Available online at www.sciencedirect.com

ScienceDirect

Procedia - Social and Behavioral Sciences 106 (2013) 2343 – 2347

Procedia
Social and Behavioral Sciences

4th International Conference on New Horizons in Education

Science and geography teachers' conceptions regarding problem-based learning related concepts

Sofia Morgado* & Laurinda Leite

University of Minho, Campus de Gualtar, Braga, Portugal

Abstract

Teaching for Problem-Based Learning (PBL) requires big changes in teachers' usual roles. As teachers' conceptions may exert an influence on their own teaching practices, putting into practice a new and demanding teaching approach like PBL may be facilitated by teacher education. This paper presents an analysis of the evolution of 33 Science and Geography teachers' conceptions regarding PBL related concepts due to an in-service course. Results indicate that most teachers overcame their conceptions of problem and started to acknowledge the idea that using problems as a starting point for learning new ideas (as required by PBL) makes sense.

1. Theoretical framework

There are several conceptions of Problem-Based Learning (PBL), being some more student-centred and other more teacher-centred (Barrows, 1986; Hmelo-Silver, 2004). This paper assumes a conception of PBL as is a student centred teaching approach that takes problems as starting points for new learning (Lambros 2004). Thus, a problem is a task that requires an answer or a solution (Jonassen, 2004). However, it must be stressed that a problem may have no solution, or it may have one or more solutions. In any case, the problem solver should not be able to anticipate the answer nor the appropriate strategy to get it. Although problems can be used at different phases of a teaching sequence (Leite & Esteves, 2005), PBL requires them to be used at the beginning of the learning sequence, as starting point for new learning. When this is the case, problems can be brought by the

* Corresponding author. Tel.: +351 253 604 274; fax: +351 253 601 201
E-mail address: sofiamorgado@ie.uminho.pt

1877-0428 © 2013 The Authors. Published by Elsevier Ltd.
Selection and peer-review under responsibility of The Association of Science, Education and Technology-TASET, Sakarya Universitesi, Turkey.
doi:10.1016/j.sbspro.2013.12.268

students or by the teacher or they can emerge from a scenario (Lambros, 2004) prepared or selected by the teacher in such a way that it elicits questions that have to do with the concepts that teachers are supposed to teach.

Solving a problem requires efforts from the problem solver. Hence, school science problems should be or at least seem real (Azer, 2008; Jonassen, 2004; Lambros, 2004) so that students feel it is worthwhile solving it. Besides, this would promote integration of knowledge (Jonassen, 2004) which is a competence relevant from an everyday point of view. In fact, real problems are multidisciplinary in nature and they require the integrated use of knowledge and skill from several different areas of expertise. If school science problems have this characteristic, then students would both feel more prone to find out a solution for them and develop competences that are relevant for solving problems later on in their private and professional lives (Azer, 2008; Hmelo-Silver, 2004; Savin-Baden & Major, 2004). Besides, if a social constructivist perspective of learning is acknowledged, then students should work in small groups to solve the problems. This would also be important for their future life as professionals have been more and more asked to work cooperatively.

Characteristics of problems and problem-solving that were mentioned so far show that differ significantly from exercises, as the latter require rote use of conceptual knowledge and mathematical expressions, have a single solution as well as an only solving strategy (Jonassen, 2004). Although they may enable training some skills that are relevant for solving problems, if exercises are one of the most frequent type of task students are asked to perform (Fortus, Krajcik, Dershimer, Marx, & Mamlok-Naaman, 2005), then they will prevent students from developing competences that are nowadays acknowledged as key components of science education for citizenship.

