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Greek preservice physical education teachers' mental models of production and reproduction teaching styles

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Abstract

The purpose of this study was to examine Greek preservice physical education (PE) teachers' presuppositions, beliefs and mental models about the reproduction and production teaching styles. The participants were 16 preservice PE teachers (10 males, six females). A qualitative methodology was used with data collected using semi-structured interviews. A multi-level analysis process using open coding and axial coding was sequentially conducted. Findings revealed two generative mental models about teaching styles. For the first mental model ($n = 5$), learning is considered as a transmissive and unidimensional (i.e. one goal pursued at a time) process. Presuppositions supported by this mental model urge the preservice teachers to believe that the reproduction teaching styles promote effective learning, class control, students' safety and discipline. For the second mental model ($n = 11$), learning is viewed as a constructivist and multidimensional (i.e. multiple goals pursued at a time) process. Presuppositions supported by this mental model urge the participants to believe that the production teaching styles effectively promote students' learning, critical thinking, responsibility, motivation, autonomy and discipline. The aforementioned mental models highlight the developmental nature of preservice PE teachers' learning concerning the production and the reproduction teaching styles. These mental models reveal the diversity of PE preservice teachers' understanding of the teaching and learning processes. Furthermore,

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findings support Vosniadou's assumption that learners come to formal education not as a *tabula rasa* but holding a naive understanding about the world.

Keywords
Teaching styles, preservice teachers, constructivist learning, transmissive learning, conceptual change

Introduction

Teaching physical education (PE) is a complex job, as the PE teacher is tasked to deliver lessons to educate students for multiple educational goals (Graham, 2008). PE teachers' education plays a determining role in their subsequent effective teaching (Capel and Blair, 2007). Preservice teachers' early socialization during various professional experiences may shape their beliefs and choices for teaching styles (Curtner-Smith et al., 2001). The spectrum of teaching styles is an integrated framework about teaching and learning (Mosston and Ashworth, 2008), which provides PE teachers a 'tool box' with various teaching options to cope with student diversity and achieve instructional goals (Sanchez et al., 2012). Since 1966, the spectrum has gradually evolved into the current version with 11 teaching styles: (a) command; (b) practice; (c) reciprocal; (d) self-check; (e) inclusion; (f) guided discovery; (g) convergent discovery; (h) divergent production; (i) learner's individual designed programme; (j) learner initiated; and (k) self-teaching (Mosston and Ashworth, 2008). Mosston and Ashworth (2008: 11) suggested that 'two basic human capacities are reflected within the spectrum structure: the capacity for [knowledge] reproduction and the capacity for [knowledge] production'. Thus, the 11 teaching styles are often categorized within these two epistemic clusters. Five teaching styles (a–e) represent the reproduction cluster because students 'reproduce known knowledge, replicate models, and practice skills' (Mosston and Ashworth, 2008: 9). On the other hand, six teaching styles (f–k) represent the production cluster in which the teacher guides students to discover and produce knowledge (Goldberger et al., 2012).

Teaching creates a learning context that contributes to the accomplishment of specific learning objectives or goals (Goldberger et al., 2012). Garn and Byra (2002) suggested that the implementation of a given teaching style may lead to specific outcomes that are in alignment with national PE standards. It has been argued that the reproduction teaching styles promote psychomotor performance, while the production approach emphasizes the cognitive domain and may promote students' motivation (Garn and Byra, 2002; Hein et al., 2012).

So far, researchers have mainly explored relationships among student outcomes specific to teaching styles within the reproduction cluster (Chatoupis, 2010). Jenkins and Byra (1996) demonstrated that the inclusion teaching style promotes skills retention more effectively than the practice and the self-check teaching styles. Similarly, the self-check teaching style has been found to promote students' tennis skills more effectively than the command style (Patmanoglou et al., 2008). Finally, Alhayek (2004) found that the implementation of the practice style helped students to perform better in the basketball jump shot and dribbling compared to the reciprocal teaching style.

A small number of studies have examined the influence of the problem-solving approach of teaching on outcomes related to critical thinking and motor performance. More specifically, several researchers found that the divergent discovery teaching style promoted students' critical thinking and motor skill performance (Chatoupis, 2013; Chen and Cone, 2003; Cleland and

Gallahue, 1993). Other researchers who employed different problem-based teaching approaches in teaching motor skills also reported an improvement in students' critical thinking (McBride, 1992; McBride et al., 1990). Similarly, Dyson (2002) found students' motor skill performance improved when implementing a cooperative learning approach to teaching PE that emphasizes student social responsibility and problem-solving.

Recently, Greek researchers have found that PE teachers (Syrmpas et al., 2016) and preservice PE teachers (Syrmpas and Digelidis, 2014) have reported using spectrum teaching styles from the reproduction cluster more often than those from the production cluster. Similarly, a number of studies in the UK (Curtner-Smith and Hasty, 1997; Curtner-Smith et al., 2001), the USA (Cothran et al., 2000; Kulinna and Cothran, 2003) and Finland (Jaakkola and Watt, 2011) confirmed the preference of using reproduction-based teaching styles in practice.

So far, there has been little research on preservice PE teachers' experiences with, and perceptions of, the spectrum of teaching styles. For example, the findings of a study conducted in the UK revealed that preservice teachers tend to implement the reproduction teaching styles more frequently than the production teaching styles (Parker and Curtner-Smith, 2012). Similarly, the findings of another study (Syrmpas and Digelidis, 2014) revealed that preservice PE teachers found teaching styles from the reproduction cluster to be more beneficial to students, and thus the students reported that they were willing to implement styles from the reproduction cluster more than the production cluster. However, more research that examines preservice PE teachers' perceptions and knowledge about teaching styles is needed. This study aspires to address this gap by studying Greek preservice PE teachers' conception of teaching styles.

The Greek PE curriculum

In Greece, the current PE framework (HMERA, 2006) champions lifelong physical activity promotion and healthy lifestyle adoption through the implementation of self-regulation techniques and the development of life skills (Goudas et al., 2006). This most recent Greek PE framework demands the adoption of a wide array of teaching styles from both the production and reproduction clusters, which have been incorporated into the reformed teacher education programmes along with student textbooks to help attain the multidimensional curricular goals (motor, cognitive, moral, social and affective goals) (Digelidis et al., 2006).

