

FIVE YEARS OF PCK SUMMIT, WHAT HAS ENDURED: 1. A DESCENDING HIERARCHICAL CLASSIFICATION OF THE SCIENCE PCK PUBLISHED PAPERS

Brunno Carvalho Gastaldo, Pablo Micael Castro, Paula Homem-de-Mello, Sérgio Henrique Leal
Federal University of ABC

ABSTRACT: In the science teacher educational field, the Pedagogical Content Knowledge is a prevailing construct. Nevertheless, several divergences can be found in the literature concerning its nature and ways to access/measure. In order to mitigate those differences, the PCK Summit was held in 2012 with 22 researchers, and from it a new definition of PCK and a Consensus Model emerged. However, it seems that this model was not adopted by those researchers, what brings the question of the impact of the conference in the PCK research. It was performed a lexicometric analysis of the papers published before and after using Descending Hierarchical Classification that revealed that, in fact, the discourses have changed. From our finds, the Summit solved some questions about the nature of PCK, exhausted the description of teacher practice, introduced the methodological discourse, as has amplified the use of quantitative approaches.

KEYWORD: Descending Hierarchical Classification (DHC); Lexicometric analysis; PCK Summit;

OBJECTIVES: This work is the first part of a two-part work about the impact of the PCK Summit on the PCK-Summit researchers, according to the changes in the discourse of the papers published by them before and after the encounter. In this part, it is analyzed the differences in general discourses developed before, during and after the PCK Summit. In turn, the second part will be analyzed the changes in the discourse of the research groups in specific. The point in such two-part work is to determine if any change can be observed in the discourse thought the years, and they can be pinned to the Summit.

THEORETICAL FRAMEWORK

In the Educational field little agreement is found on the key features of a good teacher (Barnhart & van Es, 2015), nevertheless some knowledge are frequently present in the literature. Grossman (1990, p. 5) showed four as the “cornerstones” of the Knowledge Base for Teaching, the Pedagogical Content Knowledge (PCK) being in the spot above all others. Since then, several models were proposed, but some divergences, as nature of PCK, components, measurement, and contexts for studying, divided the researcher (Borowski *et al.*, 2011).

The difficulties that such differences had brought led to a reunion of the PCK's major research groups, who tried to unify the field in a singular definition for PCK (Helms & Stokes, 2013). The congress-like event, called PCK Summit, was held in Colorado Springs in 2012, and gathered 22 researchers around the objective of "explore the potential of a consensus model of PCK to guide science education research [and the] identification of specific next steps [to] move the field forward" (Carlson, Stokes, Helms, Gess-Newsome, & Gardner, 2015, p. 16). As stated by the organisers, the selection of the participants focused in established academics conducting PCK research, promising newcomers, professionals working in education research and non-profit organizations (Carlson et al., 2015; Helms & Stokes, 2013). In preparation to this conference, researchers were asked to write detailed answer to a questionnaire about their PCK research program (e.g. their definition of PCK, model used, assessment tools, etc), and then to read the texts from the other participants (Helms & Stokes, 2013).

During the event, the organization committee promoted an intense debate among the participants as they were constantly put in small groups to resolve discrepancies, and then to share the conclusions with the whole group. Near to the end of the event, participants were instigated to voluntarily join one of the four interest groups that emerged from the meeting. In the last day of the event, a Consensus Model of PCK was assembled as: "PCK is the knowledge of, reasoning behind, and enactment of the teaching of particular topics in a particular way with particular students for particular reasons for enhanced student outcomes" (Garritz, 2015; Helms & Stokes, 2013)

However, after four years, researchers seem to keep investigating in their specific fields of interest, not using the Consensus Model of PCK.

METHODS

In order to verify the influence of the PCK Summit on worldwide PCK-research, we have conducted a lexicometric exploratory, descriptive, and comparative analysis of the papers published before, during and after the Summit conference.

Data collection was made using the following selected data base: Google Scholar, Research Gate, ERIC and Directory of Open Access Journals (Harzing & van der Wal, 2008). Other sources as P ersee, Scopus,  eridit, Fachportal, and Web of Science were not used as they did not present any relevant results. The main keywords were *science PCK*, and the restrictions consisted in papers written in English, peer-reviewed, having at least one author that attended the Summit, and published in the period between four years before and after the PCK Summit. The selected papers were used in full to form a corpus that was normalized from idiom variances and terminology used.

The initial corpus was divided into three sub-corpora, related to the period of the publication: before (α), during (ϵ) and after (β) the PCK Summit. Then, the analysis was performed using the IRAMUTEQ[®] software (Fallery & Montpellier-Management, 2007; Sarrica, Mingo, Mazzara, & Leone, 2016). A statistical lexicography was made from those sub-corpora and, from it we carried out a Descending Hierarchical Classification (DHC) (Costa, Reis, Sousa, Moreira, & Lamas, 2017).

