INDUCEMENT OF COGNITIVE CONFLICT IN THE TEACHING OF GAMES TACTICS IN PHYSICAL EDUCATION

Iakovos Mastrogiannis[1]*, Panagiotis Antoniou [2] and Katerina Kasimatis[3]

[1]PhD candidate, Democritus University of Thrace, GREECE, iakomas@sch.gr

[2]Assoc. Prof. Dr., Democritus University of Thrace, GREECE, panton@phyed.duth.gr

[3]Asst. Prof. Dr., School of Higher Pedagogical and Technological Education, GREECE, kasimati@aspete.gr

*Corresponding author

Abstract

Physical Education has been -and is still- dominated by the behaviorist philosophy's technical approach to teaching and learning, which focuses on the development of technical skills in isolation from the context in which they unfold, i.e. the game situation. A growing number of scientists and researchers in the field claim that this has resulted in the inability of students to transfer the technical skills in the actual game. Moreover, it has effected reduced participation and alienation of students from physical activity. According to constructivist theory, students come to class with existing conceptions or preconceptions regarding the world around them and, if ignored by the teacher, they are simply suppressed, not eliminated. Also, learning is viewed as a process of changing student preconceptions to meet accepted conceptions in each scientific discipline or, to use the commonly accepted term, as a process of conceptual change. The inducement of cognitive conflict constitutes a commonly used instructional strategy in sciences for the achievement of conceptual changes in students' cognitive structures. A necessary prerequisite to inducing cognitive conflict is the elicitation of student preconceptions so that they are taken under consideration for the design and implementation of subsequent instructional interventions. Additionally, the constructivist philosophy's tactical approach to teaching in Physical Education, advocates a more holistic approach to learning. It incorporates the cognitive dimension into the learning and teaching of Physical Education. It focuses on the understanding of the game and on game tactics in the realistic context of game-playing, before the learning and development of the technical aspect. The aim of the present paper is to highlight the potential of using the instructional strategy of inducement of cognitive conflict between student preconceptions on game tactics and accepted conceptions in the discipline, in the context of the tactical model of teaching and learning in Physical Education.

Keywords: Cognitive conflict, Preconceptions, Physical Education, Tactical Model, Conceptual Change, Constructivism.

1. THEORETICAL FRAMEWORK

1.1. Constructivist theory and learning

The consideration of the student as the architect of his own learning stems from the Piagetian logic on learning (Driver, 1989). Piaget (1964) suggests two fundamental principles underpinning learning:

- ✓ adaptation and
- ✓ organization

Organization refers to the natural tendency of an individual to organize his conceptions into related, interconnected structures, the most basic of which is the schema. The organization of these conceptions is encountered in literature with terms such as cognitive structure (Vosniadou & Mason, 2012; Scott et al., 1991; Driver & Scanlon, 1988; Champagne et al., 1985) or conceptual framework (Hewson & Hewson, 1983) or alternative framework (Nussbaum & Novick, 1982; Driver & Easley, 1978) or mental representations or

ISBN: 978-605-64453-2-3

conceptual schemes (Driver, 1989) or merely conceptions (Hewson & Hewson, 1983) or representations (Limon, 2001).

Adaptation refers to the inherent need of an individual to maintain a state of cognitive balance or, according to Piaget's own term, a state of equilibration. When a student recognizes a contradiction between his existing conceptions (preconceptions) and new knowledge and realizes his inability to resolve it based on his existing knowledge, he attempts to reduce the discrepancy through the mechanisms of assimilation and accommodation. In other words, the awareness of this contradiction (conflict) constitutes a motivating factor for resolving it (Chi, 2008; Nussbaum & Novick, 1982; Posner et al., 1982; Stavy & Berkovitz, 1980). In literature, it is referred to with terms such as disequilibrium (Piaget, 1964), cognitive dissonance (Festinger, 1957) and more recently with the most common terms of conceptual conflict (Hewson & Hewson, 1984) or cognitive conflict (Lee & Kwon, 2001; Limón, 2001).