Theoretical framework

The framework theory of conceptual change (FTCC). The FTCC as one of the prominent theories for conceptual change and learning, serves as the theoretical framework for this study. The FTCC has been used in various educational contexts such as astronomy (Vosniadou et al., 2004), mathematics (Christou et al., 2007), physics (Stathopoulou and Vosniadou, 2007), biology (Hatano and Inagaki, 2003) and PE (Pasco and Ennis, 2015a, 2015b). The FTCC is an applicable theory that can help us better understand how preservice PE teachers learn. It is important to explore preservice teachers' initial beliefs about teaching in order to understand their cognitive background and its role in the learning process (Vosniadou, 2002). Vosniadou (2007a) describes the learning process as a knowledge acquisition process in which the learner plays an active role. According to this approach, learning takes place through the evolvement of mental models. Mental models act as the mediating mechanisms underlying knowledge development and/or modification. Duit and Treagust (2003: 1) described the FTCC as 'a powerful framework for improving science teaching and

learning', but this framework has not yet been applied to examine PE preservice teachers knowledge of teaching styles. The FTCC is a useful theory for exploring learners' prior beliefs (Vosniadou, 1994), and depicting learners' initial attempts to understand and analyse information related to a specific phenomenon in their social and cultural context (Vosniadou and Brewer, 1994). This initial attempt to decipher the structure and function of the world is the foundation on which learners process any new information they receive from their surroundings. Vosniadou (2013) argued that learning from the perspective of FTCC is a gradual, slow and longitudinal process and a learner's knowledge growth is largely subject to the influences of personal, social, cultural and contextual factors (Vosniadou and Brewer, 1987).

According to constructivist learning theories (Piaget, 1929; Vygotsky, 1978), existing knowledge plays an important role in a learner's attempt to understand and give rational explanations about new information or problems to solve. In their attempt to explain an unfamiliar situation or to solve a problem, learners are likely to create naive theories.

Initial learners' attempt, mainly during their infancy, to give explanations about a specific physical phenomenon and form domain-specific structures based on their subjective feelings and the information received from contextual factors, which are also called presuppositions (Vosniadou, 1994). Framework theories such as FTCC discuss a learner's ontological and epistemological presuppositions. Ontological presuppositions comprise learners' assumptions about the nature and concepts of a specific phenomenon within a specific domain (Chinn and Brewer, 1993), whereas epistemological presuppositions comprise the learner's assumptions about the nature or the development of concepts and their attempt to give rational explanations about the nature of their knowledge within a specific domain (Vosniadou and Ioannides, 1998). Presuppositions are embedded within naive theories. Naive theories are often contradictory to the scientific knowledge (Vosniadou, 1994).

Teachers can affect students' knowledge construction by creating an attractive learning environment that provides students with opportunities to actively participate in the learning process and helps them to be aware of the inconsistency between their naive theories and the scientific theories. In fact, teachers should utilize instructional strategies to promote a learning environment that enables students not only to reconstruct their naive theories to be more scientific, but also to better understand their way of learning. The interaction between all the members of the class or those participating in a group is likely to lead them to develop rational explanations for a given problem (Vosniadou, 2007a).

Specific Theory

Specific theory refers to learners' beliefs with which they describe the properties or the behaviour they attribute to a specific phenomenon (Vosniadou and Ioannides, 1998). Specific theory is formed either through the observation of the world or through the cultural information that learners receive during daily life. Specific theory is embedded within the framework theory (Vosniadou, 2002). In the case that learners have to revise their framework theory, then specific theory is constrained by the framework theory because presuppositions are relatively coherent since they are confirmed every day through observations (Vosniadou, 1994).

Mental models

Mental models are structures of the learners' specific knowledge used to understand, analyse and represent the structure and function of the world (Brewer, 1987). Learners construct mental models automatically or by retrieving information from their long-term memory when they have to solve a

problem or to give rational explanations for a specific phenomenon. A learner is likely to make use of mental models in order to enrich or modify his/her existing knowledge base that is related to a specific phenomenon (Vosniadou, 2001).

Vosniadou (1994) suggested that three types of mental models exist: initial or intuitive; synthetic; and scientific mental models. Initial or intuitive models are formed mainly during childhood and reflect children's cognitive attempt to understand phenomena observed in their social and cultural surroundings. The initial or intuitive model is the simplest type of mental model and refers to learners' initial attempt to understand a specific phenomenon, which most of the time is in contrast with the prevailing scientific concept (Vosniadou and Brewer, 1994). The initial mental models are generated from learners' previous knowledge. More specifically, according to constructivist learning theories existing knowledge plays an important role in learners' attempts to understand and give rational explanations about new information or problems (Vosniadou, 1994). Synthetic mental models are developed during the learning process and reflect learners' attempts to reform or restructure their existing knowledge, which most of the time it is in contrast with new information received from the teacher (Vosniadou, 1996). Vosniadou (1994; 2012), stressed that synthetic models are formed as a result of discrepancies between learners' perceptions and scientific theory; this is known as learners' lack of metaconceptual awareness. The product of this process may still be contradictory to or inconsistent with scientific knowledge and beliefs, but is a coherent and valuable transition state during the learning process (Vosniadou, 2012). The scientific mental model refers to further evolution of the synthetic mental model and reflects learners' cognitive ability to fully understand complex and abstract concepts. The scientific mental model forms a cognitive framework that is consistent with the prevailing scientific view (Vosniadou, 1994).

Types of conceptual change

According to FTCC (Vosniadou, 1994), learning takes place in the form of enrichment or reconstruction. Enrichment is the process where learners incorporate new information to their prior knowledge. Fragmentation and misconceptions are frequent outcomes of the enrichment process. Fragmentation refers to the process where new information is added to learners' existing framework theory and misconception refers to the process where the learner distorts new information in their attempt to seek coherence between the new information and their existing framework theory (Vosniadou and Skopeliti, 2014). However, misconceptions could be perceived as learners' productive process to understand new information. When new knowledge contradicts old knowledge, a reconstruction of the existing knowledge base is needed in order to learn further (Vosniadou, 2012). This reconstruction can be weak or radical. In the weak restructuring process, learners must do more than just adding new knowledge to their knowledge base. Learning requires a conceptual reorganization of students' knowledge base (i.e. repositioning concepts, and building new links or relationships between concepts). Finally, in the radical restructuring process, learners must change their knowledge structures to be able to accomplish higher and more complex levels of understanding (Alexander, 2006).

