M*	*F* values	η^2
Declarative knowledge	4.35_a	.74	4.41_a	.68	4.07_b	.78	11.76**	.046	4.17	4.41	4.21	6.10*	.028
Conditional knowledge	4.05_a	.75	3.48_b	.86	3.26_b	.93	26.76**	.099	3.85	3.49	3.44	8.12**	.037
Procedural knowledge	4.15_a	.63	3.78_b	.75	3.55_c	.83	19.57**	.074	3.95	3.77	3.72	3.19*	.015
Planning	4.26_a	.71	3.89_b	.86	3.73_b	.90	13.36**	.052	4.07	3.92	3.87	1.85	.009
Self-monitoring	4.20	.68	3.78	.76	3.50	.76	26.33**	.097	3.92	3.92	3.80	3.87*	.018
Problem solving strategies	4.03_a	.89	3.96_a	.93	3.56_b	1.01	13.18**	.051	3.73	4.02	3.74	6.25*	.029
Information management	3.59_a	.94	3.26_b	.87	3.20_b	.96	6.08*	.024	3.35	3.30	3.41	.33	.002
Evaluation	3.35_a	.86	2.80_b	.88	2.78_b	.91	15.57**	.060	3.19	2.81	2.87	6.43*	.029
Task-orientation	4.31_a	.50	4.00_b	.58	3.81_c	.78	18.45**	.074					
Ego-orientation	3.44_a	.88	2.81_b	.87	2.74_b	.92	14.50**	.059					
Task-involving climate	4.32_a	.59	4.06_b	.61	3.73_c	.82	22.09**	.091					
Ego-involving climate	2.52_a	.97	2.54_a	.77	2.54_a	.79	.331	.002					

Note: Group means sharing the same subscript are not significantly different at least at the .05 level (after Scheffe tests), *$p < .05$, ** $p < .001$.

tion and task-involving climate. These results are in line with previous studies in physical education and sport settings (Gano-Overway, 2008; Ommundsen, 2003, 2006; Solmon and Boone, 1993; Solmon and Lee, 1997) where task-involvement was found to have a significant impact on adaptive self-regulatory processes. In relation to the present study, reported metacognitive activity differences remaining after the removal of covariates' main effect were small. This finding provides evidence for the important role of task-involvement concerning the activation of metacognitive processes and consequently self-regulation during physical education lessons, without necessarily implying causality. However, it seems that the existence of a mastery climate and students' tendency toward task-orientation probably generates the appropriate psychological background where new information exploits effectively with the use of metacognitive strategies.

The differences remaining between the three age groups give sense to the opinion of Solmon and Lee (1997) that the lesson's degree of difficulty probably influences activation of metacognitive processes. Nowadays, it is a fact that high skilled athletes do not have to think about what they are doing and as Singer et al. (1993) stated, they "learn to let it happen" rather than "trying to make it happen". Furthermore, it is a fact that as children grow up they move to a different developmental stage and perform automatically an increased number of movements.

Once automaticity is achieved and children adapt movements according to different conditions, they shift their attention from the process of performance to performance outcomes (Duda et al., 2005). As Solmon and Lee (1997) argued, older students -therefore considered as more experienced - possibly do not need the use of learning strategies to achieve lesson demands. In other words, they stressed the importance of choosing the appropriate degree of difficulty of the learning context so as to activate students' learning strategies at all age levels. Given the fact that in this study proportional differences were also noticed even after the removal of covariate effects, someone could claim that this is a reasonable point of view. In fact, this perception is also in agreement with costructivism which is the basis of self-regulated learning claiming that effective learning needs meaningful, open-ended, challenging problems for the learner to solve' (Fox, 2001), as well as the principles of 'the threshold of problematicity' theory (Elshout, 1987; Prins et al., 2006). This theory supports the notion the task's degree of difficulty influences the activation of students' metacognitive processes during learn-

ing. In other words, it seems that there is a part of the mind that takes into account the task's difficulty and present level of ability and informs individuals whether it is necessary or not to use metacognitive skills. Thus, tasks perceived as complex by young students could be perceived as less difficult by older and more experienced students (Prins et al., 2006). Supportive evidence of this conception can also be found in Chen and Singer (1992) notion analysis results where all metacognition variables demonstrated significant positive relations with task-orientation and task-involving climate. These results are in line with previous studies in physical education and sport settings (Gano-Overway, 2008; Ommundsen, 2003, 2006; Solmon and Boone, 1993; Solmon and Lee, 1997) where task-involvement was found to have a significant impact on adaptive self-regulatory processes. In relation to the present study, reported metacognitive activity differences remaining after the removal of covariates' main effect were small. This finding provides evidence for the impor-tant role of task-involvement concerning the activation of metacognitive processes and consequently self-regula-tion during physical education lessons, without necessarily implying causality. However, it seems that the existence of a mastery climate and students' tendency toward task-orientation probably generates the appro-priate psychological background where new information exploits effectively with the use of metacognitive stra-tegies.

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Consequently, several approaches facilitating students' metacognition could be hypothesized. According to theory as an example, student-centered teaching styles such as self-check, reciprocal, divergent, inclusion and learner's design styles (Mosston and Asworth, 1994), set students at the center of the learning process making them accountable for what they learn and how they learn. Although in the present study there was no measurement of preferred teaching and learning, in fact this could be true as Veenman and Beishuizen (2004) reported research findings in academic domain revealing that learning-by-discovery and learning-by-doing tasks force students to activate influential metacognitive processes.

At this point, it is also interesting to mention that according to Frydenberg and Lewis (1999), adolescents tend to reduce their use of productive coping strategies. Although this notion reflects adolescents' general behaviour facing a problem -whether it is a learning or a social one- someone could tell that the results of the present study possible reflect this kind of behaviour in physical education settings.

In conclusion, present and previous research findings give able evidence of the important role of task involvement on students' metacognitive processes. However, further research needs to be conducted before the complete understanding of how achievement goals and other variables influence the way pupils of different age levels self-regulate in physical education classes. For example, nowadays there is increasing evidence that ego goals as well could produce adaptive behaviors under certain conditions either in academic (Hidi and Haravkiewicz, 2000) or in physical education domains (Ommundsen, 2006). Research efforts towards this direction could possibly provide additional knowledge about high skilled motor performance as it is already known (Duda, 1989) that top athletes are highly both task- and ego-oriented. Although in the present study such adaptive forms of

ego-orientation were not examined, the findings underscore the importance of task-involvement for the activation of students' metacognitive processes in physical education settings. Teachers who create in their lessons a motivational climate that promotes personal development not only positively effect students' intrinsic motivation but also maximize the possibility to create self-regulated learners in physical education. This is most important as it is rather easier to change motivational climates to a clearly task-involving pattern, than to change goal-orientations or to create appropriate conditions for ego-involvement so as to produce adaptive behaviors.

In addition, this study's findings underscore the possible importance of physical education curricula contents. Future research should focus on the introduction of appropriate teaching methods which take into account students' personal capabilities and help them to become aware of the way they learn, in order to contribute directly to metacognitive enhancement.

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