1.1.1 The Learning Process of Conceptual Change and Student Preconceptions

The constructivist learning theory -in contrast to the behaviorist learning theory that views learning as a fragmentary accretion of new knowledge- views learning as a process of changing student conceptions or, to use the commonly accepted term, as a process of conceptual change (Scott et al., 1991; White & Gunstone, 1989; Hewson & Hewson, 1984; Hewson & Hewson, 1983). There are two forms of conceptual change (Posner, Strike, Hewson, & Gertzog, 1982):

A. Assimilation: Students address a new situation using existing conceptions, incorporating new conceptions into their existing cognitive structure. It is the mildest form of conceptual change and is relatively easily accomplished.

B. Accommodation: Students' preconceptions are not adequate enough to allow them address new situations. Students must either reorganize their preconceptions or replace them with new ones. It is the most radical -and relatively hard to accomplish- form of conceptual change.

Another fundamental constructivist principle opposing to behaviorist consideration of students as tabula rasa, is that students come to class with already formed preconceptions regarding the world around them (Duit et al., 2008; Limón, 2001). This entails serious implications to learning due to the enormous explanatory power they provide to students (Driver, 1989; Posner, Strike, Hewson, & Gertzog, 1982). Hence, these preconceptions resist strongly to attempted changes (White & Gunstone, 2008; Windschitl & Andre, 1998; Driver, 1989; Hewson & Thorley, 1989; Champagne et al., 1982) and constitute the supportive framework upon which all future learning is based (Millar, 1989; Driver, 1989; Driver & Scanlon, 1988). According to Komis (2001), if they are ignored by the teacher, they are simply suppressed, not eliminated.

For conceptual change to be accomplished, preconceptions held by students have to be elicited and taken under consideration before any instructional intervention (Duit et al., 2008; Scott et al., 1991; Hewson & Hewson, 1984). Indeed, knowledge of student preconceptions provide significant information on their existing cognitive structure and facilitates the design of more efficient interventions (LimónC:\Users\USER07\APΘPA\constructivism\COGNITIVE CONFLICT\On the cognitive conflict as an instructional strategy for conceptual change-a critical appraisal-Table 1.doc, 2001; Kokkotas, 1998). Moreover, recruiting typical instructional strategies, i.e. ignoring student preconceptions, entails the risk of students perceiving scientific conceptions as irrational (Hewson & Hewson, 1983). Nevertheless, even though the research community has provided ample evidence, there has been inadequate diffusion into the teacher community thus far and, as a result, conceptual change instructional strategies are scarcely practiced in school (Vosniadou & Mason, 2012).

A fortunate finding -of significance to learning and instructional design- is that of the commonality student preconceptions exhibit in several science content areas and across students belonging to different nationalities and cultures (Tan et al., 2008; Cetin, 2007; Goh, Khoo & Chia, 1993; Driver, 1989; Vosniadou & Brewer, 1987; Champagne et al., 1982).

1.1.2 Inducing cognitive conflict for conceptual change

The instructional strategy of cognitive conflict has been used in large scale, mainly in sciences, since the 1980s. Since, a significant amount of research on its impact was triggered (Tsai & Chang, 2005; LimónC:\Users\USER07\APΘPA\constructivism\COGNITIVE CONFLICT\On the cognitive conflict as an instructional strategy for conceptual change-a critical appraisal-Table 1.doc, 2001; Nussbaum & Novick, 1982; Stavy & Berkovitz, 1980) and cognitive conflict is recognized as fundamental in achieving conceptual change (Vosniadou & Mason, 2012; LimónC:\Users\USER07\APΘPA\constructivism\COGNITIVE CONFLICT\On the

ISBN: 978-605-64453-2-3

cognitive conflict as an instructional strategy for conceptual change-a critical appraisal-Table 1.doc, 2001; Chan et al., 1997; Posner, Strike, Hewson, & Gertzog, 1982).