Using FTCC to explore preservice PE teachers' beliefs about teaching styles could help scholars to better understand the learning process in teaching PE. Such inquiries may guide teacher educators to help preservice teachers by providing them with new information related to their naive theories and facilitate conceptual changes. According to Vosniadou (1994), teachers should help students to understand their naive theories based on the generation of mental models. Therefore, teacher educators' knowledge about preservice teachers' naive theories could generate important feedback to better train PE teachers. Through subsequent socialization experiences during the

learning process with preservice PE teachers, teacher educators could help them reconcile the discrepancies between misconceptions and scientific mental models (Vosniadou, 2007b). Finally, the revelation of preservice PE teachers' mental models can help scholars to understand the social or contextual factors that facilitate or constrain the learning process. The purpose of the present study was to explore preservice PE teachers' presuppositions, beliefs and mental models related to the production and the reproduction teaching styles.

Methodology

Participants

Participants were 16 preservice PE teachers (male: $n = 10$, female: $n = 6$) randomly selected from a pool of 90 second year students of a four-year PE teacher education (PETE) programme (age: mean = 20.31, standard deviation = 0.87) in a Greek University. Based on the PETE curriculum, second year students were selected because they have not been formally exposed to the reproduction or production teaching styles. However, they have been introduced to concepts (i.e. motivation and autonomy) that may help them to form synthetic mental models about teaching styles. All preservice PE teachers were fully informed of the nature of the study and provided written consent to participate. The study was conducted with the approval of the University Ethics Committee.

Data collection

An interview guide was designed to explore the preservice PE teachers' experiences with, and beliefs about, the production and the reproduction teaching styles. Following Patton's (2002) recommendations, the semi-structured individual interviews consisted of questions concerning the participants' background, experience, knowledge and attitudes related to teaching styles and methods.

The interviewer was a trained PhD student and the interviews took place at the university facilities during the participants' third semester of study. The interviewer had previously attended courses for qualitative studies and conducted three studies that involved formal interviews for data collection. Each preservice PE teacher was individually interviewed one time, lasting 25–30 min per interview session. The interviews were conducted in Greek and subsequently translated into English. All interview conversations were audio-recorded and subsequently transcribed by the lead researcher for data analysis. The interview protocol was designed around the spectrum of teaching styles theory as well as the characteristics of each teaching style. The interview guide also included a short thread of background questions (e.g. sporting background, experience with teaching styles during schooling, coaching or teaching encounters etc.), followed by short scenarios of the practice teaching style (reproduction cluster) and the guided discovery teaching style (production cluster). Findings of previous studies suggested that practice and guided discovery teaching styles are among the most used teaching styles by Greek PE teachers (Syrmpas and Digelidis, 2014). Therefore, the researchers chose those two teaching styles in order to probe preservice teachers to answer questions about teaching styles that were familiar to them. Information provided to the participants about these two teaching styles included photocopies of example lesson plans. The short scenarios of the two chosen teaching styles were adopted from Mosston and Ashworth's (2008) textbook, using a basketball drill that was presented using two different teaching styles, namely, style b and style g. Based on each scenario the preservice PE teachers were prompted to describe the roles of the teacher and students in the style b and g lessons. For example, interviewees were asked to describe the differences and similarities regarding who makes decisions and plans

the lesson, and how instructions are provided during the lesson. Additionally, they were asked to describe the source of knowledge in each of the two scenarios. Then based on the characteristics that the preservice PE teachers attributed to each teaching style, they were prompted to describe under which circumstances they would use each teaching style and why. For example, a preservice PE teacher reported that in the scenario of style b 'PE teacher plans the lesson and gives the feedback, and students reproduce the knowledge/skills for learning'. Then based on this report he was asked: 'Under what circumstances will you implement a teaching style that the PE teacher plans the lesson, gives the feedback and students reproduce the knowledge or skills?' In addition, for each of these two teaching styles, the preservice teachers were asked to report on their perceptions about class control, student motivation, autonomy, critical thinking, discipline and safety. During the interviews, participants were asked to explore the relationship between the two teaching styles and the aforementioned characteristics (i.e. class control etc.). Pseudonyms are used to represent each participant's transcribed audiotaped interview and to ensure anonymity.

Data trustworthiness

Data trustworthiness was established through the use of four strategies described by Shenton (2004): (a) random sampling; (b) adoption of well-established research methods; (c) peer review; and (d) negative case analysis. More specifically, the participants in the study were randomly recruited from the list of sophomore preservice PE teachers enrolled in the PETE programme of a Greek university. Following Patton's (2002) recommendations, open-ended questions were used to explore the preservice PE teachers' pedagogical approaches and methods in relation to their experience, knowledge and attitudes. During data analysis, two researchers served as peer reviewers to verify the themes identified by each other and to ensure good inter-coder agreement (Campbell et al., 2013). Finally, a negative case analysis was conducted to identify data that did not support the themes.

Data analysis

We utilized NVivo8 as a tool for data analysis. All documents were analysed using content analysis (LeCompte et al., 1993). Data analysis was an arduous task because teaching is by its nature a multidimensional and complex task (Graham, 2008), and perceived as an ill-defined domain since a teacher has to deliver complex concepts to various contexts (Mishra et al., 1996). Qualitative analysis procedures proposed by LeCompte et al. (1993) were adopted to identify patterns of themes representative of the participants, including a multi-level thematic analysis incorporating constant comparison and analytic deduction and induction. In addition, the data collection protocol was consistent with qualitative methodological recommendations in conceptual change research (Vosniadou et al., 2001) which explores learners' mental models. The mental models' classification was made deductively based on the congruence or incongruence with the prevailing scientific theories. Thus, the attribution of specific characteristics to the production and the reproduction teaching styles, respectively, occurred on the basis of which of the two teaching styles effectively promotes specific teaching goals.