Teaching for PBL requires big changes in teachers' usual roles. As a matter of fact, instead of being a "knowledge teller" (Leite & Esteves, 2012), teachers have to be knowledge building facilitators and student guides (Azer, 2008; Hmelo-Silver, 2004; Lambros, 2004). However, assuming these new apparent passive roles may make teachers feel uncomfortable; they may feel that they are not doing their job appropriately (Savin-Baden & Major, 2004; Goodnough & Cashion, 2006). Besides, research has shown that teachers do not hold clear conceptions of exercise and problem, as they use the word problem when they are referring to exercises (Freitas, Jiménez & Mellado, 2004) or they do not distinguish exercise from a problem (Sousa & Fávero, 2003; Freitas, Jiménez & Mellado, 2004). As there is some evidence that teachers' conceptions may exert an influence on their own teaching practices (Van Driel & Abell, 2010), putting into practice a new and demanding teaching approach like PBL may be facilitated by teacher education. Thus, this paper aims at analysing how Science and Geography teachers' conceptions regarding Problem-Based Learning related concepts evolve, due to an in-service course.

2. Research Methodology

Participants in the study are 33 Science (27) and Geography (six) in-service teachers, teaching in secondary schools located in the north and centre of Portugal, who volunteered to attend an in-service course on PBL. As it is usual in Portugal, even in science, most of the subjects (28) are female. The majority (26) are graduates (only) and had been in the teaching profession for more than 16 years. This means that they are well established as teachers and therefore they are an appropriate sample to studying teachers' conceptions. However, they may be more motivated towards the issue than their counterparts were.

The course, focusing on "Teaching Science and Geography through PBL", with 25 hours face-to-face work, was recognized by the Portuguese Ministry of Education as an in-service teacher education course qualifying for teacher progression in the career. The course was organized so that teachers could: reflect upon the role of problems and exercises in Science and Geography teaching; characterize Science and Geography teaching oriented towards PBL; develop teaching materials relevant for PBL; develop instruments for students' assessment. Two editions of the course were run by one of the authors of this paper together with a third colleague. Participants' final learning assessment was based on an essay individually done.

Data were collected, before and after the course, by means of a questionnaire. Open questions focusing on the concepts of exercise, problem and problem based learning were included. Data were content analysed based on *a posteriori* defined sets of categories.

3. Results and discussion

Participants in the study were questioned about the relationship between problem and exercise, before and after the course. All of them mentioned that exercise and problem are different. When teachers explained why they are different, several correct ideas were mentioned. However, a few of them did not give an explanation for that, neither before nor after the course. In addition, before the course, teachers tend to mentioned the most common characteristics (A and E) while the most unusual ones were omitted (C) or were mentioned by only one teacher (D). After the course, the percentages of teachers mentioning ideas B and C are higher than they were before. This means that some teachers gained some awareness of two distinctive characteristics of problems, one related to the obstacle it offers to the problem solver and another one related to the possible numbers of solutions. However, none of these ideas was shown by the majority of teachers that participated in the study.

Table 1. Evolution of teachers' ideas about the relationship between exercise and problem (%)

Problem (P) *versus* Exercise (E)	Before	After
A - A Problem is cognitively more broad and demanding than an Exercise	30,3	24,2
B - A Problem presents an obstacle to the problem solver; an Exercise does not	18,2	42,4
C - A Problem may have no solution or one or more solutions; an Exercise has one only solution	0,0	24,2
D - A Problem may have several solving strategies; an Exercise has only one	3,0	9,0
E - A Problem serves new knowledge learning and application; an Exercise serves training purposes	37,4	39,4
G - Do not know / No answer	12,1	9,1

All the participants in the study were also asked about what they think that PBL is. Before the course, one third either did not answer or stated that did not know what it is (F). This percentage (the highest one before the course) was reduced to a half after the course, which is an unexpected result as teachers had just finished the course were this concept was focused and arterials were prepared.

Table 2. Evolution of teachers' ideas about PBL (%)

Characteristics of a PBL approach	Before	After
A - The problem is the starting point for learning	27,3	39,4
B - Students are at the centre of the teaching and the learning processes	24,2	69,7
C - Students are responsible for their own learning	0,0	60,6
D - The teacher is a learning facilitator	6,1	30,3
E - PBL develops conceptual and procedural knowledge	9,1	15,2
F - Do not know / No answer	33,3	15,2

Before the course no teacher mentioned that "Students are responsible for their own learning" (C), but the percentage on this category increased a lot after the course (60,6%). Other categories in which the number of teachers increased a lot from before to after the course are B (24,2% → 69,7%) and D (6,1% →30,3%). This increase may mean that participants in the course understood the role and responsibility of the students in a PBL approach and that a few of them also became aware of teachers' role as a learning facilitator. However, taken together, these results suggest that it is easier for teachers to accept the change in students' role than in their own role, and therefore they are consistent with literature reviewed in the first section of this paper. In addition they may suggest that they focused more attention in people roles that in problems role as percentage in category A increased about 10% only. This may also mean that most of them resisted to the idea that problems on a theme or concept can be used before teaching them.