A prerequisite, and a decisive factor for the successful inducement of cognitive conflict, is considered to be the elicitation and in-depth knowledge of student preconceptions before each attempted teaching intervention (Duit et al., 2008; Limón, C:\Users\USER07\APΘPA\constructivism\COGNITIVE CONFLICT\On the cognitive conflict as an instructional strategy for conceptual change-a critical appraisal-Table 1.doc2001; Scott et al., 1991; Scott et al., 1987). Being aware of student preconceptions, the teacher has set the foundations for the planning of teaching approaches that formulate favorable conditions for inducing cognitive conflict. This involves the design of appropriate learning activities on the basis of their potential to provide opportunities for students to, initially, activate and then challenge and directly question their preconceptions (Limón, C:\Users\USER07\APΘPA\constructivism\COGNITIVE CONFLICT\On the cognitive conflict as an instructional strategy for conceptual change-a critical appraisal-Table 1.doc2001; Scott et al., 1991; Shuell, 1987).

Nevertheless, the inducement of cognitive conflict is not always a simple affair. Every instructional approach based on cognitive conflict involves the element of potential conflict, in the sense of its recognition by the student (Vosniadou & Mason, 2012; Scott et al., 1991). Researchers (Lee et al., 2003; White & Gunstone, 1989) insist that students do not abandon their preconceptions simply because the teacher, somehow, informed them of the accepted conceptions in a scientific discipline. Student preconceptions have been adopted by students as functional in specific contexts, meaning that they provide students with the potential of interpreting experience.

1.1.3 Conditions for conceptual change

How does cognitive conflict, though, affect the learning process? When a student recognizes a cognitive conflict, this recognition motivates him to resolve the conflict either by trying to reorganize the existing conceptions or by seeking new information (Biggs, 1990; Keller, 1987; Posner, Strike, Hewson, & Gertzog, 1982; Piaget, 1967).

According to the conceptual change model of Hewson (1981) and Posner, Strike, Hewson and Gertzog (1982), to effect conceptual change, a new conception should, in most cases, satisfy three conditions:

I. It has to be **intelligible**. Teachers spend most of their time in making new conceptions intelligible to students. A student will not adopt a new conception unless it is considered as intelligible, i.e. the student must understand what the conception means. Scott et al. (1991), in a review of relevant literature on pedagogical strategies based on the inducement of cognitive conflict, argue that such strategies can be effective because viable alternative solutions (new conceptions) originate from students themselves and become understood as a result of discussion and inquiry among students.

II. It has to be **plausible**. For a new conception to be considered as plausible, i.e. believable, the student has to consider it as intelligible and, in addition, believe that it is potentially true. This means that it must be compatible with his preconceptions. Therefore, the investigation of student preconceptions should precede the inducement of cognitive conflict so that teachers have an understanding of what would -more likely- seem plausible or implausible to students and then adjust instructional interventions accordingly.

III. It has to be fruitful. A new concept is considered to be fruitful, i.e. fertile, useful, if it provides students the capability to resolve hitherto unsolved problems. In other words, if it accomplishes something of value to the student, if it introduces new directions, provides new possibilities, new approaches and ideas.

In conclusion, for a new conception to be adopted against an existing one and conceptual change to occur in a student's cognitive structure, initially the student has to experience dissatisfaction with the existing conception, i.e. to experience a conflict between the existing and the new conception. If the new conception is intelligible, initially plausible and provides greater explanatory and predictive capabilities, then favorable conditions have been formed for the displacement of the existing conception. These conditions determine the status of a conception. The degree to which a conception meets these three conditions (intelligible, plausible and fruitful) establishes its status (Cakir, 2008; Hewson, 1981). The more of these conditions are met the higher the status of the conception. The conditions that shape the status of a conception are applicable to both conceptions already held by the student and those under consideration. Therefore, during the learning process of inducing cognitive conflict, effort should be directed towards maximizing the status of a new conception while minimizing the status of the existing conception to facilitate conceptual change. According to the

ISBN: 978-605-64453-2-3

conceptual change model of Hewson and Posner et al., employing problematic situations that highlight the explanatory inability of student preconceptions and reducing their status, can greatly assist the adoption of a new conception, provided that the student recognizes the problematic situation (cognitive conflict).