Researchers also inductively analysed the data based on participants' quotes. For example, the researchers examined the more profound reasons that urge preservice PE teachers to implement or not implement each of the teaching styles. The researchers examined eight interviews independently and proposed themes. They subsequently compared these themes and generated a joint list of themes. Next, all of the transcribed interviews were coded and processed to propose themes. More

specifically, sequential qualitative data analyses were conducted using open and axial coding. The open coding process was conducted on all interview data to identify similarities and differences in the preservice PE teachers' responses. This process allowed the researchers to infer preservice PE teachers' mental models about teaching styles. For example, a preservice teacher reported: 'This way I can control the class better'. This quote was coded as 'students' control' and then categorized within the theme entitled 'preservice teachers' perceptions of the benefits of teaching styles'. Similarly, a preservice teacher stated: 'The implementation of this approach leads students to critical thinking. They learn not only new skills but knowledge as well . . . also this way they will develop their responsibility and thus they will behave appropriately both during a lesson and in general in their lives. Additionally, they will be friendly and willing to cooperate with peers. Finally, they will be aware of what is useful to them and make better choices in their lives . . . PE teachers should create a learning environment which helps students develop their personality in order to be responsible and active citizens in the future.' This quote was coded as 'multidimensional knowledge' and categorized under the theme entitled, 'preservice teachers' perceptions of learning approaches'.

Then, an axial coding process was conducted (Corbin and Strauss, 2015) in order to identify features that define mental models held by the preservice PE teachers. This first attempt to identify mental models was a subjective process. Therefore, a re-analysis of each preservice teacher's responses was conducted in order to ensure intra-rater reliability and confirm that the features for mental model inference were consistently identified and revealed (Vosniadou and Brewer, 1994). Then, the same two researchers examined the data and disagreements were discussed in order to reach 90% agreement. Researchers also examined if elements of the data did not support or appeared to be contradictory with the emerging themes reported in the results section. Data analysis also involved examining and screening negative cases that could reject assumptions or provide an alternative explanation for a given phenomenon.

Results

The findings revealed two mental models of the reproduction and the production teaching styles: an initial mental model; and a synthetic mental model. The two mental models were generated under the constraints of ontological presuppositions and beliefs about teaching and learning. Mental models were identified based on the FTCC, the spectrum of teaching styles theory and the specific criteria that were identified through data analysis. The preservice PE teachers were categorized by the two mental models based on their ontological and epistemological presuppositions and beliefs about teaching styles (Vosniadou, 1994) including: (a) beliefs about the nature of the learning process (e.g. transmissive or constructivist, and unidimensional or multidimensional); (b) beliefs about the influence of the PE teachers' authority or students' active participation in the learning process; and (c) the perceived benefits of the production and the reproduction teaching styles, respectively. Participants who held ontological presuppositions and beliefs that were in contrast with the prevailing theory were categorized as holding initial mental models. On the other hand, participants who formed misconceptions influenced by the new information that was in contrast with their existing knowledge were categorized as holding synthetic mental models. Preservice teachers who held the initial mental model ($n = 5$) may have formed their understanding of the reproduction and the production styles based on their previous sporting and schooling experiences. Preservice teachers who held the synthetic mental model ($n = 11$) may have formed their understanding of the reproduction and the production styles based on the influence of the curriculum experience received during their first year of study. Data analysis revealed a pattern between preservice teachers' beliefs

about the most effective teaching approach to promote students' learning and their intention to implement this teaching approach in the future as certified PE teachers.

Initial mental model

Five preservice PE teachers (Kostas, Yannis, Maria, Nikos and Charis) held the initial mental model of teaching styles. This initial mental model was generated under the constraint of a set of ontological presuppositions and beliefs. Preservice teachers held this mental model based upon the ontological presupposition that teachers' authority leads to student discipline, class control and effective learning which is unidimensional and transmissive.

General framework theory

Ontological presuppositions. These five preservice PE teachers, based on their prior experiences and backgrounds, perceived that a teacher's authority plays a determinant role in the learning process by ensuring students' reproduction of knowledge. For example, for the question, 'Do you believe that learning is more effective when students assimilate the knowledge that the PE teacher provides to them or when the PE teacher helps them to discover the correct answer or skill performance and why?' Kostas stated:

> Learning is a process, which should rely exclusively on PE teachers' knowledge. Teacher's authority is a determinant factor for an effective learning process . . . the lesson will flow smoothly, students will learn effectively and faster since the PE teacher plans the lesson structure.

These participants also interpreted learning as a transmissive process in which PE teachers should rely on knowledge reproduction. Furthermore, they considered that learning should focus only on the development of a specific goal (motor development). Learning was understood as unidimensional (i.e. one dimension: skill learning). In particular, Nikos stated:

> Yes, students will learn effectively, because the PE teacher has the cognitive background and he/she is trained to give all the appropriate information or to demonstrate the skill and then to give feedback to his/her students. Then students could learn the skill more effectively.

Epistemological presuppositions. These five preservice teachers established a cause–effect relationship between the implementation of the teaching styles and the learning outcomes. More specifically, all preservice teachers' responses revealed that both clusters of teaching styles lead to specific outcomes. In some cases, they attributed these outcomes to the same cluster of teaching styles. For example, all of them reported that the production cluster styles promote students' motivation, autonomy and critical thinking. They also stated that reproduction cluster styles promote students' safety and class control. In some other cases, they attributed a specific teaching/learning outcome either to the reproduction or production cluster. For example, some preservice teachers perceived the reproduction cluster to promote students' effective learning while some others perceived the production cluster to have such functionality.

Specific theory

Beliefs. Preservice PE teachers' ontological presuppositions influenced their beliefs about teaching styles and the formation of mental models. Based on the ontological presupposition that learning is

unidimensional, some of the preservice teachers in this study expressed the specific belief that learning in PE should promote skillfulness. For example, when asked, 'Can you tell me the goals of your PE lesson', Nikos stated that 'The lesson should focus on students' motor development.'