To increase trustworthiness and minimize the inherent bias of the research (Kincheloe & McLaren, 2000; Rajendran, 2001), all data was analysed by two independent researchers followed by a post-hoc discussion (MacCoun & Perlmutter, 2015), also the methods and data were deposited in the Center for Open Science's Open Science Framework to assure transparency (Gastaldo & Castro, 2016; Nuzzo, 2015)

RESULTS

In order to perform the analysis, 52 papers were used: 14 from α , 25 from β , and also 13 from ϵ . They were released from the supplementary words, and after lemmatisation, remained (used/total words)

β - 4247/5645, ϵ - 613/701, and α - 1804/2873. Then the salient 10 words enabled recognition of the typical features of a class that led to tagging the discourses by its synthase semantic content, in a hermeneutical analysis (Chartier & Meuneier, 2011; Lahlou, 1996, 2012). The categorization, which is a synthetic semantic abductive inference, showed (Figure 1) that α has three different discourses (*classe*). The first, and the largest, regards the class and teacher enactment description. In the second class, the two contributing groups are the Loughran one (creator of the CoRe, and strong defender of its potential employment in developing PCK), and the group of Rebecca Schneider, this class covers the formation of the teacher, the development of PCK, and its importance on the educational field. The third, and smaller one, debates the different models of teacher professional knowledge, PCK as a main knowledge, as its components.

	<p>Lesson, student, ask, class, lecture, plan, pupil, give, work, think</p>	Class description
	<p>Teacher, science, education, learn, research, development, PCK, practice, professional, PaP-eRs</p>	Teacher's PCK development
	<p>Component, orientation, magnusson, model, PCK, KISR, map, KSU, PK, connection</p>	PCK model
	<p>Measure, test, score, rubric, achievement, multiple, item, scale, ACK, biology</p>	PCK measurement
	<p>Year, participant, program, secondary, preservice, sample, lesson, middle, education, course</p>	Longitudinal studies
	<p>PaP-eRs, CoRe, Loughran, equilibrium, KSU, Berry, Mulhall, Key, Borko, professional</p>	Portray PCK
	<p>Learn, knowledge, influence, belief, require, PK, relate, personal, general, specific</p>	Nature of PCK
	<p>Test, item, measure, score, validity, sample, physics, scale, instrument, evolution</p>	PCK measurement
	<p>CoRe, associate, student, practicum, learn, teach, skill, concept, professional, acid</p>	CoRe uses
	<p>Component, specific, topic, knowledge, discipline, understand, transformation, Shulman, Magnusson, strategy</p>	Content transformation for teaching
	<p>Curriculum, material, review, decision, educative, colleague, goal, reform, shape</p>	Curriculum
a	b	c

Fig. 1. Results from the DHC a - dendrogram; b - ten most salient words; c - semantic categorization

For the discourses developed during the Summit (ϵ), four discourses can be observed. The first class is clearly marked by quantitative expressions related to measurement of PCK, and comprises 3 research groups that had used quantitative methods and Rollnik's group¹. The second, by its turn, plunges in longitudinal studies, in which several comprehend teacher's formation courses. The following class, which is the largest, is related to the nature of PCK and, differently from the predecessors, it includes

1. Group lider (Carlson, Stokes, Helms, Gess-Newsome, & Gardner, 2015)

grain size, components, and relations with other dimensions. The last, and smallest, class concerns the portrayal of PCK, as a qualitative way of assessment.

Finally, β also presented 4 types of discourse, all them having similar size. The first is related to the way CoRe can be used; it is formed by two papers that uses CoRe to characterize the PCK, being two thirds from the most characteristic segments originated from Loughran's group which uses it for developing the PCK. The next class concerns the transformation of the subject matter to a 'teachable' form of content. In this class, three-quarter of the segments comes from Rollnick's group whose interest is exactly the transformation of content to enable learning. The third class refers to the curriculum, and all the segments are derived from only one paper of van Driel's group. The last class is, once more, related to quantitative analysis questions, which is semantically like what appeared in the Summit.

By analysing all discourses, three approaches can be recognized among them: the first is related to theoretical aspects of PCK, as models and specificity; the second covers methodological aspects, as data collect; and the third involves both aspects, then it was named mosaic, as the use of CoRe to collect data and develop PCK.

The theoretical approach appears in β (class 2 & 3) and ϵ (class 3). It is noticeable that previously to the Summit a great emphasis is given to the components of PCK and its development, whereas in the Summit the whole nature of the PCK was discussed, as well as its specificity and interconnection with other knowledges.

The methodology approach was introduced in the Summit (discourses 1 & 2) and lasts until β (class 4). Although the quantitative methodology was used in α , it is only in the Summit that it forms a distinct discourse, even influencing groups to adopt it.

The mosaic approach is present in all three moments: α - class 1; ϵ - class 4; and β - discourses 1 & 2. In α , works were descriptive, however such characteristic is less evident in ϵ : the description remains only towards teacher's knowledge and with great highlight in instrument CoRe. Nevertheless, instrument CoRe is present in a few papers in β . The β - class 2 belongs to the same approach but it has elements from all others: it uses quanti and qualitative methods (from methodological approach), and discusses specificities of PCK (from theoretical approach).