1.2. From the Technical to the Tactical Approach of teaching in Physical Education

Current everyday practice indicates that games occupy the majority of the time in Physical Education classes (Webb & Pearson, 2008; Brooker, Kirk, Braiuka, & Bransgrove, 2001; Rink, French, & Tseerdsma, 1996). Yet, the focus lies on activities for the learning of technical elements (Light, 2008; Kirk & MacPhail, 2002; Turner, 1996; Thorpe & Bunker, 1989), following the behaviorist philosophy's technical approach to teaching and learning in Physical Education (Light, 2008). Practicing technical skills isolated from the context in which they unfold, i.e. in the game situation, results in a "coaching" approach (Light, 2008, p. 23) to teaching games at school and an inability to transfer these skills in the actual game (Adam, 2013; Hopper, 2002; Kirk & MacPhail, 2002; Brooker, Kirk, Braiuka, & Bransgrove, 2001; Turner, 1996). Alarming as this may be, though; most disquieting is the fact that the technical approach has effected reduced participation and alienation of students from physical activity (Webb & Pearson, 2008; Graham, 1995) and marginalization of low-skilled students of both sexes (Adam, 2013; Ennis, 1999).

Physical Education has been affected by a generalized shift in the international research community, since the late 1980s, towards constructivist approaches to learning. Bunker and Thorpe (1982) were the first to propose the teaching model of TGfU (Teaching Games for Understanding), which encapsulates the principles and philosophy of the tactical approach to teaching and learning in Physical Education, adhering to constructivist philosophy. Since then, several variations of the TGfU model have emerged with the terms Sport Education (Siedentop, 1994), Tactical Games (Griffin et al., 1997), Game Sense (Australian Sports Commission, 1999), Play Practice (Launder, 2001) Conceptual-based Games, Game Centred Approach, Tactical Decision Learning Model and more.

The tactical pedagogical model views learning in a holistic manner, by bringing the cognitive dimension into the forefront. Tactics, decision-making and understanding of the game take priority over the development of technical skills (Adam, 2013; Webb & Pearson, 2008; Kirk, 2005; Kirk & MacPhail , 2002; Rink, 2001). In doing so, it involves students in modified games or the real game -depending on students' developmental level- right from the start (Grehaigne, Richard, & Griffin, 2005; Kirk & MacPhail, 2002; Thorpe, 1990), integrating learning and teaching in the realistic context of game situations (Clark & Harrelson, 2002). The need for the learning and improvement of technical skills arises from the demands of real game-playing (Griffin, Brooker, & Patton, 2005; Grehaigne, Richard & Griffin, 2005; Hopper, 2002) and their practice follows the regular practices used in the technical approach (Kirk & MacPhail, 2002). The tactical approach is based on the assumption that knowledge of game tactics will improve students' decision-making abilities during game-playing, thereby improving overall performance (Brooker, Kirk, Braiuka, & Bransgrove, 2001), increasing physical activity levels and engagement (Forrest, Webb and Pearson, 2006), while making games more interesting (McKeen, Webb, & Pearson, 2007).

2. DISCUSSION AND SUGGESTIONS

As emphasized by Grehaigne, Richard and Griffin (2005), the process of teaching and learning of games is not an "all or nothing" matter, but rather a matter of defining the aspect in focus. According to a study conducted by French & Thomas (1987), the strongest distinguishing factor between children, regarding performance in beginners and expert players, is knowledge and cognitive skills rather than any physical ability. Research on the importance of cognitive processing in Physical Education (Solmon, 2006) and strategic knowledge in games (Dodds et al., 2001), have also been documented. Abernethy (1996) and Kirk and MacPhail (2002) recognize as well the importance of cognitive skills as preceding and interrelated to the execution of a movement. Nevertheless, Physical Education teachers insist on neglecting cognitive and focus on physical aspects of learning (Bell, 2005; Light & Fawns, 2003). In addition, they resist adopting student-centered approaches to a greater extent than educators in other disciplines (Light & Georgakis, 2005), while behaviorist approaches keep a strong grip on Physical Education.