Additionally, participants who held this initial mental model believed that the reproduction approach promotes class control, students' effective learning, discipline and safety. When he replied to the question, 'In which of the following cases the PE teachers would more effectively promote students' safety? (a) when he/she chooses to be the source of knowledge and students' simply reproduce the skill/knowledge? or (b) when the teacher helps students to discover the correct answer/skill performance?' Nikos stated, 'This way I can better control the class (class control) . . . due to the fact that the lesson will be planned by me, then it is easy to predict any source of distraction or danger' (students' safety). He also reported about students' discipline: 'Students will be more disciplined and they will not make noise nor be distracted', while Charis focused on safety, stating:

> Since the lesson is planned and organized by me then it is easier to detect promptly possible sources of danger and therefore, I can take all the precautions to prevent accidents. Students should follow my instructions and they just have to perform the skills that I have planned.

Finally, Yannis's response suggests that the reproduction approach promotes student learning:

> This way the PE teacher could give feedback to his/her students. In the case where a student performs a skill, the student should evaluate his/her own performance based on the internal feedback or the feedback received from another student. But in this case the provided feedback could be incorrect since students do not have enough knowledge background.

The preservice teachers' interview responses also revealed they perceived that the production teaching styles promote students' autonomy, motivation and critical thinking. Nikos considered that the production teaching styles promote students' autonomy:

> By providing students with opportunities for active participation they will feel more willing to participate in the learning process . . . this will not only help to develop their personality but they could be able to control better their life in the future.

Maria stated that the production approach is also a way to increase students' motivation. More specifically, she reported, 'In the case that students feel that their opinion counts and their PE teacher trusts them, they will participate more actively in the learning process.' Charis perceived that the production approach promotes students' critical thinking:

> A PE teacher should prompt his/her students to discover answers to a given problem by posing questions. Only through this process will they learn effectively.

However, one of the above preservice teachers (Nikos) stated that:

> Through the teacher's instruction students should discover the answer/learn the skill . . . when you help them reproduce your own movements or knowledge, which you have taught and studied. Then they will learn to do it right through repeating this movement or to find the correct answer.

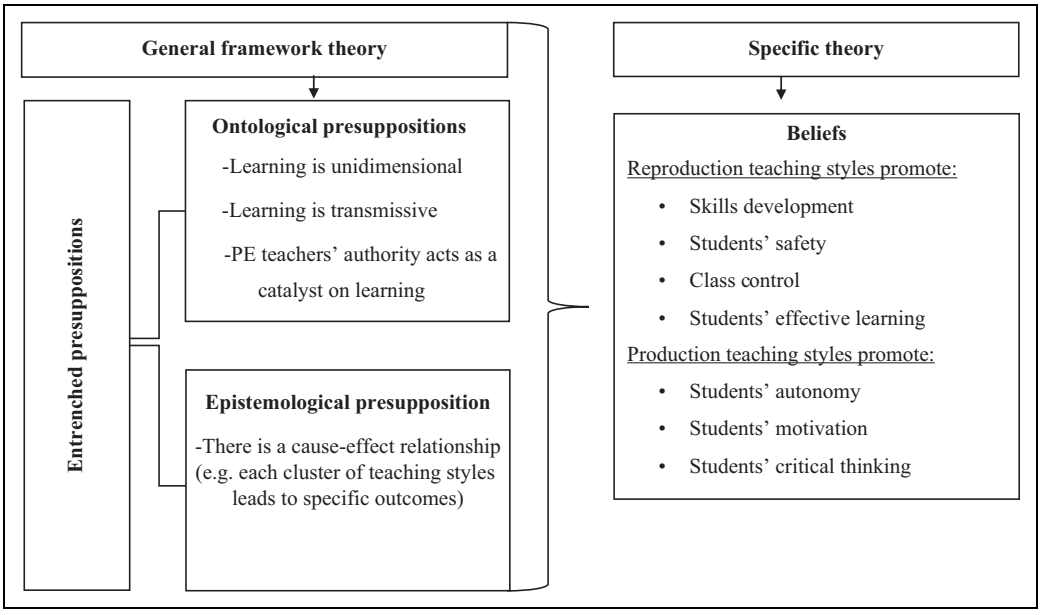

Figure 1. Hypothetical conceptual structure underlying preservice teachers' initial mental model of reproduction and production teaching styles.

It appears that this preservice teacher held the naive belief that teachers' authority could promote students' critical thinking. This belief was characterized as naive because, according to prevailing constructivist theory, critical thinking could be achieved through teachers' mediation and learners' active participation in the learning process (Bonnette et al., 2001; McBride et al., 1990). Only one participant was questioning his beliefs. However, he did not embrace the alternative belief of what he initially held and as a consequence he reported that he did not intend to adopt an alternative teaching approach. More specifically, Kostas, in the first part of his interview stated, 'learning is more effective when the PE teacher is the source of the knowledge', then later in the interview reported that 'The production approach helps students learn more effectively', and immediately following this stated that 'this is in contrast with my prior statement'. The participant then followed up with the statement that he prefers the reproduction approach because 'I am not sure that this teaching method works (production style) but if it works I would love to see it'. This preservice teacher constituted a negative case framework to serve as a focus for comparison of both theory and practice. Kostas reported that he is a skiing teacher. Although he questioned his beliefs, his previous experiences with a sport in which safety is of great concern may have urged him to reject the adoption of an alternative perspective. The hypothesized conceptual structure underlying students' initial mental model of the production and the reproduction teaching styles is described in Figure 1.

Synthetic mental model

Eleven of the preservice PE teachers (Yorgos, Stratos, Margarita, Christos, Sakis, Ntina, Nike, Thomas, Mary, Dimitris and Elena) were categorized within the synthetic mental model, which was generated under the constraint of a set of ontological presuppositions and beliefs. The preservice PE teachers who held this mental model generated the presuppositions that students play an

active role in the learning process and the production teaching styles promote student autonomy, motivation and responsibility, factors that lead to effective learning, which is multidimensional and constructivist.