CONCLUSION

The results have shown that, although the Consensus Model has not been adopted by researchers until the present time, a maturation of the PCK construct can be noticed, and a longitudinal analysis of the changes of the discourse reflects the resolution of different issues. The characterization of the classroom is a subject that seems to be overcome, whereas the nature of the PCK lasted until the Summit, even being referred as a key feature to be resolved (Borowski et al., 2011; Carlson et al., 2015; Helms & Stokes, 2013), and such discourse does not appear since then. On the other hand, the development of PCK is a fruitful matter, which nourishes the discourses 1, 2 & 4 from ϵ . Also, the discourses found in β appears to be a consequence of the Summit: ϵ - 1 & β - 4 are semantically congruent; the β - 3 derives from the prospection made in the Summit (Carlson et al., 2015; Helms & Stokes, 2013); the β - 1 correlated to ϵ - 4; and for the β - 2, it has its roots in ϵ - 1 & 3

So, it is possible to affirm that, most likely due to the encounter of different researchers of the field, and in spite of the changes in the discourse being heavily influenced by the publishing groups, a convergence in key aspects, as the nature of the PCK, was found.

BIBLIOGRAPHY

- BARNHART, T., & VAN ES, E. (2015). Studying teacher noticing: Examining the relationship among pre-service science teachers' ability to attend, analyze and respond to student thinking. *Teaching and Teacher Education*, 45, 83-93. doi:10.1016/j.tate.2014.09.005
- BOROWSKI, A., CARLSON, J., FISCHER, H. E., HENZE, I., GESS-NEWSOME, J., KIRSCHNER, S., & VAN DRIEL, J. H. (2011). *Different models and methods to measure teachers' pedagogical content knowledge*. Paper presented at the Proceedings of the ESERA 2011 Conference: Science learning and Citizenship, Lyon, France. http://www.esera.org/media/ebook/strand13/ebook-esera2011_BOROWSKI-13.pdf
- CARLSON, J., STOKES, L., HELMS, J., GESS-NEWSOME, J., & GARDNER, A. (2015). The PCK Summit: A process and structure for challenging current ideas, provoking future work, and considering new directions *Re-examining Pedagogical Content Knowledge in Science Education* (pp. 14-27). New York: Routledge.
- CHARTIER, J.-F., & MEUNEIER, J.-G. (2011). Text Mining Methods for Social Representation Analysis in Large Corpora. *Papers on Social Representation*, 20, 37.31-37.47.
- COSTA, A. P., REIS, L. P., SOUSA, F. N. d., MOREIRA, A., & LAMAS, D. (2017). *Computer Supported Qualitative Research*. Switzerland: Springer.
- FALLERY, B., & MONTPELLIER-MANAGEMENT, C. (2007). Quatre approches pour l'analyse de données textuelles : lexicale, linguistique, cognitive, thématique [Four approaches to the analysis of textual data: lexical, linguistic, cognitive, thematic]. Paper presented at the XVI Conférence Internationale de Management Stratégique, Montreal.
- GARRITZ, A. (2015). PCK for dummies. Part 2: Personal vs Canonical PCK. *Educación Química*, 26(2), 77-80. doi:10.1016/j.eq.2015.04.001
- GASTALDO, B. C., & CASTRO, P. M. A. (2016). Impact of PCK Summit on international PCK papers. *Center for Open Science*. Retrieved from osf.io/j3wta doi:10.17605/OSF.IO/5KSM5
- GROSSMAN, P. (1990). *The making of a teacher: Teacher Knowledge and Teacher Education*. Columbia: Teachers College Press, Teachers College, Columbia University.
- HARZING, A. W. K., & VAN DER WAL, R. (2008). Google Scholar as a new source for citation analysis. *Ethics in Science and Environmental Politics*, 8, 61-73. doi:10.3354/esepp00076
- HELMS, J., & STOKES, L. (2013). A Meeting of Minds around Pedagogical Content Knowledge: Designing an International PCK Summit for Professional, Community, and Field Development. Retrieved from
- KINCHELOE, J. L., & MCLAREN, P. (2000). Rethinking critical theory and qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *Handbook of qualitative research* (2 ed., pp. 279-314). EUA: Sage.
- LAHLOU, S. (1996). A method to extract social representations from linguistic corpora. *Japanese journal of experimental social psychology*, 35(3), 278-391.
- LAHLOU, S. (2012). Text mining methods: an answer to Chartier and Meunier. *Papers on Social Representation*, 20, 38.31-38.37.
- MACCOUN, R., & PERLMUTTER, S. (2015). Hide results to seek the truth. *Nature*, 526, 187-190.
- NUZZO, R. (2015). Fooling ourselves. *Nature*, 526, 182-185.
- RAJENDRAN, N. S. (2001). *Dealing With Biases in Qualitative Research: A Balancing Act for Researchers*. Paper presented at the Qualitative Research Convention 2001: Navigating Challenges, Kuala Lumpur.
- SARRICA, M., MINGO, I., MAZZARA, B., & LEONE, G. (2016). *The effects of lemmatization on textual analysis conducted with IRaMuTeQ: results in comparison*. Paper presented at the 13ème Journées internationales d'Analyse statistique des Données Textuelles, Nice.