The constuctivist philosophy's, student-centered tactical approach provides fertile ground that allows for the integration of the cognitive dimension of learning in the teaching of games in Physical Education, thus approaching learning and teaching in a holistic manner. In the context of the conceptual change model of Hewson and Posner et al., since the instructional strategy of inducing cognitive conflict has been proven effective in the revision of student preconceptions, it is suggested that it is used in the teaching and learning of game tactcics in Physical Education. Students, even before formal teaching takes place, hold certain preconceptions in regard to cultural forms of games -like basketball, football or volleyball- shaped through

ISBN: 978-605-64453-2-3

experience and exposure to mass media (Kirk & MacPhail, 2002). To effectively challenge student preconceptions regarding particular game tactics and to successfully induce cognitive conflict, the elicitation of these student preconceptions has to take precedence. Students should have the opportunity to clearly state their preconceptions on game tactics in the realistic context of a game.

Having acquired knowledge of student preconceptions, Physical Education teachers can identify possible misconceptions and outline the cogntive path students have to follow in the conceptual change process of adopting the accepted conceptions in the discipline. This facilitates the design of those activities that could potentially induce cognitive conflict to students, i.e. it provides a sense of what might be considered as intelligible, plausible and fruitful to students, thus increasing the chances of meeting the prerequisite conditions for conceptual change. Hense, the proposed instructional approach views learning, not as an accretion of information in students memory, but rather as a process of conceptual change and focuses on the understanding of the game before the development of technical skills.

One might argue that the whole process of eliciting student preconceptions and inducing a cognitive conflict is time-consuming and an unfeasible task to realize in a Phyical Education curriculum. On the other hand, if commonality in student misconceptions regarding particular game tactics is detected and documented (as holds true in science), that would provide a starting point and enable an informed teacher to concentrate on inducing cognitive confict. Moreover, research on cognitive coflict inducing activities for specific game tactics could lighten the burden of designing learning activities from scratch.

REFERENCE LIST

Abernethy, B. (1996). Basic concepts of motor control: Psychological perspectives. In B. Abernethy, V. Kippers, L.T. Mackinnon, R.J. Neal, & S. Hanrahan, *Biophysical foundations of human movement*, 295-311, Melbourne: Macmillan.

Adam, A. (2013).The place of team sports in senior high school. *Ekivolos, (10),* 16-21.

Australian Sports Commission. (1999). *Game Sense Cards.* Canberra: ASC.

Bell, T. (2005). The Play SMART research project: Promoting thinking through physical education. *Learning and Teaching in Action, 4(1)*, 35-40.

Biggs, J. (1990). Teaching for desired learning outcomes. In Entwistle, N. (Ed.), Handbook of educational ideas and practices (pp. 681–693). New York: Routledge.

Brooker, R., Kirk, D., Braiuka, S., & Bransgrove, A. (2001). Implementing a game sense approach to teaching junior high school basketball in a naturalistic setting. *European Physical Education Review, 6(1),* 7-26.

Bunker, D., & Thorpe, R., (1982) A model for the teaching of games in secondary schools. *Bulletin of Physical Education, 18(1)*, 5-8.

Cakir, M. (2008). Constructivist Approaches to Learning in Science and Their Implications for Science Pedagogy: A Literature Review. *International Journal of Environmental & Science Education, 3(4),* 193-206.