General framework theory

Ontological presuppositions. The preservice teachers who held this synthetic mental model interpreted teaching as a constructivist process in which the teacher acts as mediator of students' knowledge while students play an active role in the learning process. More specifically, Dimitris stated, 'Learning is effective when the PE teacher gives information, poses a question and then urges students to discover the answer. The PE teacher should stimulate his/her students through questions to discover the answer'. Unlike those holding the initial mental model, these preservice PE teachers understood learning as multidimensional. For example, Thomas reported:

> The implementation of this approach leads students to critical thinking. They learn not only new skills but knowledge as well . . . also this way they will develop their responsibility and thus they will behave appropriately not only during a lesson but in general in their life. Additionally, they will be friendly and willing to cooperate with peers. Finally, they will be aware of what is useful to them and thus they will make better choices in their life . . . PE teachers should create a learning environment which helps students develop their personality in order to be responsible and active citizens in the future.

Epistemological presuppositions. The preservice teachers who were categorized within this mental model held similar epistemological presuppositions as the preservice teachers within the previous model. They perceived that there is a cause–effect relationship between the implementation of the teaching styles and the learning outcomes.

Specific theory

Beliefs. The preservice teachers with the synthetic mental model of teaching styles have constructed a general framework that differentiates themselves from those who held the initial mental model. However, they attributed common and different characteristics to the production and the reproduction teaching styles compared to preservice teachers who held the initial mental model.

The preservice PE teachers holding the synthetic mental model shared common beliefs with preservice teachers categorized within the initial mental model. More specifically, they also perceived that the production teaching styles promote students' critical thinking, autonomy and motivation. For example, Dimitris stated that critical thinking could be promoted 'In the case that the PE teacher creates a learning environment where students try to discover a solution and develop critical thinking through their interaction with their teacher'. Additionally, Yorgos proposed, 'A person with critical thinking will be an active citizen in the future'. In terms of the development of autonomy, Margarita stated '[on] his way (through the production approach) the PE teacher allows his/her students to actively participate in the learning process'. In support of this, Yorgos stated that the production approach promotes 'Students' initiation, autonomy and expression of opinions . . . which in turn helps students to be active persons and active citizens in the future'. Furthermore, Elena reported, 'I will implement this approach (production) because in my point of view it promotes students' motivation . . . . a motivated student actively participates in the learning process and learns effectively' (motivation).

They also reported that the reproduction teaching styles ensure class control and students' safety. For example, Elena mentioned about students' safety:

> A lesson delivered by the PE teacher is organized and so the site in which students exercise is prescribed, so the PE teacher has considered any possible source of danger. When students are afforded an active role in the learning process and PE teachers' instructions and guidance are limited, it is likely that accidents may happen.

Ntina similarly reported, 'The reproduction teaching styles ensure class control. ... When the PE teacher controls the class, the context is safe. Otherwise, it may lurk unexpected incidents or accidents' (class control and students' safety).

However, it appears that the preservice teachers holding the synthetic mental model, through the enrichment process, added new information to their existing framework and ascribed different characteristics to the aforementioned styles. More specifically, these preservice teachers perceived that the production approach promotes students' effectiveness of learning, satisfaction, responsibility and discipline. For example, when asked the question, 'In which way will you promote your students' effective learning?' Stratos stressed that:

> Learning is more effective when the PE teacher facilitates his/her students to discover the mistake because it is easier for them to confront it and finally to perform well. However, if the PE teacher gives students the feedback, instead of letting them explore and discover solutions, it is likely that the students would not show agency and initiative.

Furthermore, the preservice teachers of this synthetic mental model valued students' responsibility in addition to the aforementioned characteristics of the production approach. More specifically, Mary stated, 'Students' active participation in the learning process and autonomy promotes their responsibility'. Additionally, Sakis perceived that 'Students' active participation in the learning process leads them to behaving responsibly'. Moreover, Nike reported about satisfaction when stating, 'This approach (production) promotes cooperation between the teacher and students who jointly make the decisions, where students enjoy the lesson'.

The preservice teachers within this mental model identified student responsibility in addition to the aforementioned characteristics of the production approach. More specifically, Stratos stated, 'Students' active participation in the learning process and autonomy promotes their responsibility and therefore their discipline too' (students' discipline).

Finally, two preservice teachers (Sakis and Thomas) considered that the production approach could promote class control. For example, Sakis reported, 'This approach (production) promotes class control because students have an active role in the learning process and thereafter they feel more responsible and they realise that their contribution is important for the lesson's effectiveness'. Although these preservice teachers held different beliefs, they were still categorized within the same synthetic mental model because they shared common general and specific frameworks. Both preservice teachers (Sakis and Thomas) added that students' responsibility promotes class control. Within this mental model, it could be assumed that preservice teachers were informed during their first year of studies about the benefits of students' autonomy, motivation and responsibility and, since this information is consistent with their prior knowledge, included these beliefs in their existing conceptual structure. Based on their assumptions, the production teaching styles encourage students to take an active role in learning where learning can be seen as a

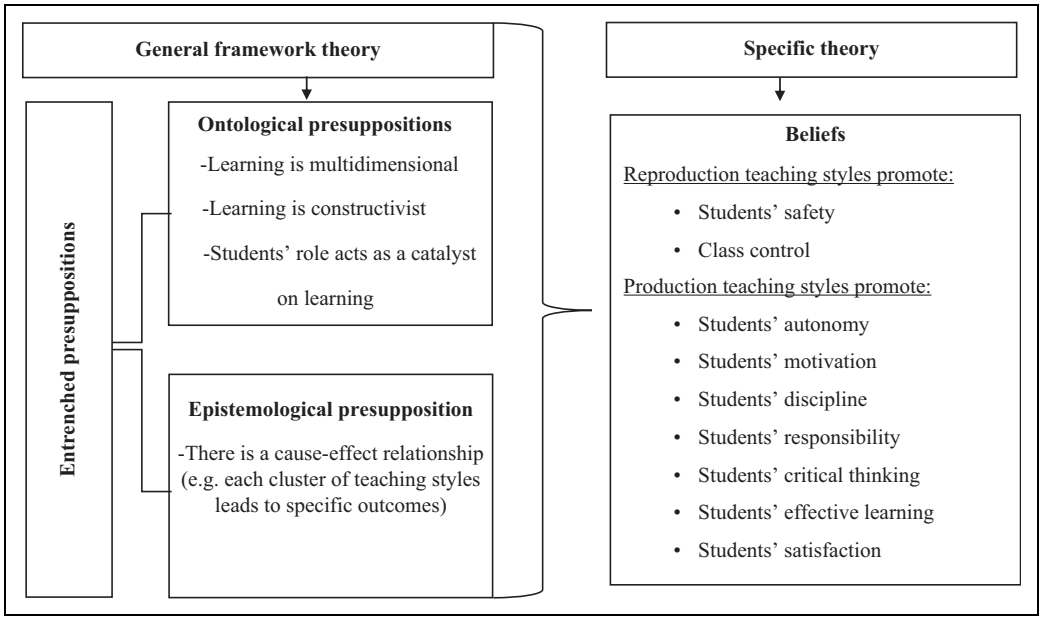

Figure 2. Hypothetical conceptual structure underlying preservice teachers' synthetic mental model of reproduction and production teaching styles.