4. Concluding remarks

Results suggest that teachers' conceptions evolved due to the in-service course they attended. However, evolution is not too consistent with regard to the diverse categories used for the purpose of data analysis, being those representing less innovative ideas and/or those that put into question their 'comfortable' authoritative status the less mentioned. Although these results could be anticipated, they may have implications for implementing PBL oriented Science and Geography teaching. An implication of this is that teachers need support from teacher educators if they are going to put PBL into practice. It should include helping teachers in preparing teaching materials, namely problems and scenarios, and accompanying them when they are working with their students, in order to make sure that they just guide students in their problem-solving tasks, without telling them the problem answers. In fact, this support would help teachers not only to use PBL appropriately but also to develop their pedagogical content knowledge, namely with regard to teaching Science and Geography through PBL.

Acknowledgements

This research was carried out within the scope of the Research Project "Science Education for Citizenship Through Problem-Based Learning" (PTDC/CPE-CED/108197/2008), funded by FCT within the scope of the Thematic Operational Program Competitivity Factors (COMPETE) of the European Union Community Support Framework III co-funded by the European Regional Development Fund (ERDF/FEDER).

References

Azer, S. (2008). *Navigating problem-based learning*. Elsevier: Churchill Livigstone.

Barrows. H. (1986). A taxonomy of problem-based learning methods. *Medical Education*, *20*, 418-486.

Fortus, D., Krajcik, J., Dershimer, R., Marx, R. & Mamlok-Naaman, R. (2005). Design-based science and real-world problem-solving. *International Journal of Science Education*, *27(*7), 855-879.

Freitas, I., Jiménez, R. & Mellado, V. (2004). Solving physics problems: the conceptions and practice of an experienced teacher and an inexperienced teacher. Research in Science Education, 34, 113-133.

Goodnough, K. & Cashion, M. (2006). Exploring problem-based learning in the context of high school science: design and implementation issues. *School Science and Mathematics*, *106* (7), 280-295.

Hmelo-Silver, C. (2004). Problem-based learning: What and how do students learn? *Educational Psychology Review*, *16*(3), 235-266.

Jonassen, D. (2004). *Learning to solve problems: an instructional design guide.* San Francisco: Pfeiffer.

Lambros, A. (2004). *Problem-based learning in middle and high school classrooms*. Thousand Oaks: Corwin Press.

Leite, L. & Esteves, E. (2005). Ensino orientado para a Aprendizagem baseada na resolução de problemas na Licenciatura em ensino de Física e Química. In B. Silva, & L. Almeida (Eds.). *proceedings of the Congresso Galaico-Português de Psicopedagogia* (Cd-Rom) (pp.1752-1768). Braga: University of Minho.

Leite, L. & Esteves, E. (2012). Da integração dos alunos à diferenciação do ensino: o papel da aprendizagem baseada na resolução de problemas. In S. Castellar & G. Munhoz (Org.). *Conhecimentos escolares e caminhos metodológicos* (pp. 137-152). São Paulo: Xamã..

Savin-Baden, M. & Major, C. (2004). Foundations of problem-based learning. Maidenhead: Open University Press.

Sousa, C. & Fávero, M. (2003). Concepções de professores de Física sobre a resolução de problemas e o ensino da Física. *Revista Brasileira de Pesquisa em Educação em Ciências*, 3(1), 58-69.

Van Driel, J.H., & Abell, S.K. (2010). Science teacher education. In B. McGraw, P. Peterson, E. Baker, (Eds.), *International Encyclopedia of Education*, 3rd edition; Vol. 7 (pp. 712-718). Oxford: Elsevier.