Cetin, G. (2007). English and Turkish pupils' understanding of decomposition. Asia-Pacific Forum on Science Learning and Teaching, vol. 8(2), Article 5. Retrieved October 23, 2014, from: http://www.ied.edu.hk/apfslt/v8_issue2/cetin/cetin2.htm.

Champagne, A. B., Klopfer, L. E., & Gunstone, R. F. (1982). Cognitive research and the design of science instruction. *Educational Psychologist, 17(1),* 31-53.

Champagne, A. B., Gunstone, R. F., & Klopfer, L. E. (1985). Effecting changes in cognitive structures among physics students. In L. West, & A. Pines, (Eds.), *Cognitive structure and conceptual change* (pp. 61-90). Orlando, FL: Academic Press.

Chan, C., Burtis, J., & Bereiter, C. (1997). Knowledge building as a mediator of conflict in conceptual change. *Cognition and Instruction, 15(1),* 1–40.

Chi, M. T. (2008). Three types of conceptual change: Belief revision, mental model transformation, and categorical shift. In S. Vosniadou (Ed.), *International handbook of research on conceptual change* (pp. 61-82). New York, NY: Routledge.

ISBN: 978-605-64453-2-3

Clark, R., & Harrelson, G. L. (2002). Designing Instruction That Supports Cognitive Learning Processes. *Journal of Athletic Training, 37(4 suppl)*, 152-159.

Dodds, P., Griffin, L., & Placek, J. H. (2001). A selected review of literature on development of learners' domain-specific knowledge. *Journal of teaching in Physical Education, 20(4)*, 301-313.

Driver, R. (1989). Students' conceptions and the learning of science. *International Journal of Science Education, 11(5),* 481 – 490.

Driver, R., & Easley, J. (1978). Pupils and paradigms: A review of literature related to concept development in adolescent science students. *Studies in Science Education, 5(1)*, 61–84.

Driver, R., & Scanlon, E. (1988). Conceptual change in science: A research programme. *Journal of Computer Assisted Learning, 5(1),* 25-36.

Duit, R., Treagust, D., & Widodo, A. (2008). Teaching Science for Conceptual Change: Theory and Practice. In S. Vosniadou (Ed), *International handbook of research on conceptual change* (pp. 61-82). New York, NY: Routledge.

Ennis, C. (1999). Creating a culturally relevant curriculum for disengaged girls. *Sport, Education and Society, 4(1)*, 31-49.

Festinger, L. (1957). *A Theory of Cognitive Dissonance*. New York: Harper and Row.

Forrest, G., Webb, P., & Pearson, P. (2006). Teaching Games for Understanding: A model for pre-service teachers. *1st Oceania International Council for Health, Physical Education, Recreation, Sport and Dance Congress*. Wellington: New Zealand.

French, K., & Thomas, G. (1987) The relation of knowledge development to children's basketball performance. *Journal of Sport Psychology, 9(1)*, 15-32.

Goh, N. K., Khoo, L. E. and Chia, L. S. (1993). Some misconceptions in chemistry: A cross cultural comparison and implications for teaching. *Australian Science Teachers Journal, 39(3)*, 65–68.

Graham, G. (1995). Physical education through students' eyes and in students' voices: Implications for teachers and researchers. *Journal of Teaching in Physical Education, 14(4)*, 478-482.

Grehaigne, J.F., Richard, J-F., & Griffin, L.L. (2005). *Teaching and learning team sports and games.* New York: RoutledgeFalmer

Griffin, L., Brooker, R., and Patton K. (2005). Working towards legitimacy: Two decades of teaching games for understanding. *Physical Education & Sport Pedagogy, 10(3)*, 213 - 223.

Griffin, L. L., Mitchell, S. A., & Oslin, J. L. (1997). *Teaching sport concepts and skills: A tactical games approach*. Champaign, EL: Human Kinetics.

Hewson, P. W. (1981). A conceptual change approach to learning science. *European Journal of Science Education, 3(4),* 383-396.

Hewson, M. G. & Hewson, P. W. (1983). Effect of instruction using students' prior knowledge and conceptual change strategies on science learning. *Journal of Research in Science Teaching, 20(8),* 731-743.