multidimensional and constructive process. The hypothesized conceptual structure underlying students' synthetic mental model of the production and the reproduction teaching styles is described in Figure 2.

Discussion

The findings of this study revealed two mental models supported by the underlying conceptual structures. According to Vosniadou and Brewer's (1994) theoretical framework, initial mental models are formed by the influence of learners' prior experiences and are in contrast with the prevailing scientific theory. Synthetic mental models are hybrid models formed by the influence of the scientific knowledge on learners' existing knowledge. Learners usually hold misconceptions about the new information. Thus, those preservice PE teachers who linked their presuppositions to their prior experiences and beliefs were classified as belonging to the initial mental model. Those who linked their presuppositions to the information about students' motivation and autonomy during first year courses in the teacher education programme were classified as belonging to the synthetic mental model. The identification of these two mental models is consistent with previous research findings where learners held diverse presuppositions and beliefs, and therefore different mental models (Ioannides and Vosniadou, 2002).

More specifically, five preservice PE teachers who held the initial mental model formed the ontological presupposition that learning is a transmissive process. This finding is consistent with previous findings (Stylianou et al., 2013; Widodo et al., 2002) that teachers typically perceive learning as transmissive rather than a constructive process. These participants also formed the ontological presupposition that learning in the PE context should mostly focus on students' skill

development. Thus, it can be concluded that these preservice teachers held the entrenched presupposition that learning is unidimensional. However, this specific presupposition appears contradictory to the goals of the Greek PE curriculum that specifies that skill development should be the main but not the only goal when teaching PE. According to Vosniadou and Brewer (1992), learners' entrenched presuppositions could constrain the learning process. In this specific case, the preservice teachers of the initial mental model demonstrated difficulty in understanding the multidimensional structure of PE lessons. A rational explanation for this specific presupposition could be linked to their sporting background, as preservice PE teachers' prior experiences during schooling significantly influence their future teaching preferences and perceptions as teachers (Lawson, 1983; Schempp and Graber, 1992). Consequently, in this case these preservice teachers may have perceived that they should adopt similar styles and lesson goals. Vosniadou (1996) suggested that learners' initial perceptions and specific expectations influence the learning process. Furthermore, relevant research (Jenkins and Byra, 1996; Sanchez et al., 2012) supports the notion that the reproduction teaching styles are more effective in promoting motor skill development than the production approach. Arguably, these specific preservice PE teachers perceived that learning is unidimensional since the emphasis is on skill development and the reproduction teaching styles lead to this goal emphasis.

The findings of the present study are consistent with those of previous studies (Vosniadou, 1994; Vosniadou and Ioannides, 1998) in that learners are not a *tabula rasa* (void of knowledge). On the contrary, they have already formed an initial and somewhat stable perception of teaching styles before their enrolment on a teacher education programme. More specifically, the participants stated that they were not knowledgeable about or familiar with the guided discovery teaching style. Nonetheless, they had formed certain perceptions of this teaching approach mainly based on their prior experiences during schooling and their sporting background. The preservice teachers reported that they were convinced about the correctness of their beliefs. Only one participant questioned his beliefs. However, he did not embrace the alternative belief of what he initially held and as a consequence he reported that he did not intend to adopt an alternative teaching approach. The above finding confirms Vosniadou's (2002) suggestion that learners' initial perceptions are very solid due to their daily confirmation through observation and influence of personal and social factors or learners' lack of metaconceptual awareness.

One of the preservice teachers (Nikos), who was categorized within the initial mental model, formed the preconception that critical thinking could be developed through the reproduction teaching styles. The reason that the aforementioned beliefs were described as flawed is that previous research (Knight and Waxman, 1987) suggests that the reproduction approach negatively influences students' critical thinking. Goldberger and Howarth (1993) also stressed that British PE teachers should implement production teaching styles in order to meet the requirements of the national curriculum of PE which demands students to develop skills such as 'judging', 'decision making' and 'evaluating'. Teaching strategies that encourage students to explore a range of movement possibilities or to problem-solve activate their critical thinking skills (Bonnette et al., 2001; Chen and Cone, 2003). A rational explanation for this preconception could be the participant's misinterpretation of the teacher's role in the development of critical thinking. Nikos may have interpreted that the PE teacher plays a dominant role in problem-solving teaching styles because he felt that the teacher guided the class through the movement activities rather than the students discovering the activities themselves through the questions posed by the teacher.

Alternatively, the preservice teachers that have been categorized within the synthetic mental model held the presupposition that learning is multidimensional. This presupposition is in

congruence with Kirk and Macdonald's (1998) constructivist approach that can be considered as multidimensional which implies that students may learn more than one thing during each PE lesson. However, these preservice PE teachers also held misconceptions. More specifically, they considered that the multidimensional nature of learning could be achieved effectively through the production approach. These presuppositions and beliefs were contradictory to the spectrum theory, which stipulates that each teaching style meets a set of specific outcomes (Mosston and Ashworth, 2008). Most of the curricular goals (e.g. socio-moral, cognitive and affective) could be effectively promoted through the production teaching styles (Garn and Byra, 2002). However, students' skills and physical development could be better accomplished through the reproduction teaching styles (Garn and Byra, 2002; Mosston and Ashworth, 2008). Thus, it is counterintuitive to suggest that the implementation of the production approach could effectively promote each one of the reported PE lesson goals. As Goldberger and his colleagues (2012) suggested, PE teachers should implement a variety of teaching styles aiming at accomplishing the diverse goals of PE lessons. Assuming that these preservice teachers misinterpreted the effectiveness of the production teaching styles to accomplish PE lesson goals, it can be said that this finding confirms Vosniadou's (2013) suggestion that misconceptions are learners' erroneous understanding of scientific theories, which subsequently urge learners to generate synthetic mental models.