Hewson, P., W., & Hewson, M. G. A. (1984). The role of conceptual conflict in conceptual change and the design of science instruction. *Instructional Science, 13(1),* 1-13.

Hewson, P. W., & Thorley, N. R. (1989). The conditions of conceptual change in the classroom. *International Journal of Science Education, 11(5)*, 541-553.

Hopper, T. **(**2002). Teaching Games for Understanding: The Importance of Student Emphasis over Content Emphasis. *Journal of Physical Education, Recreation & Dance, 73(7),* 44-48.

Keller, J. M. (1987). Strategies for stimulating the motivation to learn. *Performance & Instruction, 26(8),* 1–7.

Kirk, D. (2005). Future prospects for teaching games for understanding. In L. Griffin & J. Butler (Eds.), Teaching games for understanding: Theory, research, and practice (pp. 213-227). Windsor: Human Kinetics.

Kirk, D. & MacPhail, A. (2002). Teaching Games for Understanding and Situated Learning: Rethinking the Bunker-Thorpe Model. *Journal of Teaching in Physical Education, 21(2)*, 177-192.

ISBN: 978-605-64453-2-3

Kokkotas, P. (1998). *Contemporary approaches to teaching science. The constructivist approach to teaching and learning.* Athens: Gutenberg.

Komis, V. (2001). *Didactics of Informatics.* Patras: Greek Open University.

Launder, G. (2001). *Play practice: The games approach to teaching and coaching sports*. Illinois: Human Kinetics.

Lee, G. & Kwon, J. (2001). What do you know about students' cognitive conflict in science classroom: A theoretical model of cognitive conflict process. Proceedings of the 2001 (January 18-21) Annual Meeting of the Association for the Education of Teachers in Science, Costa Mesa, CA, 309–325.

Lee, G., Kwon, J., Park, S., Kim, J., Kwon, H., Park, H. (2003). Development of an instrument for measuring cognitive conflict in secondary-level science classes. *Journal of Research in Science Teaching, 40(6),* 585–603.

Light, R. (2008). Complex Learning Theory - Its epistemology and its assumptions about learning: Implications for Physical Education. *Journal of Teaching in Physical Education, 27 (1)*, 21-37.

Light, R., & Fawns, R. (2003). Knowing the game: Integrating speech and action through TGfU. *Quest, 55(2)*, 161-176.

Light, R, & Georgakis, S. (2005). Integrating theory and practice in teacher education: The impact of a Game Sense unit on female pre-service primary teachers' attitudes towards teaching physical education. *Journal of Physical Education New Zealand, 38(1)*, 67–80.

Limón, M. (2001). On the cognitive conflict as an instructional strategy for conceptual change: a critical appraisal. *Learning and Instruction, 11(4-5),* 357–380.

McKeen, K., Webb, P. I. & Pearson, P. J. (2007). Promoting physical activity through teaching games for understanding in undergraduate teacher education. In J. A. Diniz (Eds.), AIESEP 2005 World Congress (pp. 251-258). Lisboa: Faculdade de Motricidade Humana.

Millar, R. (1989). *Doing Science: Images of science in science education*. Bristol, PA: Taylor & Francis.

Nussbaum, J., & Novick, S. (1982). Alternative frameworks, conceptual conflict and accommodation: toward a principled teaching strategy. *Instructional Science, 11(3),* 183-200.

Piaget, J. (1964). Development and learning. In R. Ripple & V. Rockcastle (Eds.), *Piaget rediscovered,* Ithaca: Cornell University Press, 7-19.

Piaget, J. (1967). The mental development of the child. In D. Elkind (Ed.), Six psychological studies. New York: Random House.

Posner, G. J., Strike, K. A., Hewson, P. W., & Gertzog, W. A. (1982). Accommodation of a scientific conception: Toward a theory of conceptual change. *Science Education, 66(2),* 211–227.

Rink, J. (2001). Investigating the assumptions of pedagogy. *Journal of Teaching in Physical Education, 20(2)*, 112-128.

Rink, J., French, K., & Tjeerdsma, B. (1996). Foundations for the learning and instruction of sports and games. *Journal of teaching in physical education, 15(4)*, 399-417.

Scott, P. H., Asoko, H. M., Driver, R. H. (1991). Teaching for conceptual change: A review of strategies. In Tiberghien, A., Jossem, E., & Barojas, J. (Eds.), *Connecting Research in Physics Education with Teacher Education*, published by International Commission of Physics Education. Retrieved February 26, 2008, from: http://www.physics.ohio-state.edu/~jossem/ICPE/BOOKS.html

Scott, P., Dyson, T. & Gater, S. (1987). A constructivist view of learning and teaching in science. Leeds: University of Leeds.

Shuell, T. J. (1987). Cognitive Psychology and Conceptual Change: Implications for Teaching Science. *Science Education 71(2)*, 239-250.

Siedentop, D. (1994). *Sport education: Quality PE through positive sport experiences*. Champaign, IL: Human Kinetics.

Solmon, M. A. (2006). Learner cognition. In D. Kirk, D. MacDonald, & M. O'Sullivan (Eds.). The Handbook of Physical Education (pp. 226-241). London, England: Sage.

ISBN: 978-605-64453-2-3

Stavy, R., & Berkovitz B. (1980). Cognitive conflict as a basis for teaching quantitative aspects of the concept of temperature. *Science Education, 64(5),* 679-692.

Tan, K. C. D., Taber, K. S., Liu, X., Coll, R. K., Lorenzo, M., Li, J., Goh, N. K. and Chia, L. S. (2008) 'Students' conceptions of ionisation energy: A cross-cultural study', *International Journal of Science Education*, vol. 30(2), pp. 263- 283.

Thorpe, R. (1990). New directions in games teaching. In N. Armstrong (Ed.), New directions in physical education, Vol. 1 (pp. 79-100). Leeds, UK: Human Kinetics.

Thorpe, R., & Bunker, D. (1989). A changing focus in games education. In L. Almond (Ed.), The place of physical education in schools (pp. 42-71). London: Kogan Page.

Tsai, Y. Y., & Chang, C. Y. (2005) . Learning effects of instruction guided by the confl ict map: Experimental study of learning about the causes of the seasons . *Journal of Research in Science Teaching* , *42* , 1089 – 1111.

Turner, A. (1996). Teaching for Understanding: Myth or Reality? *Journal of Physical Education, Recreation & Dance, 67(4)*, 46-51.

Vosniadou, S., & Brewer, W. F. (1987). Theories of knowledge restructuring in development. *Review of Educational Research, 57*, 51-67.

Vosniadou, S., & Mason, L. (2012). Conceptual Change Induced by Instruction: A Complex Interplay of Multiple Factors. In K. R. Harris, S. Graham, & T. Urdan, (Eds.), APA Educational Psychology Handbook (pp. 221-246). Washington DC, US: American Psychological Association.

Webb, P. & Pearson, P. (2008). An integrated approach to teaching games for understanding (TGfU). 1st Asian Pacific Sport in Education Conference (pp. 1-9). Adelaide: Flinders University.

White, R., T., & Gunstone, R., F. (1989). Metalearning and conceptual change. *International Journal of Science Education, 11(5),* 577-586.

White, R. T., & Gunstone, R. F. (2008). The conceptual change approach and the teaching of science. In S. Vosniadou (Ed.), International handbook of research on conceptual change (pp. 619-628). New York, NY: Routledge .

Windschitl, M., & Andre, T. (1998). Using Computer Simulations to Enhance Conceptual Change: The Roles of Constructivist Instruction and Student Epistemological Beliefs. *Journal of Research in Science Teaching, 35(2)*, 145-160.

ISBN: 978-605-64453-2-3