Furthermore, the ontological presuppositions held by the preservice PE teachers of the synthetic model suggest that learning is a constructive process and rely on students' active participation in the learning process. Such ontological presuppositions further influenced their belief that the production teaching styles promote student responsibility. Mosston and Ashworth (2008) suggest that changes in students' responsibility relate to the shift in decision-making that takes place when moving from reproduction to production teaching styles. However, implementation of the production teaching styles could promote students' personal and social responsibility (Watson and Clocksin, 2013). Thus, it can be concluded that these preservice teachers' beliefs are aligned with the prevailing theory that the production teaching styles promote students' responsibility (Mosston and Ashworth, 2008).

However, preservice teachers' presuppositions are likely to constrain their learning process. More specifically, their presupposition that PE teachers' authority acts as a catalyst to class control or students' safety is contradictory to their belief that students' active participation promotes their responsibility. This finding could be perceived as a misconception. The findings of a previous study (Ennis et al., 1999) suggested that a learning environment, such as the Sport for Peace curriculum with emphasis on student autonomy and active participation in the decision-making, could enhance students' responsibility and maximize safety. This specific belief is also contradictory to Hellison's (2011) suggestion that the promotion of students' responsibility could facilitate their discipline. This misconception possibly stems from the preservice teachers' lack of experiences with teaching PE lessons through the production teaching styles.

Additionally, findings of the present study confirmed Vosniadou's (1994) suggestion that learning involves the enrichment of learners' existing knowledge. More specifically, two preservice PE teachers with the synthetic mental model believed that students' active participation promotes class control. Presumably, both preservice teachers were informed about the link between autonomy and motivation in educational contexts during their first year of study of the teacher education programme and they just added class control to the benefits of the production approach. Since this information is consistent with their prior beliefs, they integrated these beliefs with their existing knowledge structures. This finding confirms Vosniadou's (2012) suggestion that synthetic mental models are formed under the influence of assimilated knowledge in the

existing structured knowledge. Learners' conceptual change through knowledge enrichment may occur, but would likely decelerate the learning process and be a source of misconceptions. Misconceptions generated during learners' attempts to synthesize and reconcile the newly received scientific information with the existing cognitive schema contribute to the evolvement of mental models. Vosniadou (1991) suggested that learners' attempt to seek mental coherence between prior beliefs and the new information in the course of learning. In the case that new information is contradictory to existing beliefs, preservice teachers tend to distort new information in order to adjust it to their beliefs and as a result, misconceptions are formed. However, students' misconceptions should not be perceived as a flawed cognitive process but rather a productive process as the learner continues to seek rational explanations for unfamiliar phenomena (Vosniadou, 1991).

Conclusion and future implications

The findings of the present study revealed that preservice teachers have already formed an initial but incomplete understanding of the production (guided discovery) and reproduction teaching styles (practice) early in their PETE. Although the participants had not been formally exposed to the spectrum of teaching styles, their presuppositions and beliefs could be used in order to enrich the curriculum. As Vosniadou (1994) suggested, the more consistent the new information is to the existing learner's knowledge the more effective is the learning. This implies that a curriculum which includes information coherent with students' existing knowledge may accelerate the learning process and help students to construct scientific mental models.

Several preservice PE teachers in this study perceived learning as a transmissive and unidimensional process where the teacher assumes a dominant role. However, most of the participants perceived that learning is a constructivist and multidimensional process. Interestingly, preservice teachers reported a preference to implement the production teaching styles although they have had no prior experiences with this teaching approach during undergraduate studies besides their experience during schooling. A rational explanation for this could be Richardson's (2003) suggestion that newly qualified teachers could hold constructivist beliefs dogmatically. However, as Fischler (1994) stressed, there could be a distance (gap) between teachers' perceptions and their teaching practices.

The findings of the present study suggest that curriculum developers should aim to motivate students to seek lifelong learning through the development of metaconceptual awareness (Vosniadou, 2003). This could be achieved through teacher educators' awareness of preservice teachers' misconceptions (Vosniadou, 2007b). Teacher educators should help their students to discover the mismatch between their beliefs concerning learning and critical thinking, and the prevailing scientific theory (Vosniadou, 1991). Furthermore, considering that the learning process occurs in a broader social and cultural context, Vosniadou et al. (2001) suggested that teacher educators should plan lessons by providing students with learning opportunities in a context similar to the subject matter. Additionally, preservice teachers should be educated that each teaching style leads to specific outcomes and therefore they should apply the most appropriate pedagogical practice dependent upon the learning context and lesson objectives. Finally, along with the aforementioned strategies, teacher educators should enable preservice teachers to understand that motor learning development is one goal of PE, but not the sole one. PE teachers should contribute not only to students' motor skills development, but also the fulfillment of multidimensional criteria (students' cognitive, affective, social–moral and physical development) that have been established by policy-makers. Consequently, many goals of PE lessons could be achieved through the production approach but not only with this teaching approach.

The qualitative research methodology utilized in the present study enabled the researchers to conduct an in-depth examination of preservice PE teachers' perceptions about the reproduction and production teaching styles. However, the findings of the present study describe participants' specific perceptions about a particular phenomenon and cannot be generalized.

The present study was an early attempt to reveal preservice teachers' presuppositions, beliefs and mental models, which play a determinant role in their teaching choices. However, future studies should examine preservice teachers' motivation and personal traits such as self-efficacy, self-esteem and perceived control of the learning process, as these factors may influence learning. Moreover, future research should examine curriculum effectiveness on students' knowledge development by exploring preservice teachers' beliefs about the reproduction and production teaching styles throughout the duration of their studies. Finally, future research should include a broader variety of methods of data collection (e.g. including observations, and textual or visual analysis) and a greater number of participants.

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